

CGSIC

Survey-Grade Accuracy in a GIS World

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Miami, FL
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Outline

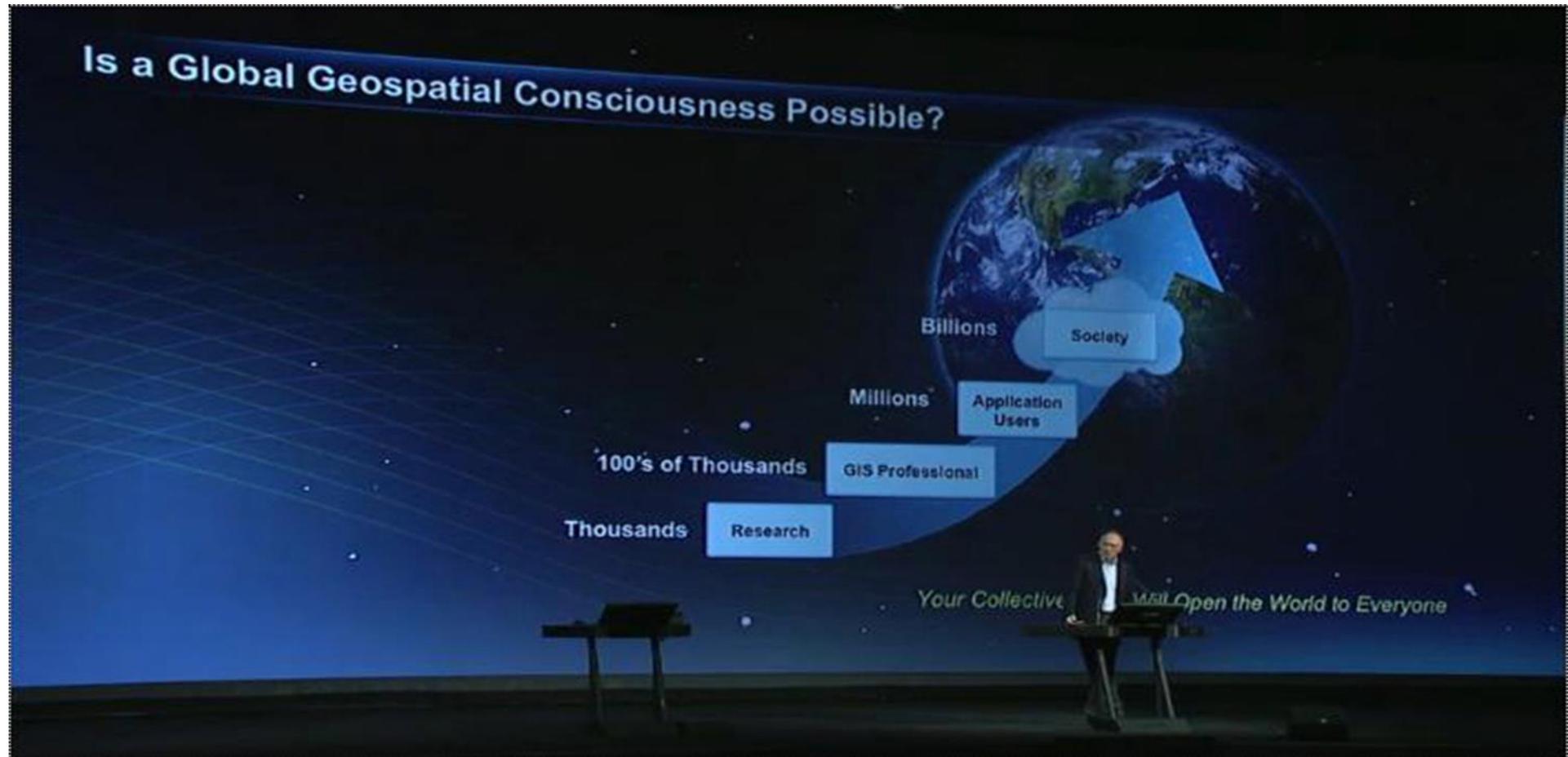
- GIS awareness/growth
- GNSS growth/effect
- Example projects

Geography and GIS

-Merriam-Webster – **geography** is a science that deals with the description, distribution, and interaction of the diverse physical, biological, and cultural features of the earth's surface.

