MGIS and Subsurface Imaging

David Kelly

Introduction

- Active ArmyGeospatial Analyst 2009-2013
- Deployed to Afghanistan August ‘10-August ’11
  - ISR Manager
- City Blueprint of Toledo since Jan 2013
- AS Cochise Community College
  - Military Intelligence
- BA American Military University
  - Collection’s Intelligence
- intercollege Master of Professional Studies (iMPS) Penn State University (current)
  - Focus in Geospatial Intelligence & certificate GIS

CITY BluePrint
OF TOLEDO, INC.

Trimble

USRADAR INC.
SUBSURFACE IMAGING SYSTEMS

Agenda

- Mapping Technologies
- MGIS
- Ground Penetrating Radar (GPR)
- Subsurface Imaging
- Subsurface Mapping
- Critical Data
- Practical Applications
- Summary
- Conclusion

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Key Terms

- GPS
- GNSS
- Trimble Flood Light Technology
- Ground Penetrating Radar (GPR)
- Spatial Technologies
- Critical Data
- Radar
- Subsurface imaging
- Mapping technologies
- ISR
- Site Observations
- Multipath

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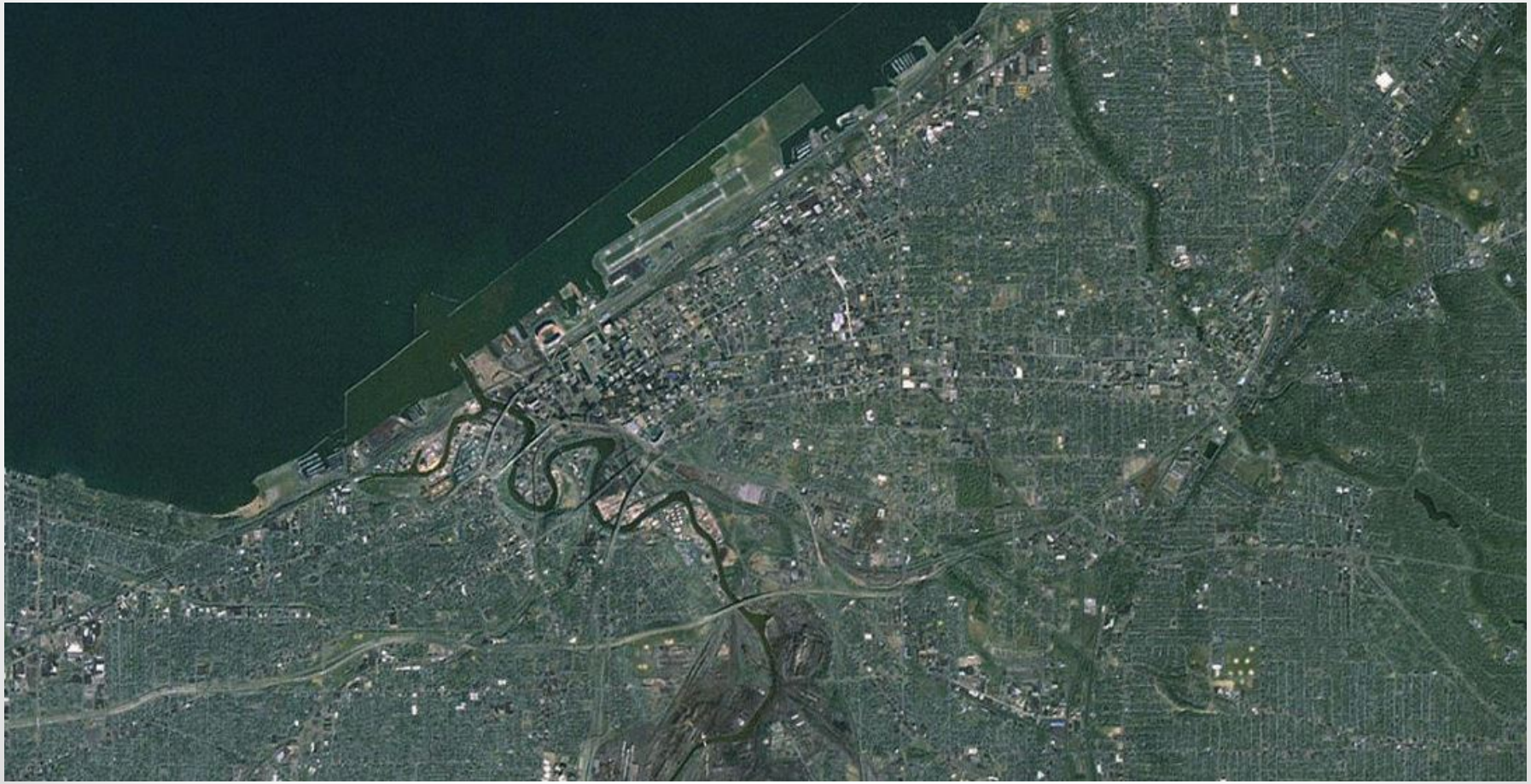
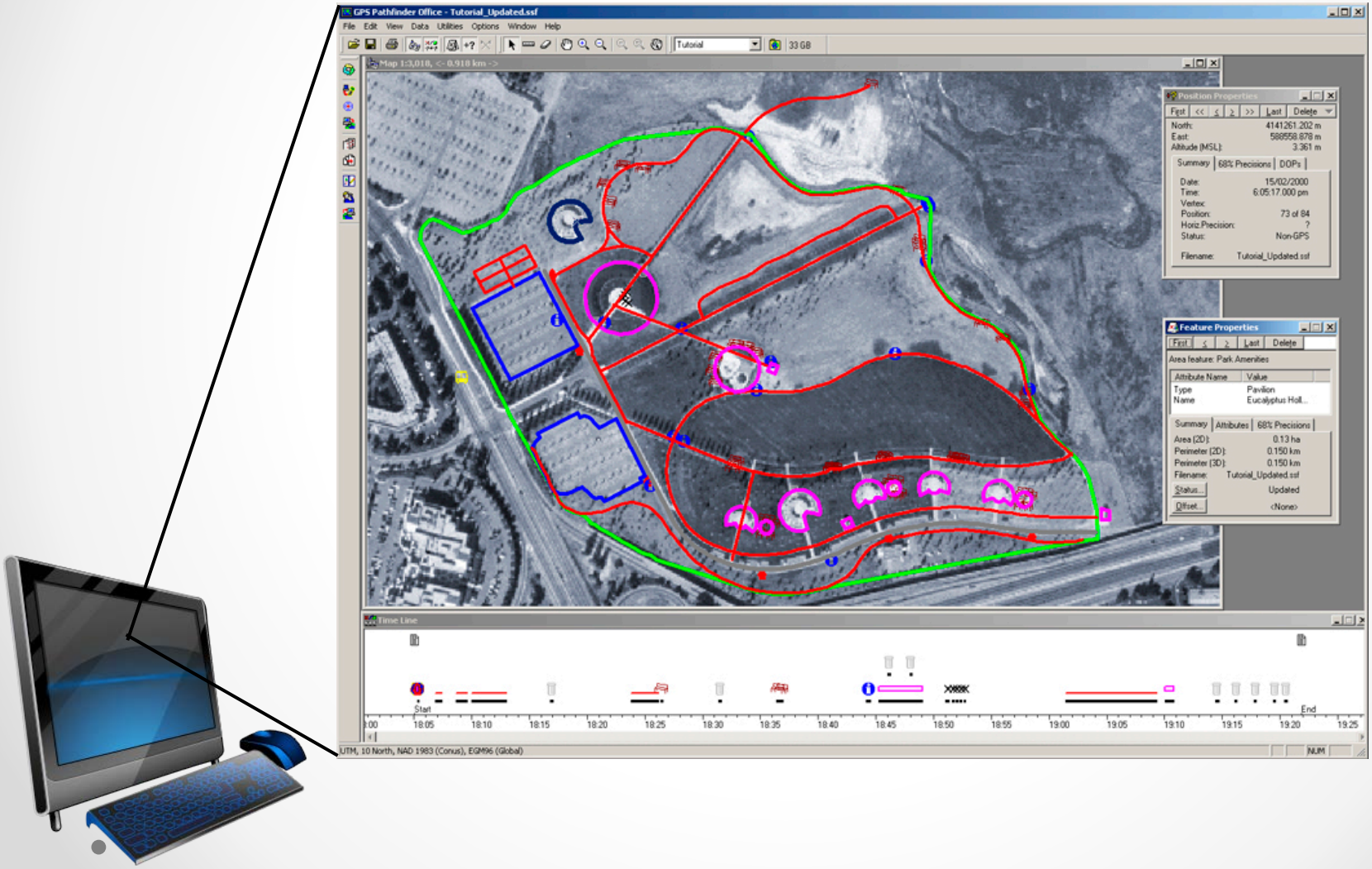
Critical Data

