



*Empowering Colleges:
Growing the Workforce*

GEOSPATIAL SECURITY

Name: Vince DiNoto

Title: Director of GeoTech Center

Email: vince.dinoto@kctcs.edu



Based upon work supported by the National Science Foundation under Grants DUE ATE 1304591, DUE ATE 164409, DUE ATE 1700496, DUE ATE 2202038. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

www.geotechcenter.org

? BALLOONS ?



UNDERSTANDING GEOSPATIAL TECHNOLOGIES

- What is geospatial technology, GIS, geospatial science and technology?
 - Maps
 - A sense of place
 - A temporal location
 - Vector and raster data
 - Analysis
 - Software and hardware driven



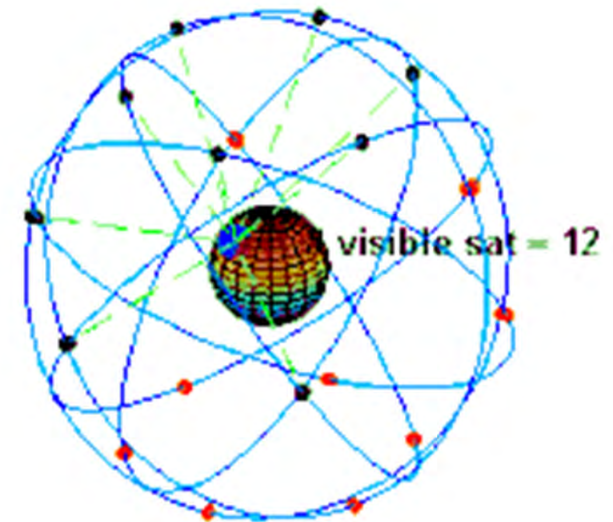
<https://www.cdc.gov/gis/index.htm>

DISCUSSION TOPICS

- GPS/GNSS Positions
- Remotely Sensed Data
- Open-Sourced Maps

GLOBAL POSITION SATELLITES (PS) GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

- GNSS is all the orbiting satellites from across the globe, but GPS refers only to the American Constellation of Satellites
- What countries have satellites (<https://www.gps.gov/systems/gnss/>)
 - GPS – U.S.
 - BeiDou/BDS – China
 - Galileo – Europe
 - GLONASS – Russia
 - IRNSS/NavIC – Indian
 - QZSS - Japan
 - Others include: the United Kingdom, Australia, and the Republic of Korea (South Korea)
- Most receivers will access satellites other than GPS (<https://www.gps.gov/policy/cooperation/>)



HOW DOES SATELLITE POSITIONING WORK (GPS)?

- 24 satellites are part of the U.S. constellation of satellites (<https://www.gps.gov/systems/gps/>)
- GPS satellites are monodirectional; they only send time signals, and the receiver can determine the position. The receiver uses multiple satellites to determine the position, the more satellites the more the precision of the positional location.
- The position of the satellites is known, the receiver captures a time stamp from the satellite, by knowing the position of a single satellite and the time, the distance from that satellite, which means the position of the user is known to be on a sphere. If a second satellite is viewed, its distance from the satellite can also be determined as a sphere and the intersection of these two spheres says that the receiver is along a line. A third satellite provides a plane position and a fourth a 3-D position. Additional satellites help refine the accuracy. (https://en.wikipedia.org/wiki/Global_Positioning_System).
- Additional accuracy can be determined by ground-based stations
 - WAAS (Wide Area Augmentation System), which are designed to assist civil aviation. (https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/was)
 - Ground stations might be used in agriculture to assist automated farming.
 - RTK/RTX is a base station. Its position is known extremely accurately. Realtime Kinematic. (https://receiverhelp.trimble.com/R750-gnss/PositionModes_RTK.html)
- Accuracy can approach 1 centimeter or less
- Until May 1, 2000, the U.S. Constellation was intentionally degraded to reduce the accuracy of measurements.
- Today GPS/GNSS technology is critical for navigation by individuals, companies and governments. New band satellites are being launched and will be complete by 2027.

HOW CAN THE POSITIONING BE CHANGED

<HTTPS://HERE.COM>

- 1. **GNSS jamming:** also known as brute-force jamming, this uses arbitrary signals, transmitted at the same frequency as GNSS signals, to prevent GNSS receivers from transmitting or receiving legitimate frequencies. Thus, the stronger the signal, the more domination of the data. A wave 10 dB or more stronger than the anticipated signal can easily be dominant.
- 2. **Denial of service (DoS) GNSS spoofing:** an attacker overrides the signal between the victim and the receiver to transmit their own false information; this was the tactic most used in the Black Sea incidents. Thus, the user cannot connect to the satellite, thus rendering the receiver useless.
- 3. **Deception GNSS spoofing:** an attacker hijacks receivers by mimicking GNSS signals to feed false data to the victim. Thus, by receiving a different timestamp for a known satellite code, the user assumes that they are in a specified position, which is incorrect.