-Geographic Information System (**GIS**) – computer software that analyzes, stores, manipulates and visualizes geographic information. (Wikipedia)

Geospatial Consciousness



Linear vs. Exponential Growth

Is geospatial technology growing linearly..... or exponentially??



Linear vs. Exponential GIS Growth

“Access to geospatial technology will grow exponentially.”

Jack Dangermond, Esri President, July 2012

**Esri is a ~\$1.2B GIS software company (privately held).*

Web GIS Exponential Growth

- Historically, GIS has been a desktop client software.
- 6 years ago, Esri introduced a web browser-based GIS platform called ArcGIS Online (AGOL)
- Today, AGOL has more than 4 million users and 1 BILLION web maps published per day

ArcGIS Online – Topo basemap

The screenshot displays the ArcGIS Online interface with a topographic basemap of the Long Beach, California area. The map is overlaid with several data layers, including survey points and pipeline verification forms. The interface includes a top navigation bar with tools like Add, Edit, Basemap, Analysis, Save, Share, Print, Directions, Measure, and Bookmarks. A search bar is located in the top right corner. On the left side, there is a 'Contents' panel with a list of layers: Atmospheric Survey, CP Anode, CP Bondwire, CP Rectifier, CP Test Point, Pipeline Verification Form, and Topographic. The map shows various cities and landmarks, including Downey, Lynwood, Willowbrook, Compton, East Compton, Paramount, Bellflower, Cerritos, Artesia, Lakewood, La Palma, Buena Park, Carson, West Carson, Harbor City, Wilmington, Port of Long Beach, Long Beach, Signal Hill, Rossmore, and Stanton. The map is powered by Esri, HERE, and Garmin.

ArcGIS Online – Ortho basemap

The screenshot displays the ArcGIS Online interface. At the top, there is a navigation bar with options: Details, Add, Edit, Basemap, Analysis, Save, Share, Print, Directions, Measure, and Bookmarks. A search bar on the right contains the text "Find address or place". Below the navigation bar, there are tabs for About, Content, and Legend. The Content tab is active, showing a list of layers under "Contents":

- Atmospheric Survey
- CP Anode
- CP Bondwire
- CP Rectifier
- CP Test Point
- Pipeline Verification Form
- Imagery

The main map area shows an aerial ortho basemap of a city. Overlaid on the map are several colored markers: green squares, yellow circles, and a few red circles. A scale bar is visible at the bottom left of the map area. In the bottom right corner, there is a logo for "POWERED BY esri" and text indicating "Earthstar Geographics, CNES/Airbus DS".

ArcGIS Online – Street basemap

The screenshot displays the ArcGIS Online interface with a street basemap. The top navigation bar includes options like Details, Add, Edit, Basemap, Analysis, Save, Share, Print, Directions, Measure, and Bookmarks. A search bar on the right contains the text "Find address or place". On the left, there is a "Contents" panel with a list of layers: Atmospheric Survey, CP Anode, CP Bondwire, CP Rectifier, CP Test Point, Pipeline Verification Form, and Streets. The map shows a grid of streets in the Long Beach area, with several data points marked by colored circles (green, yellow, red) and squares (green, yellow). Major roads like I-10, I-5, and I-110 are visible. The bottom left corner has a scale bar and copyright information for Esri.com. The bottom right corner features the Esri logo and a note: "City of Long Beach, Bureau of Land Management, Esri, HERE, Garmin, NGA, USGS, NPS".

ArcGIS Online – Zoom feature

The screenshot displays the ArcGIS Online interface. At the top, there is a navigation bar with icons for Details, Add, Edit, Basemap, Analysis, Save, Share, Print, Directions, Measure, and Bookmarks. A search bar on the right contains the text "Find address or place". On the left, a "Contents" panel lists several layers: Atmospheric Survey, CP Anode, CP Bondwire, CP Rectifier, CP Test Point, Pipeline Verification Form, and Topographic. The main map area shows a street grid with a popup window for a "CP Test Point CSFM:458 Milepost: 27.16". The popup contains the following information:

CSFM Number	458
Milepost	27.16
Inspector	[Redacted]
Legacy ID	[Redacted]
Installation Date	[Redacted]
Status	Active
Location Description	E/O 27th and Magnolia
In Service Date	February 2, 2017
Test Point Name	[Redacted]
Test Point Type	Above Ground
Measured Potential	-1,472

At the bottom of the popup, there are links for "Zoom to", "Get Directions", and "Edit". The map includes a scale bar (0 to 200 feet) and a footer with the text "City of Long Beach, County of Los Angeles, Bureau of Land Management, Esri, HERE, Garmi..." and the Esri logo.