Mapping Technologies

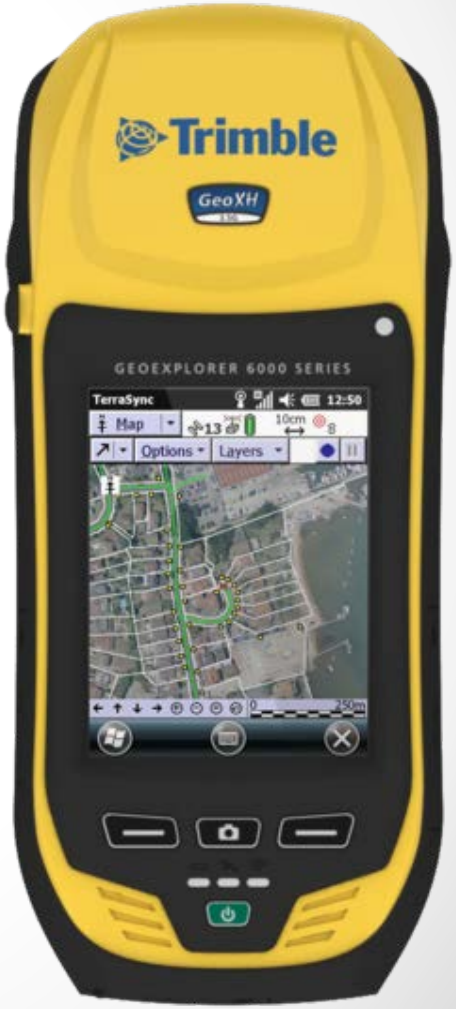


Mapping GIS (MGIS)



Trimble GeoExplorer 6000 series

- Handheld computer with integrated high accuracy GNSS
- Exceptional GNSS performance in difficult environments
- A completely integrated data capture solution
- Optimized for mapping and GIS data collection activities
- Windows Mobile versatility



Trimble Geo 6000 con't

Forward facing camera

GNSS receiver and antenna

Ext. GNSS antenna port

Auto brightness sensor

Touch panel & display

SIM card slot
(3.5G edition handhelds)

SD/SDHC card slot

LED status panel

Backlit keypad

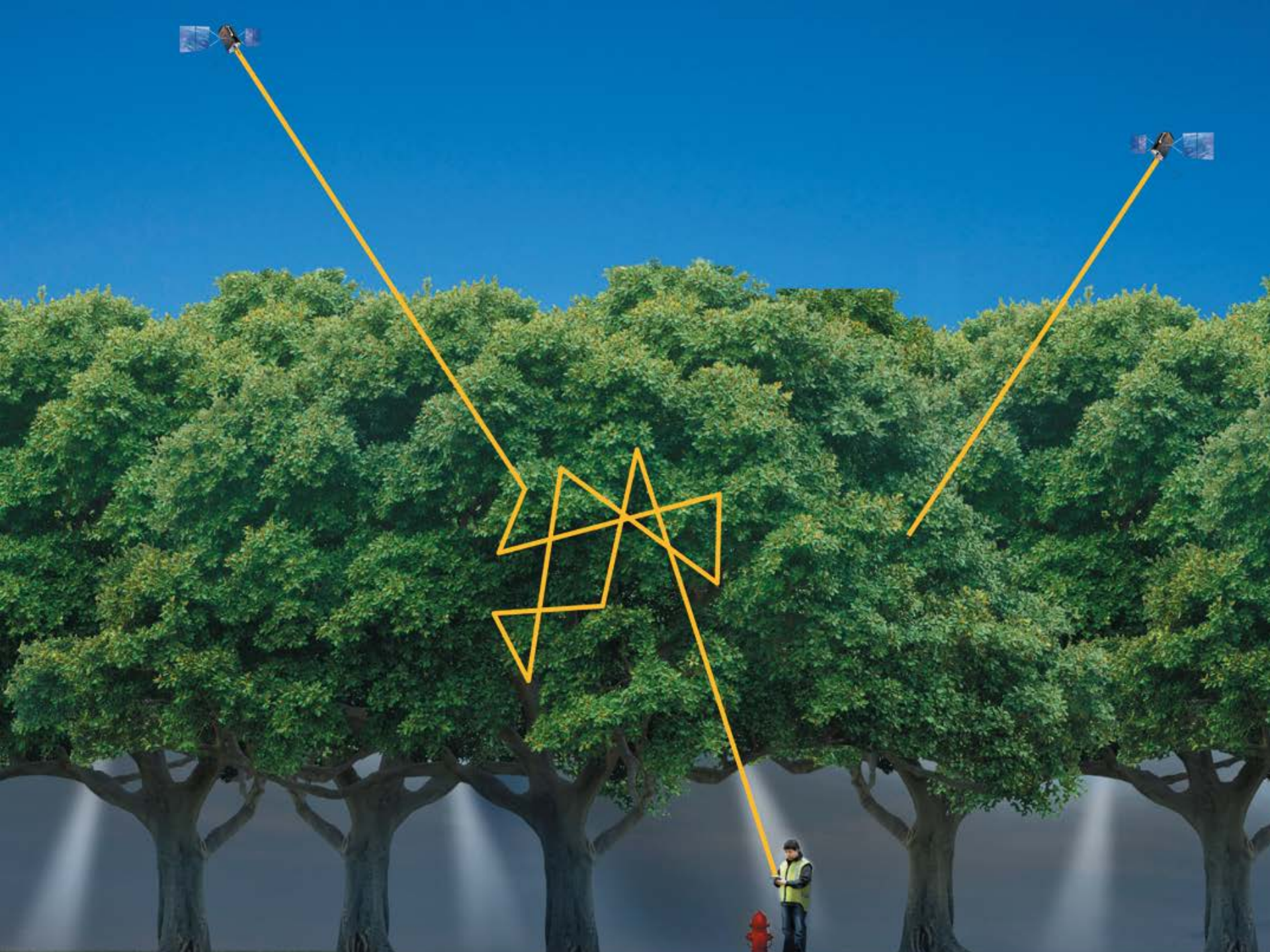
Stylus

Microphone

Speaker

Mini-USB socket

Removable battery



Trimble Floodlight

Satellite Shadow Reduction Technology

Increase satellite availability

Multi-constellation positioning

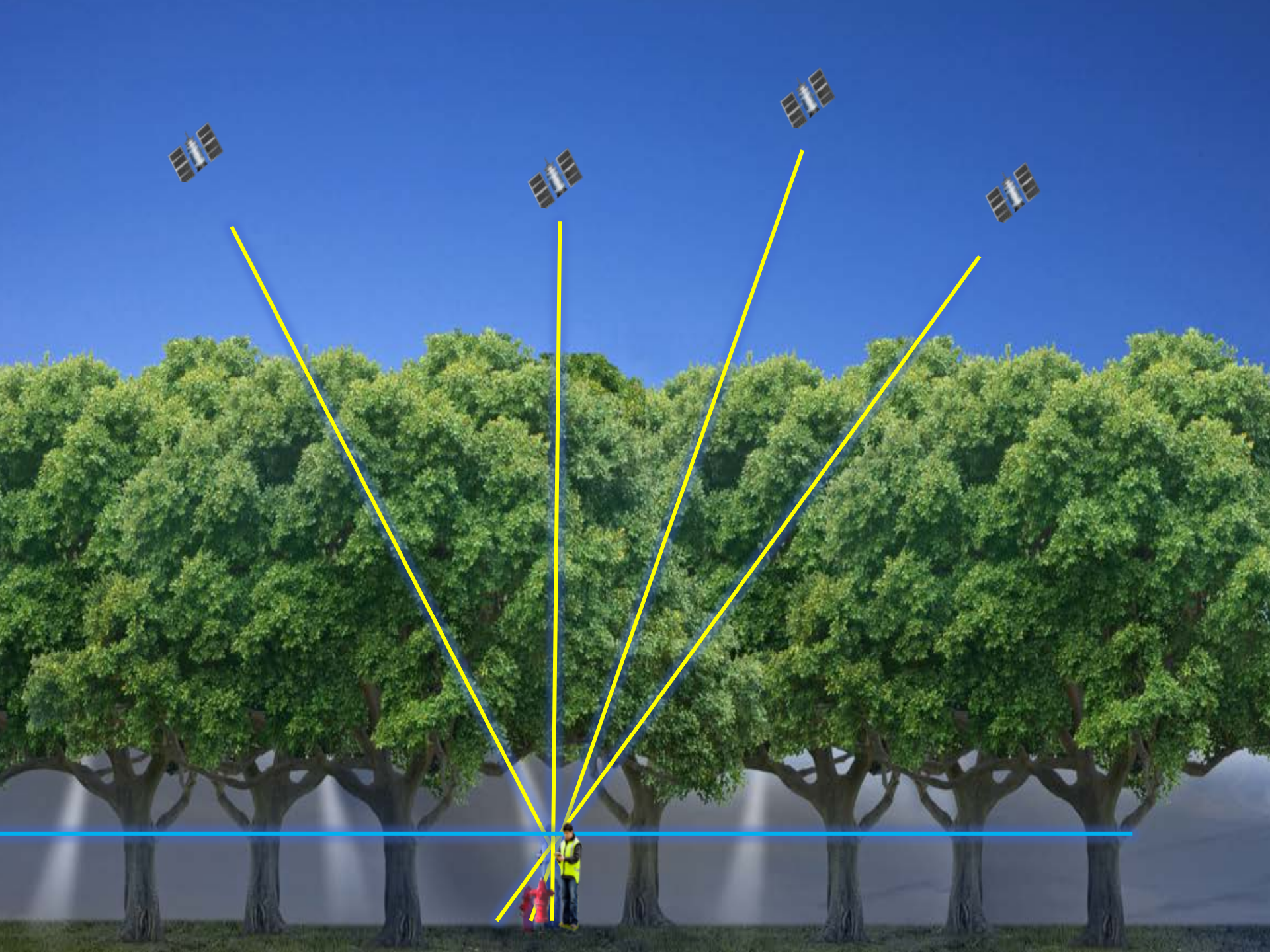
Stabilise acquisition and tracking

Advanced tracking algorithms and filters

Improve accuracy and limit position outages

Altitude-constrained positioning

* Standard on GeoXH, available as an optional upgrade on GeoXT



TerraFlex

Android

IOS

Supported Devices

- iOS 5 and greater
- Android 4.x
- Windows Mobile/WEH 6.x

Ground Penetrating Radar (GPR)

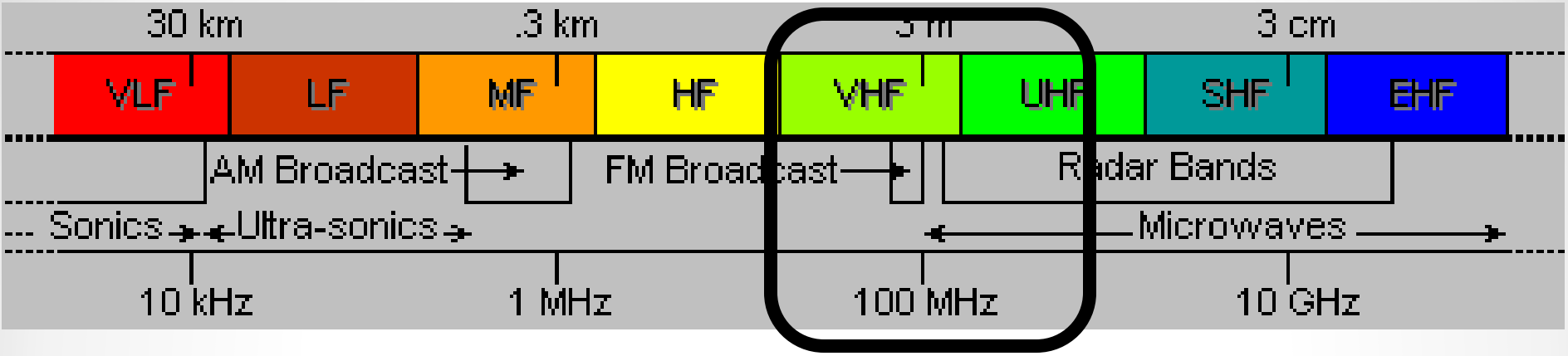
- The Seeker Antennas operate by transmitting a burst of multiple frequencies of radio energy.