ArcGIS Online – Reporting

The screenshot displays the ArcGIS Online interface with a report form titled "Atmospheric Assessment" overlaid on a map. The form is divided into several sections, each with a blue header. The "Contents" panel on the left shows various layers checked, including "Atmospheric Survey", "CP Anode", "CP Bondwire", "CP Rectifier", "CP Test Point", "Pipeline Verification Form", and "Topographic".

Atmospheric Survey CSFM: / Milepost: /

Print

Inspector Information

Name of Inspector	
Date of Inspection	August 4, 2015

Vault

City, County, State	
CSFM #	339
Milepost	19.58
Span Description	Span measured approx. 450 ft. running East to West along a suspension bridge over the LA river.
Length of Span	ft.
Diameter of Span	10.00 in.
Surface Area of Pipe	sq. ft.
Number of Valves	

Access Information

Access Issues?	Yes
Access Details	Key required for gate

Coating Assessment

Summary of Coating Condition	
Surface Area of Span	sq. ft.
Percent Coating Damage	0.03%
Percent Bare Pipe	0.03%
Overall Coating Assessment	Overall coating is in fair condition, coating on span running across bridge is very thin and rust staining is visible, tape coating is cracking and peeling at East soil to air interface

Mechanical Damage Assessment

Summary of Corrosion Condition	
Overall Corrosion Assessment	Overall corrosion is minimal along this span, coating on pipe running across the bridge is very thin and there are multiple areas where rust staining was observed but no significant metal loss was seen

Zoom to Get Directions Edit

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Data Fuels the GIS Software Engine

-Data is the fuel of GIS. Real-time, accurate data enables quicker and more accurate decisions.

-Real-time GNSS data is trending up. “Post-processed” data is fading, not just in a GNSS sense, but in general.

GPS Technology is Changing

A Few Thoughts about GNSS

GPS Technology is Changing - GNSS

- It's not just about GPS any longer.
- GLONASS (Russia) 24 healthy sats in orbit.
- Galileo (Europe) 17 healthy and growing.
- BDS (China) 9 healthy (in global orbits) and growing.
- More navigation satellites = faster, more accurate mapping in impaired conditions.



Fix: DGPS



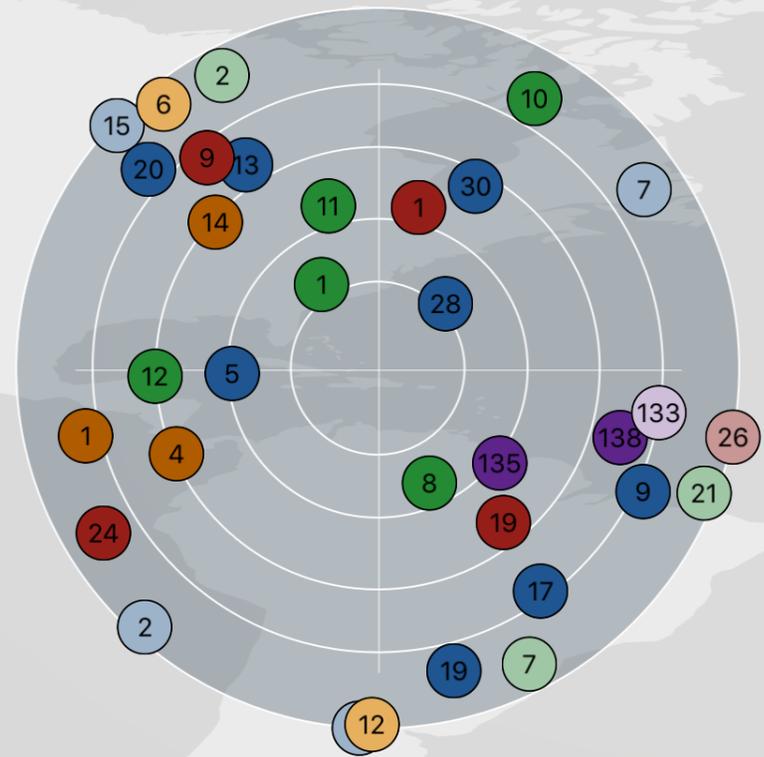
Tx/Rx
● ●

Position

Satellites

RTK Status

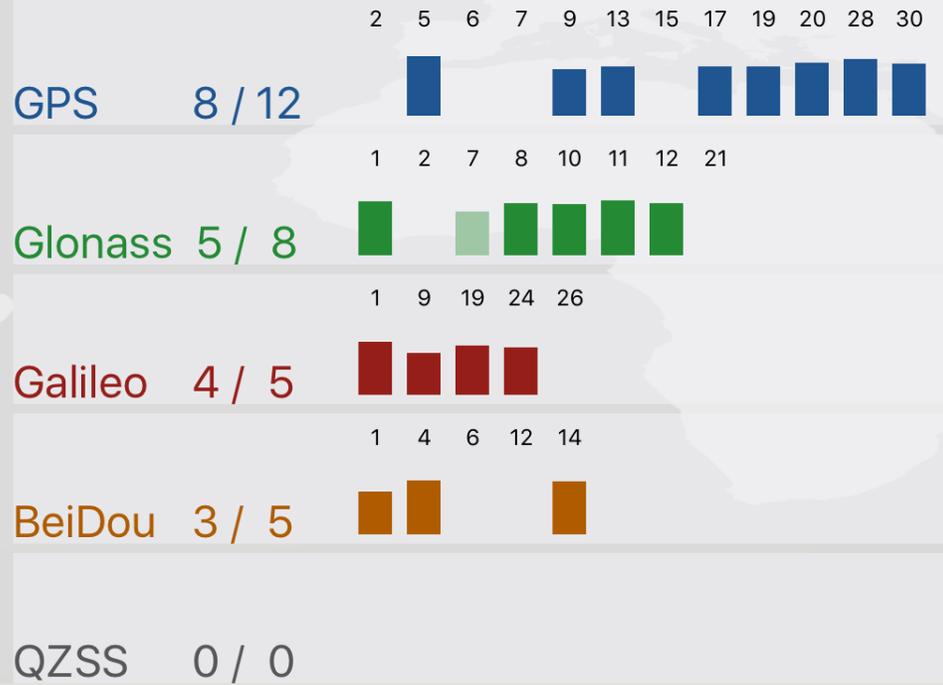
Map View



1 Used / 1 In View

Total Sats 22 / 33

SBAS Tracked 3
SBAS Ranging 2



135 138 133



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High-Accuracy GNSS Test Course



-
- Surveyed: total station to determine true coordinates.
 - Clear, mild, moderate, heavy tree canopy.
 - Static and dynamic testing