100 MHz	250 MHz	500 MHz	1000 MHz	2000 Mhz
50 MHz-450MHz	100 MHz – 950 MHz	95 MHz – 1100 MHz	500 MHz-2300 MHz	700 MHz-3000 MHz

- Each antenna uses a specific bandwidth from the radio spectrum

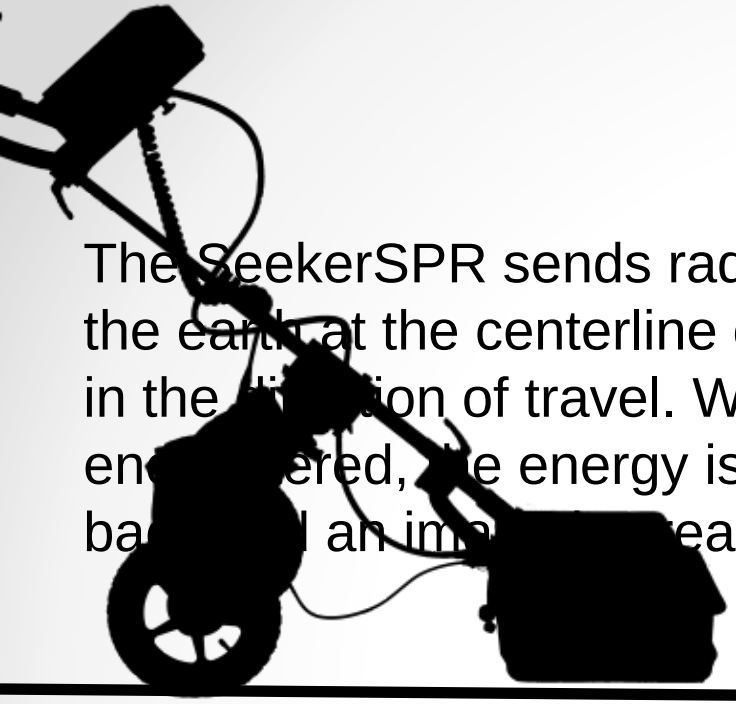
- For Example: 500 MHz antenna, the center strongest frequency is 500MHz. The bandwidth is actually from approximately 95 MHz to 1100MHz

GPR bandwidth of the radio spectrum

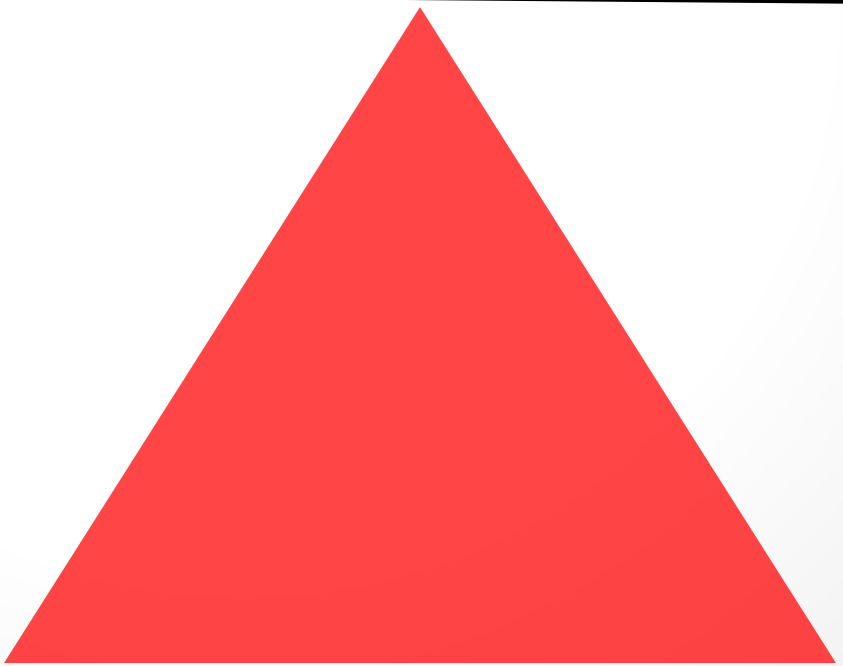


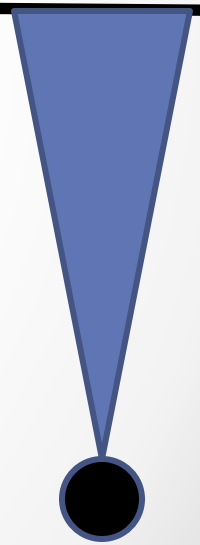
Heinrich Hertz

500MHz–900 MHz Cell Phones
535 kHz - 1.6 MHz: AM Radio stations.
54 MHz - 72 MHz: Television (channels 2-4).
76 MHz - 88 MHz: Television (channels 5-6).
88 MHz - 108 MHz: FM radio.
174 MHz - 216 MHz: Television (channels 7-13).
470 MHz - 806 MHz: Television (channels 14-69).



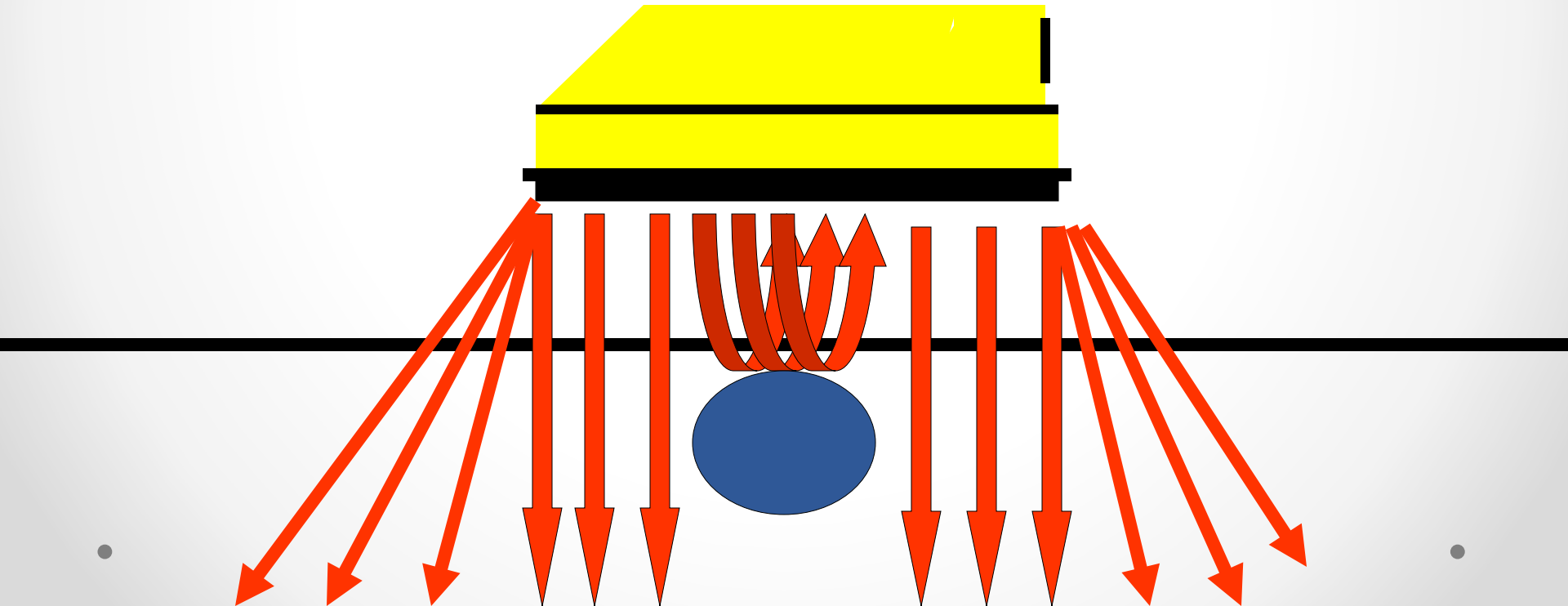
The SeekerSPR sends radar energy into the earth at the centerline of the system in the direction of travel. When a target is encountered, the energy is bounced back and an image is created.