Public Infrastructure – RTK base access

Arizona

Alabama

California

Colorado

Connecticut

Iowa

Indiana

Florida

Kentucky

Maine

Michigan

Minnesota

Missouri

Mississippi

New York

North Carolina

Oregon

Ohio

South Carolina

Tennessee

Vermont

Washington

West Virginia

Wisconsin

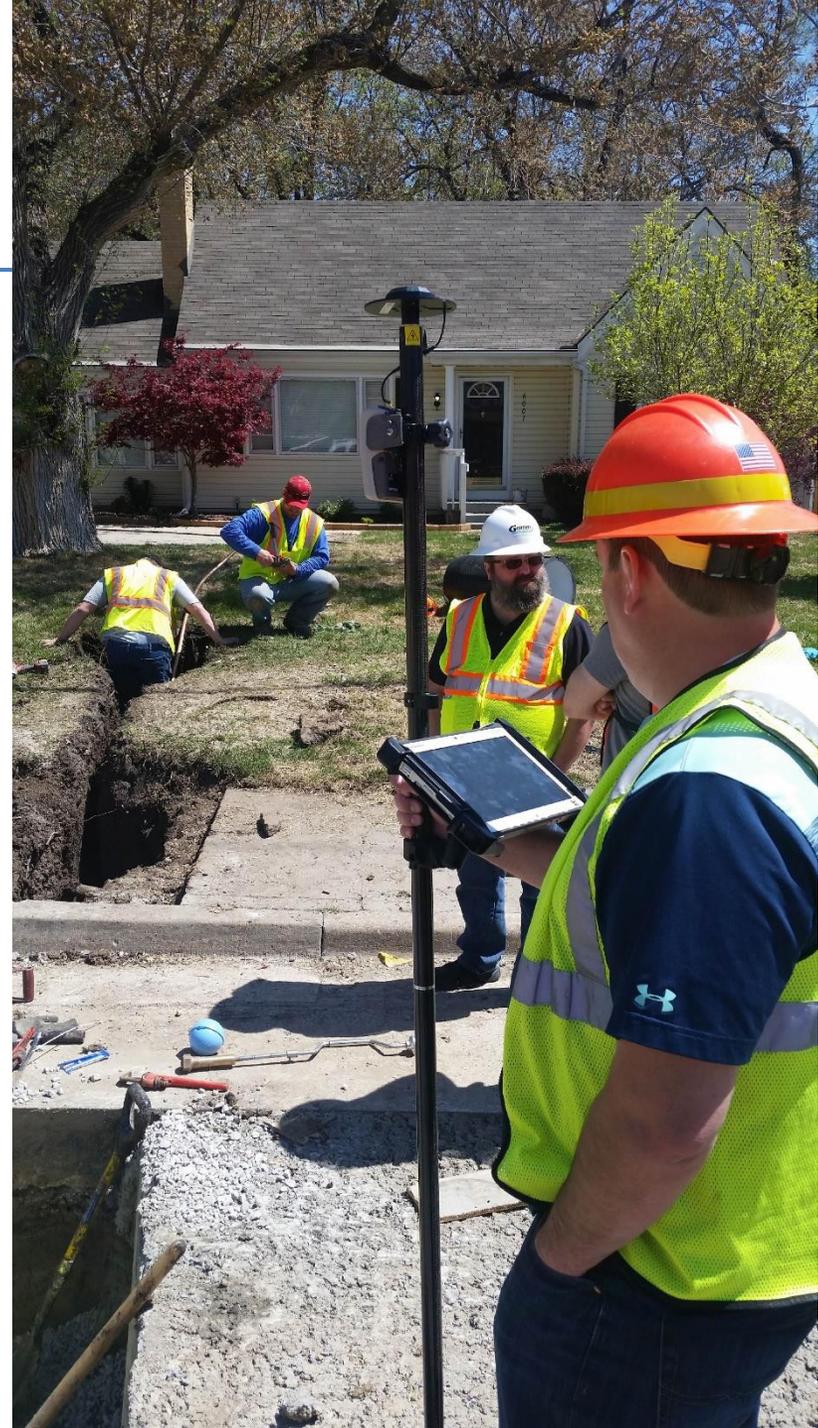
Examples of GIS users of Centimeter GNSS Technology

A Water Utility

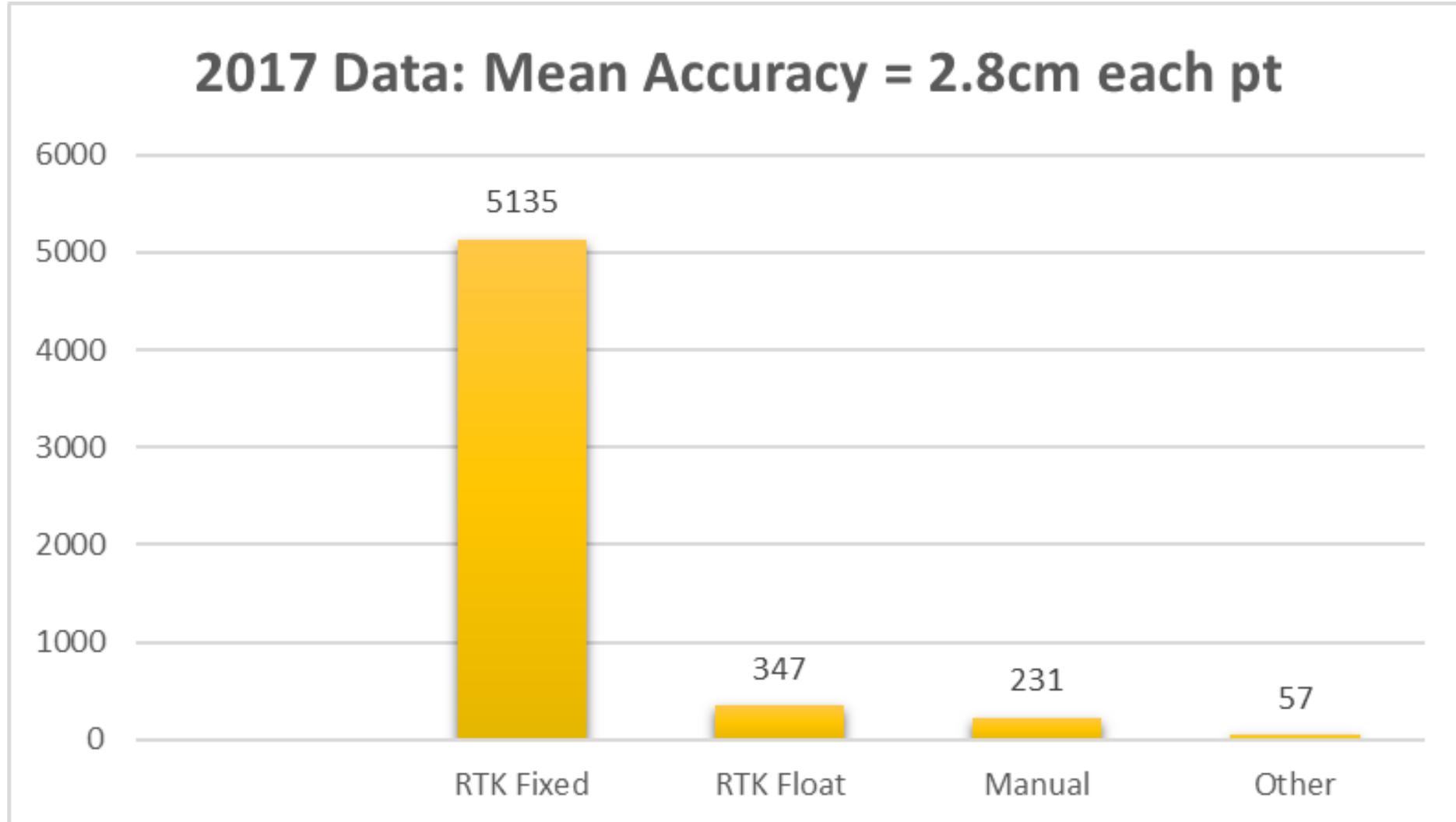
- 2,685 miles of water main serving a population of 420,000.
- 272 square miles.
- 145,000 metered accounts.
- Hundreds of thousands of fixed assets.

A Water Utility

- Free statewide RTK.
- 10x mapping productivity.
- Real-time connectivity.
- Windows tablets (BYOD).



Four months of data = 2.8cm ave Accuracy



2017 US Open Golf Course



2017 U.S. Open Overview

2017 US Open Golf Course

- The USGA requested design changes to 9 green complexes after the Open tournament.
- First task was to create a high-resolution as-built map of each green complex:
 - 3-inch elevation contours of the green surface.
 - 1 foot elevation contours of the green complex.

2017 US Open Golf Course

- Free statewide RTK infrastructure.
- Golf architect operating the RTK system and UAV.
- Green elevations mapped with RTK GNSS on a “wheel”.
- RTK GNSS used to survey Ground Control Points (GCPs) for the UAV flight.