The antenna projects the energy and the energy that returns is transformed into an image.

The depth is determined as a function of time in nanoseconds. The greater the duration in nanoseconds, the deeper the target



Radar Can Not See Through:

Salt Water: Salt water is highly conductive and radar will not see through it. In the case of a salt water table, the radar will see to it but not through it

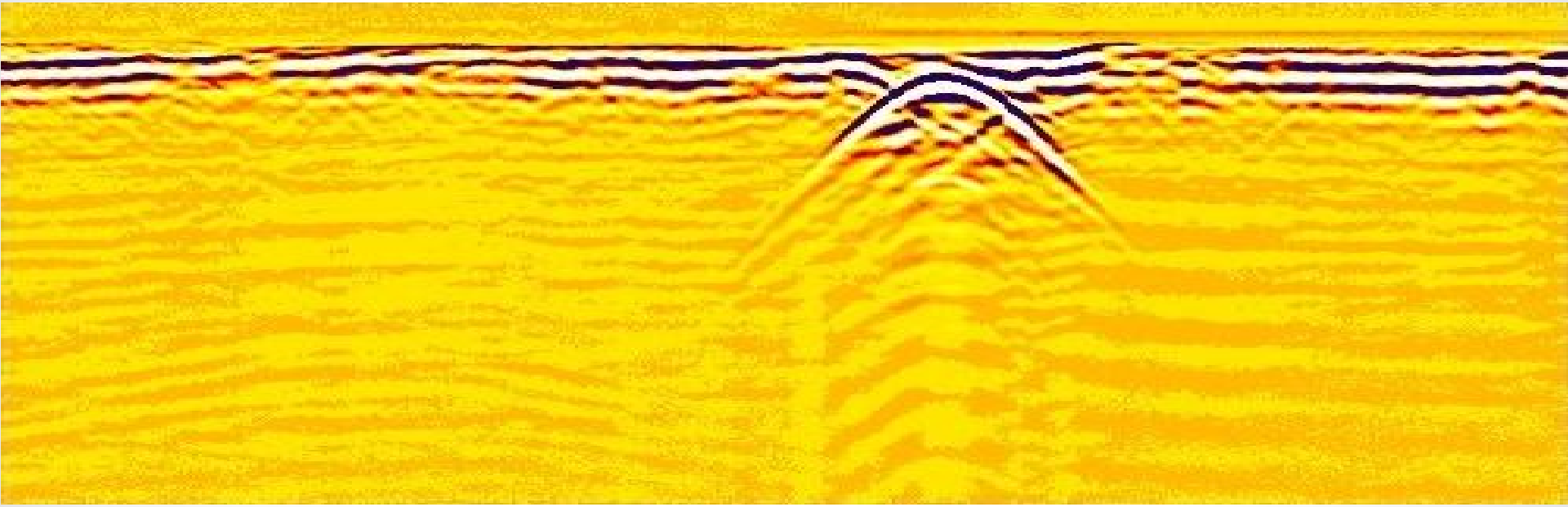
Fresh Concrete: Green concrete is also highly conductive however this property diminishes as the concrete cures.

Metal: Radar sees metal easily at great depths but will not penetrate it.