RTK GNSS “wheel” on Green Surface



Low-Level UAV Flight Pattern

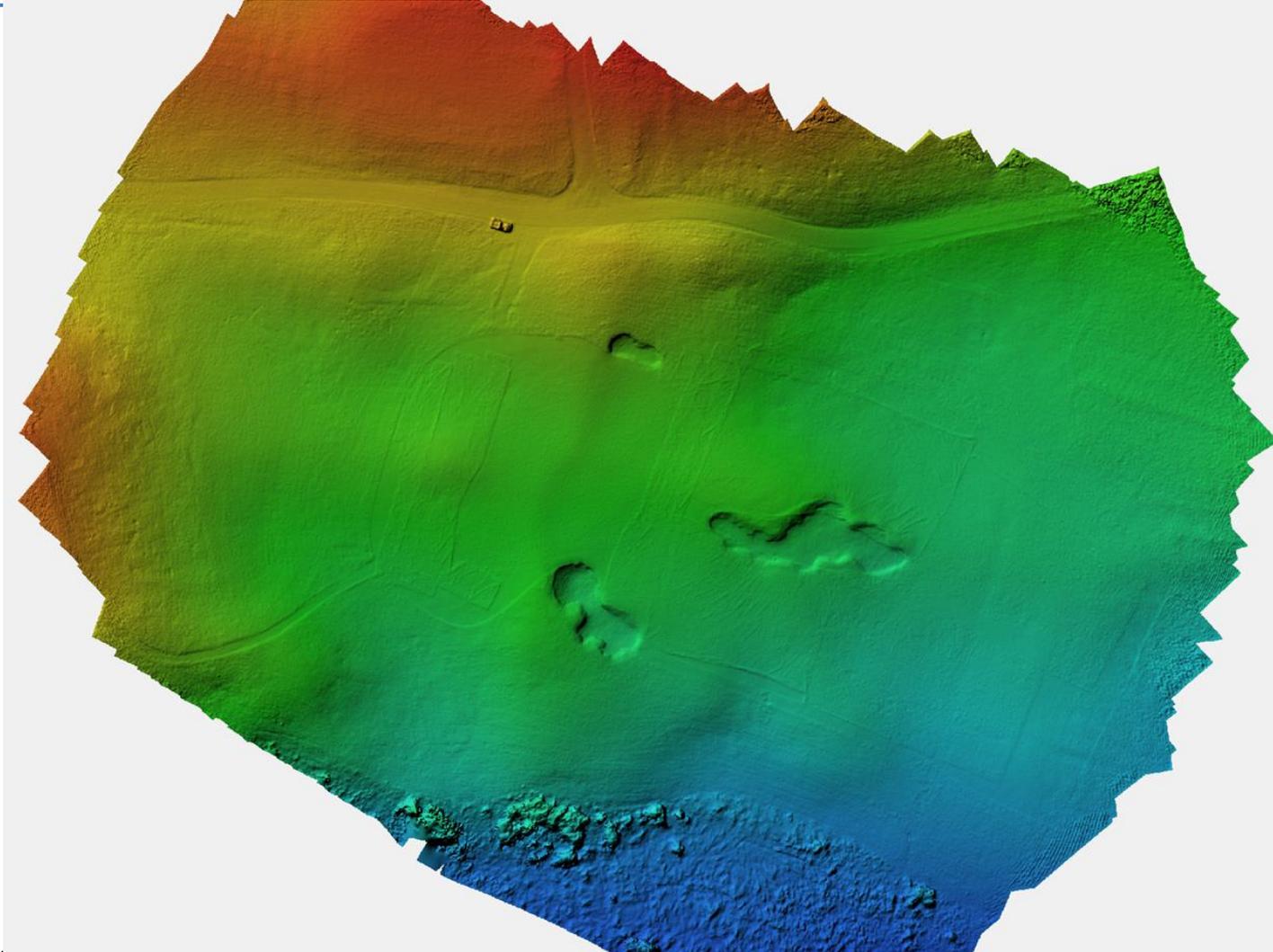
Area: 3.12 acres
Distance: 0.75 mi
Max Speed: 4.5 mph
Duration: 10m 54s
Batteries: 1
Images: 188
Points: 714
Storage: 0.94 GB