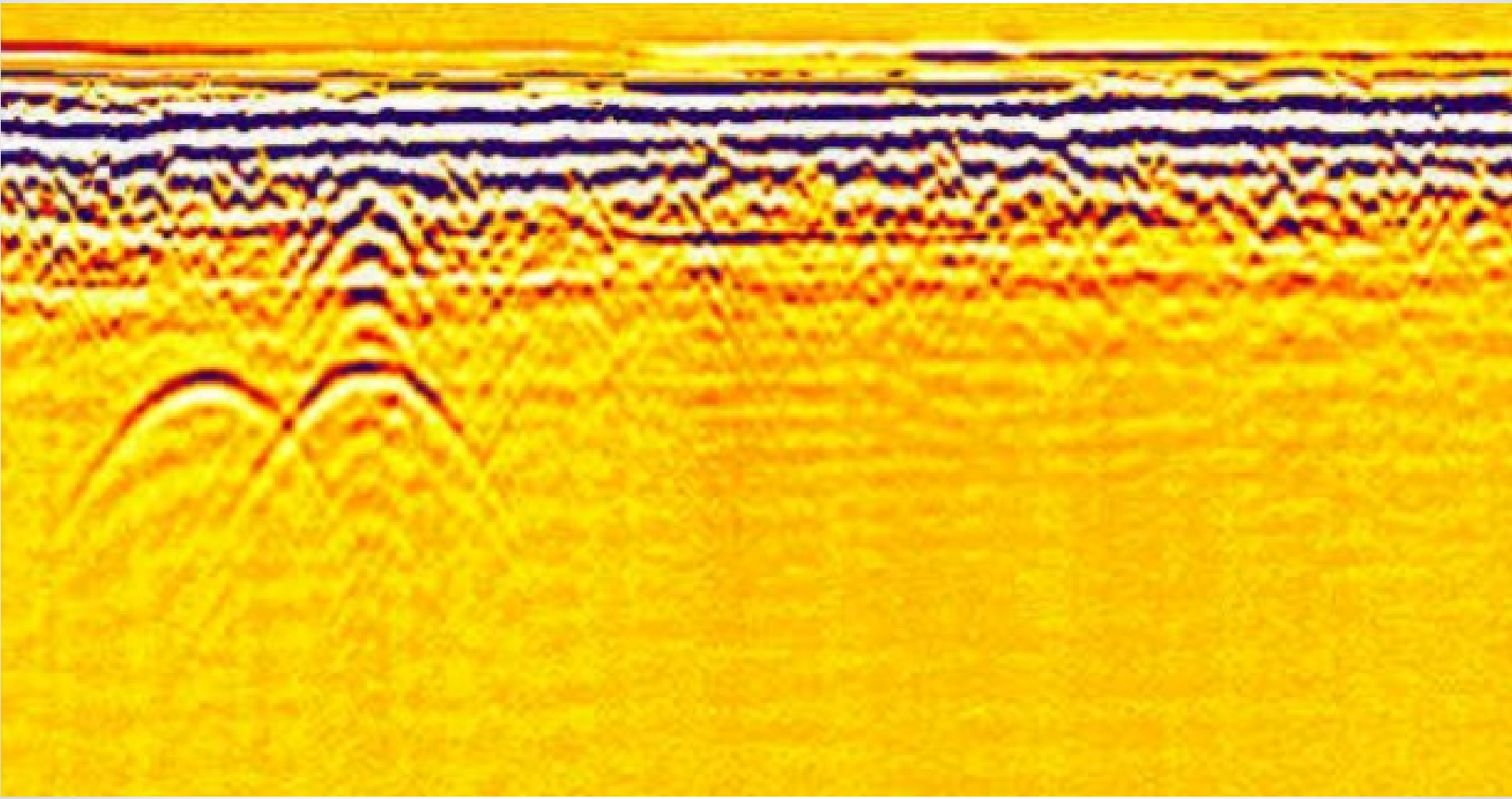
Subsurface Imaging

How is the GPR data presented

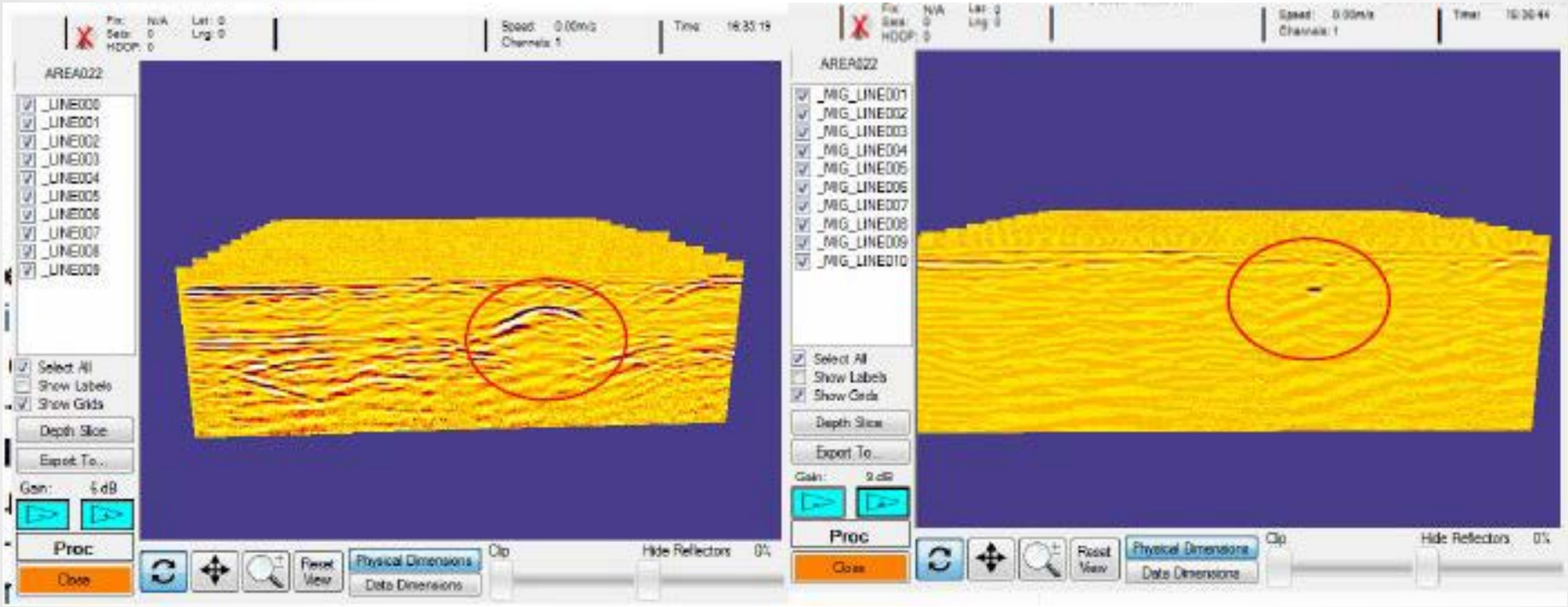
Real-time View



Real-time View



3D View


AREA022
_LINE000
_LINE001
_LINE002
_LINE003
_LINE004
_LINE005
_LINE006
_LINE007
_LINE008
_LINE009
Select All
Show Labels
Show Grids
Depth Slice
Export To...
Gain:
6 dB
Proc
Close
Reset View
Physical Dimensions
Data Dimensions
Clip
Hide Reflectors
0%
AREA022
_MIG_LINE001
_MIG_LINE002
_MIG_LINE003
_MIG_LINE004
_MIG_LINE005
_MIG_LINE006
_MIG_LINE007
_MIG_LINE008
_MIG_LINE009
_MIG_LINE010
Select All
Show Labels
Show Grids
Depth Slice
Export To...
Gain:
9 dB
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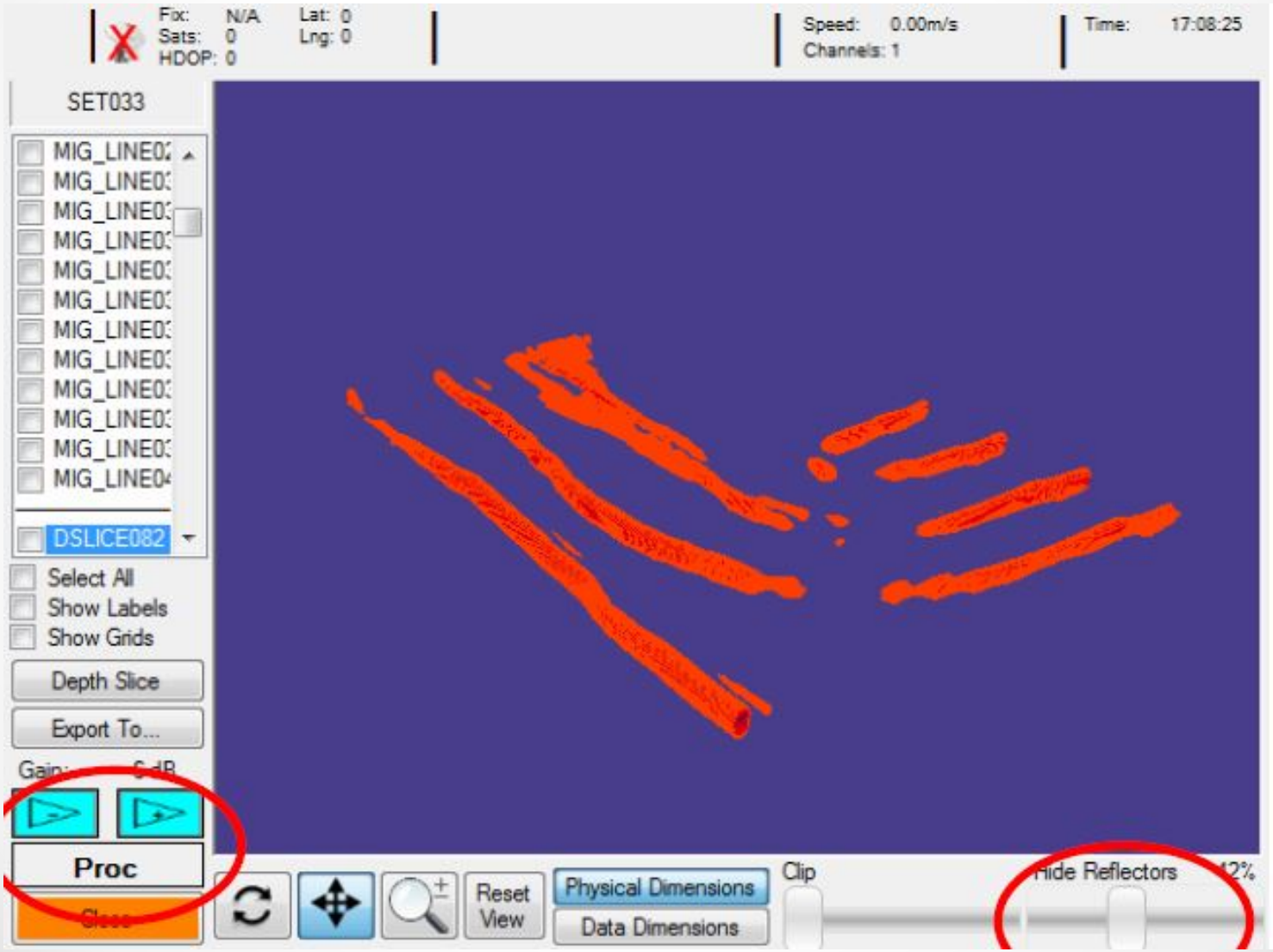
Clip
Hide Reflectors
0%

3D View


Fix: N/A
Sats: 0
HDOP: 0
Lat: 0
Lng: 0
Speed: 0.00m/s
Channels: 1
Time: 17:08:25
SET033
MIG_LINE02
MIG_LINE03
MIG_LINE03
MIG_LINE03
MIG_LINE03
MIG_LINE03
MIG_LINE03
MIG_LINE03
MIG_LINE03
MIG_LINE03
MIG_LINE03
MIG_LINE04
DSLICE082
Select All
Show Labels
Show Grids
Depth Slice
Export To...
Proc
Reset View
Physical Dimensions
Data Dimensions
Clip
Hide Reflectors

Subsurface Mapping

GPS Terms

GPS Terms

DOP or Dilution of Precision is a measure of the dispersion of GPS satellites in the sky that are in view at that moment in time. Low values of DOP, typically 4 or less, indicate that the satellites are well distributed across the sky to provide an optimal location calculation. Higher values indicate that the satellites in view are either bunched together in the same area of the sky or are in a straight line, which typically occurs when there is significant sky view blockage caused by urban canyons. In this case, the location determination may be inaccurate.
Definition from: geostats.com

HDOP or Horizontal Dilution of Precision
VDOP or Vertical Dilution of Precision
PDOP or Position Dilution of Precision

Differences with GPS

At the top of each screen is a display showing that GPS is active.

"Fixed" indicates that there is a GPS lock on a satellite.

"Sats" indicates the number of satellites that are currently in range.

"Lat" indicates the latitude position. "Lng" indicates the longitude position.

"HDOP" indicates the Horizontal Dilution of Precision.

Differences with GPS

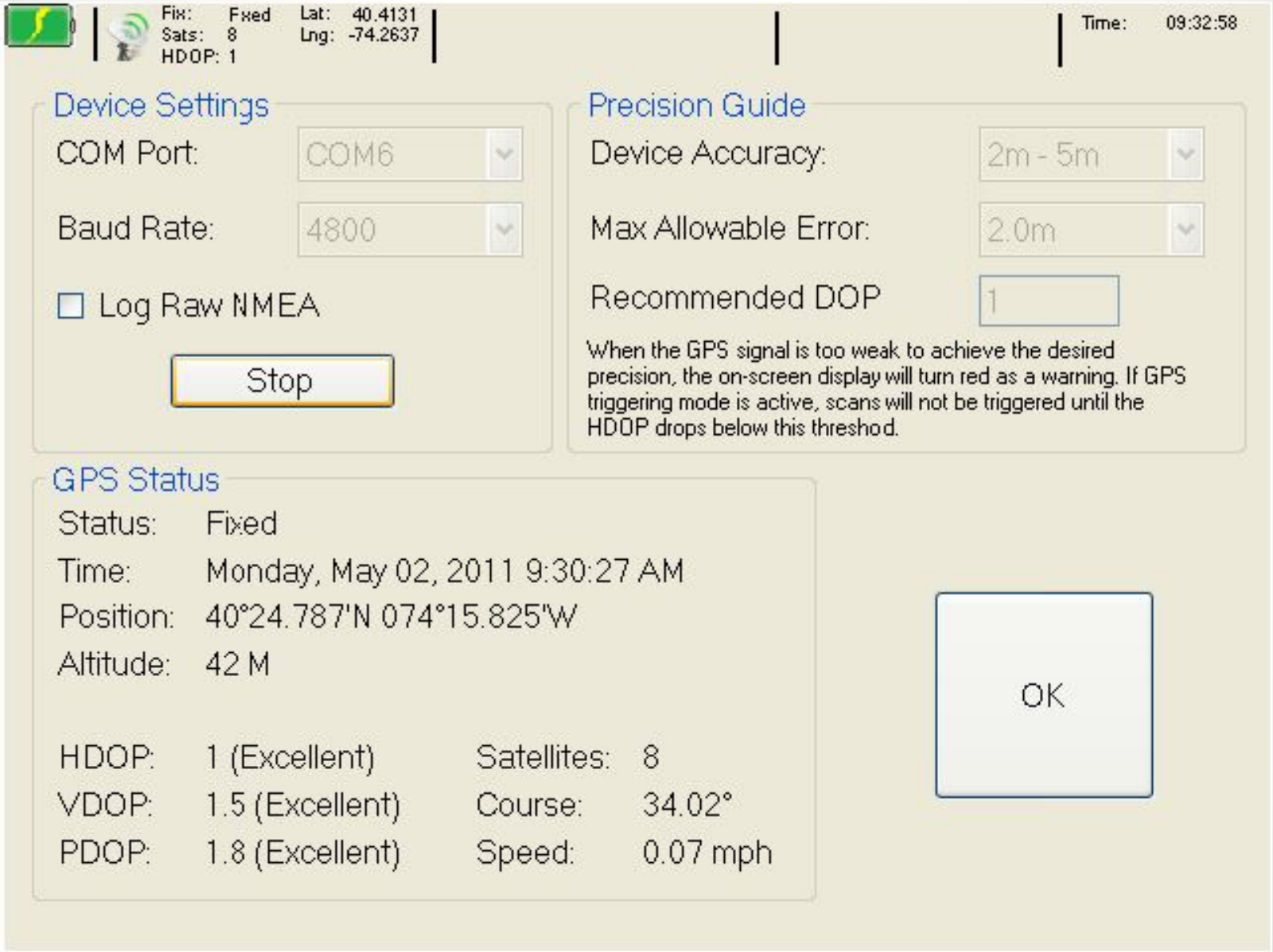
Log Raw NMEA -

Start/Stop button – Touching this button when it displays "Start" will immediately try to connect the GPS. Touching this button when it displays "Stop" will terminate the GPS connection.