Not Connected

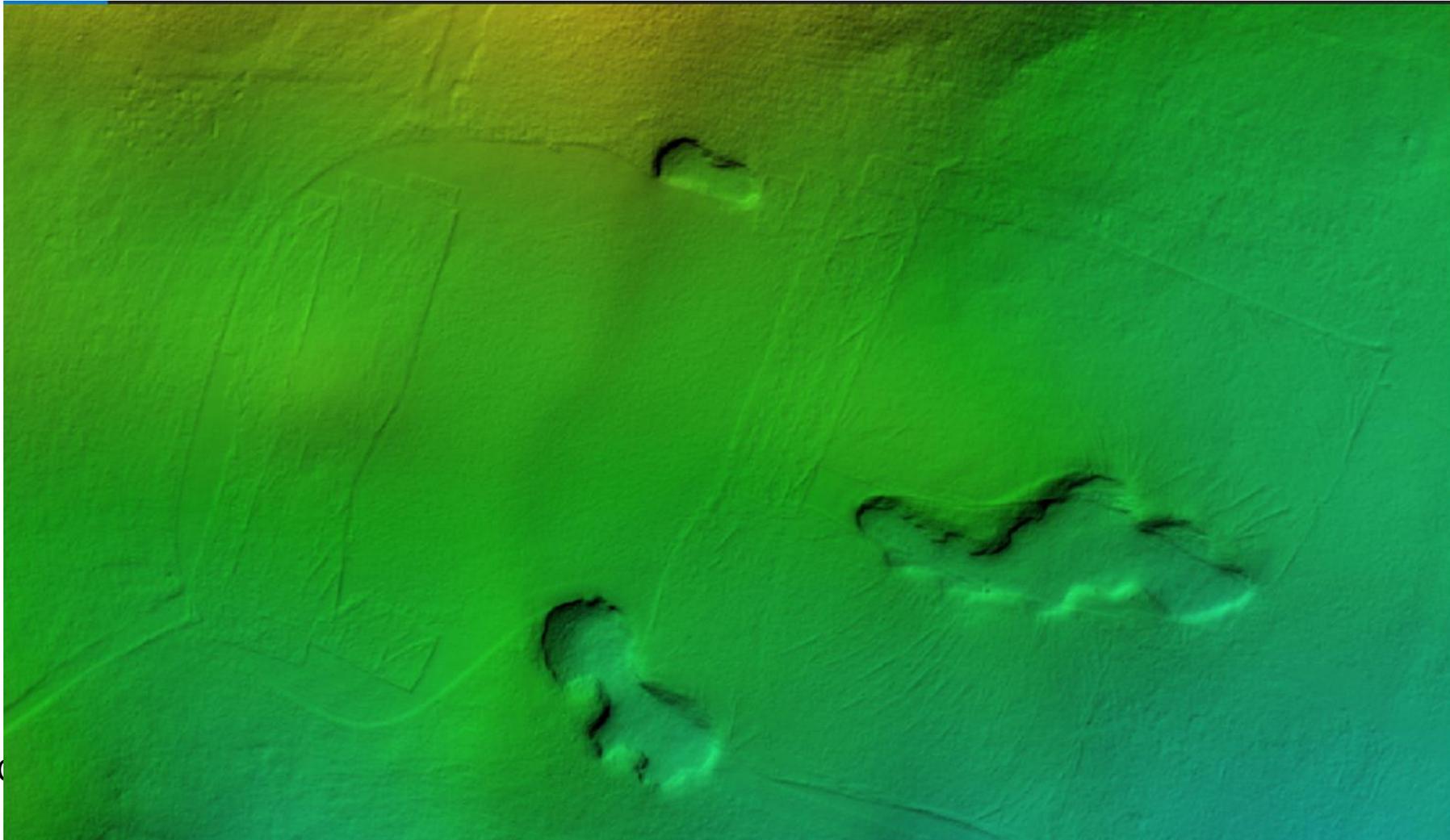
- 90%	+ 90%
Along Track	Detailed rendering of heavy trees.
- 80%	+ 80%
Across Track	Terrain, structures, trees, any water, corn.
	70% Flat areas, few trees.
	60% or less Not recommended.



Digital Elevation Model – 4cm



Digital Elevation Model – 4cm



Takeaway Messages

- Increasingly free access to RTK base infrastructure promotes RTK GNSS adoption.
- Smaller and less costly RTK receivers make high-precision available to a broad audience.
- iOS/Android/Windows compatibility makes RTK GNSS accessible to a broad audience.
- The cost of collecting high-accuracy horizontal and vertical GNSS data is less costly and easier than ever before in history.



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