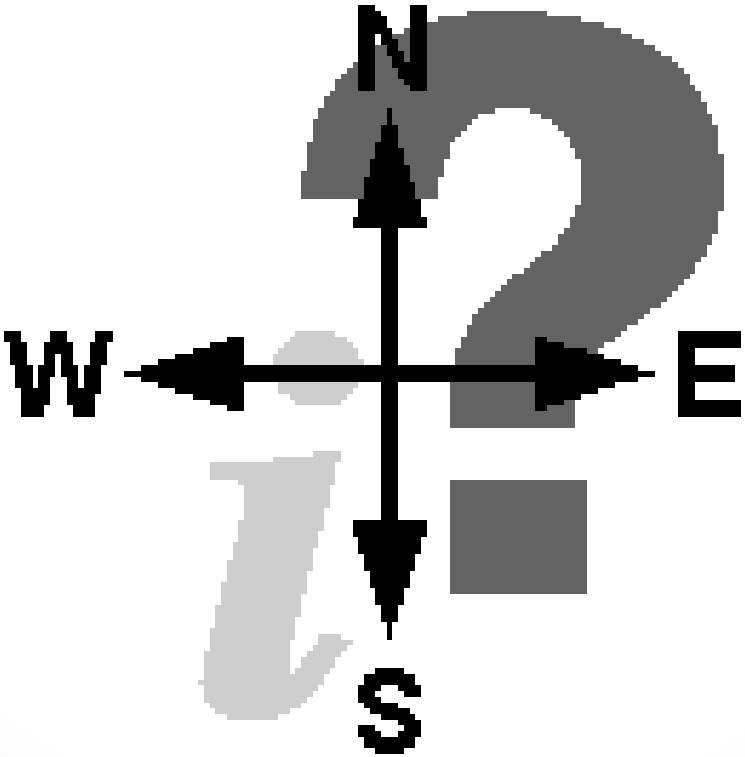
Precision Guide – Allows you to specify a minimum accuracy based on quality of the GPS signal. The HDOP value and the coordinates above the data will turn **red** to indicate that the set accuracy can not be obtained.

GPS Status – Once a connection is established, this window displays the GPS coordinates and values. **Course** shows the course in degrees if you are moving, otherwise this is a random value.

GPR Status


Fix: Fixed
Sats: 8
HDOP: 1
Lat: 40.4131
Lng: -74.2637
Time: 09:32:58
Device Settings
COM Port: COM6
Baud Rate: 4800
Log Raw NMEA
Stop
Precision Guide
Device Accuracy: 2m - 5m
Max Allowable Error: 2.0m
Recommended DOP 1
When the GPS signal is too weak to achieve the desired precision, the on-screen display will turn red as a warning. If GPS triggering mode is active, scans will not be triggered until the HDOP drops below this threshod.
GPS Status
Status: Fixed
Time: Monday, May 02, 2011 9:30:27 AM
Position: 40°24.787'N 074°15.825'W
Altitude: 42 M
HDOP: 1 (Excellent)
VDOP: 1.5 (Excellent)
PDOP: 1.8 (Excellent)
Satellites: 8
Course: 34.02°
Speed: 0.07 mph
OK

Markets/Users



Utilities Management

- **Data collection and asset management activities for utility organizations including:**
  - Water, wastewater, gas, electric and cable

- **Typical tasks include**
  - Leak/outage detection and repair
  - Relocating underground infrastructure
  - As-built mapping and open trenching
  - Infrastructure inspection and maintenance management

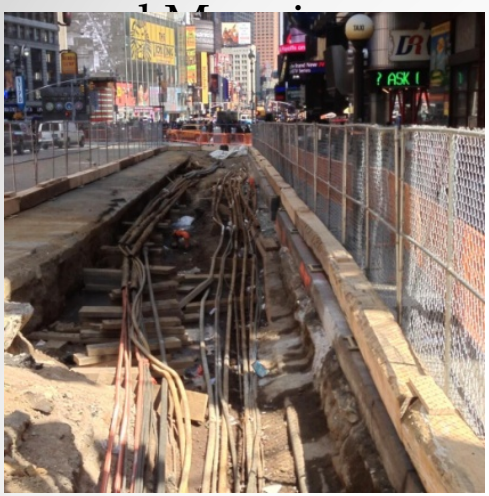
Local Government

- **Data collection and asset management for local government disciplines including:**
  - Road and road asset management
  - Public works installations
  - City-wide GIS data collection projects
  - Scheduled asset inspections for compliance and metering
  - Parks and urban forest maintenance and management

Environmental Management

- **Data collection and asset management for environmental management disciplines including:**
  - Water and waterway management
  - Forest and park service management
  - Fisheries management
  - Geophysical management
  - General environmental management

Utility Detection



Archaeology

Geophysical

The numerous application solutions present opportunities in a number of markets

Structural

Law Enforcement

Environmental

Practical Applications

By List…

- Any Company that owns, is responsible for or installs pipe or utilities of any type i.e. Utility Companies, Utility Contractors.
- Power Companies
- Water Companies/Authorities
- Sewer companies/Authorities
- Utility and Pipeline Contractors
- Natural Gas Companies
- Oil Companies
- Oilfield Maintenance Contractors
- City Planning Authorities
- Engineering/Surveying firms

By List…

- Contract Locating Firms
- Military Base Maintenance Groups
- Government Building and Grounds Maintenance
- Directional Drilling Contractors
- Telephone and Communications Installation Companies
- Airport Authorities
- Big Excavating Contractors
- Small Excavating Contractors
- Residential and Commercial Real Estate Inspectors

What Can GPR Technology Do For All Those People?

- Detect all types of pipes i.e. cast iron, clay, plastic steel, plastic, asbestos cement (transite), ductile iron, even wood pipes!
- Identify Asphalt and Concrete Limits and ThicknessIllegal or unknown connections
- Identify paths for future installations
- Locate missing valves
- Make sense of complicated networks
- Identify Rock and boulders prior to excavation
- Locate Buried Power Cables
- Locate Buried Splice Locations
- Locate Stub-outs and empty conduit
- Detect previous excavations
- Detect cables and Fiber Optic lines

<u>Types of Pipe</u>
Clay Pipes
Plastic or PVC
Concrete Pipe
Transit Pipe
Metal Pipe
Conduit
Cable or Wire
Manholes
Water Boxes
Abandoned Lines

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Questions?

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SUBSURFACE IMAGING SYSTEMS

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