Satellite
GNSS service with support for all
major satellite systems

WiFi and cell
High-accuracy on- and offline
network positioning

Network
Online network positioning for
connected devices



ONE CROSS-PLATFORM SOLUTION

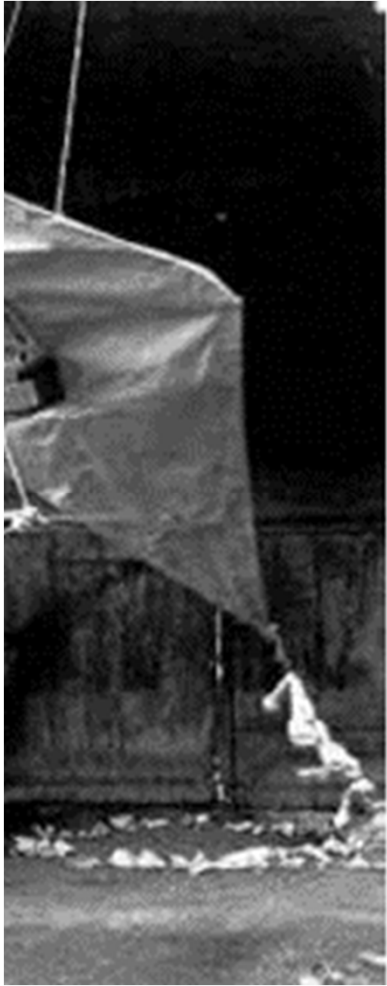
Global navigation satellite systems have always had difficulty with urban canyons and indoor area and have long been supplemented by Assisted GNSS (A-GNSS) that use the internet to fill in the gaps. At HERE we further positioning services that use both WiFi and cell data.

IS IT REAL? FROM THREAT POST

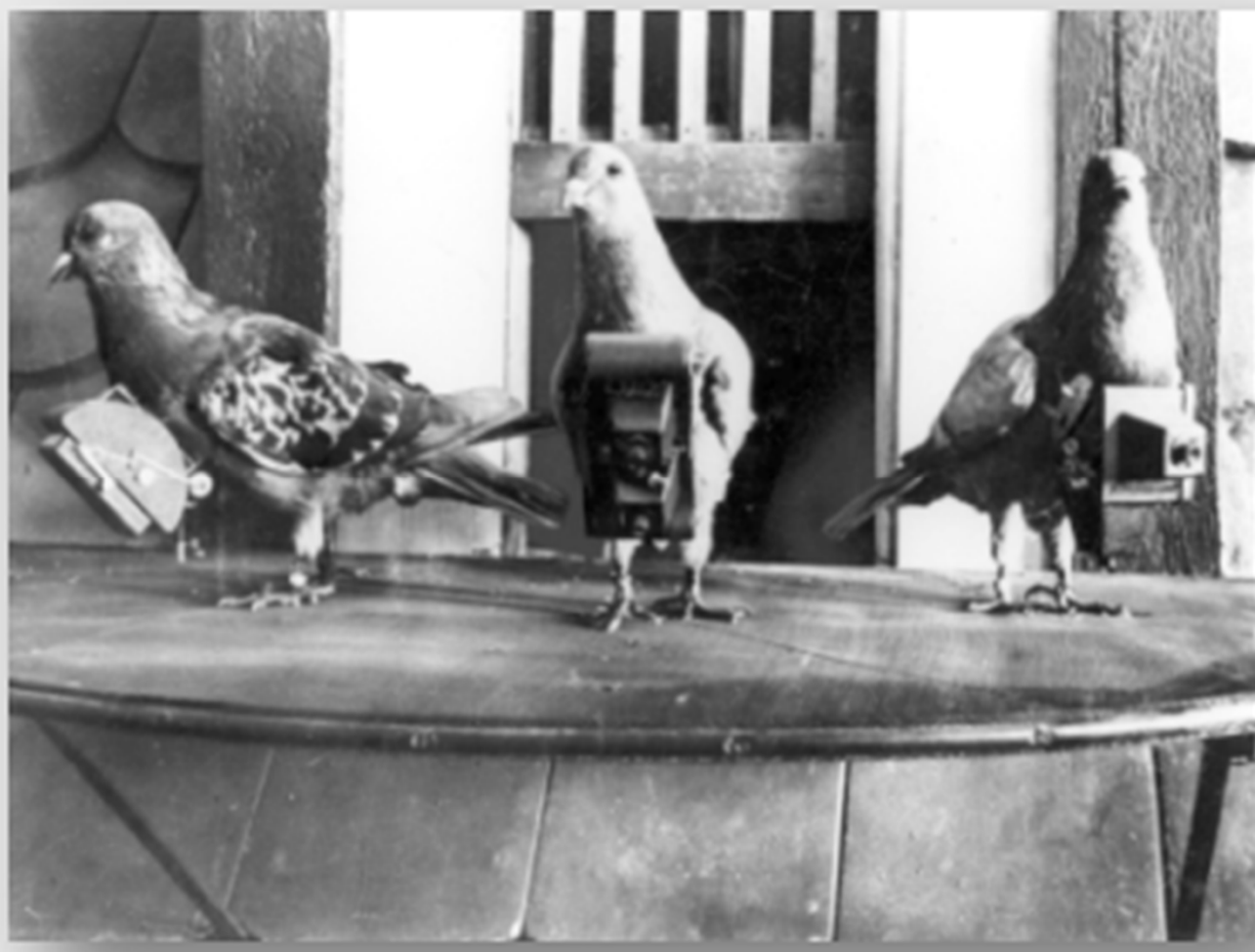
<https://threatpost.com/agencies-satellite-hacks-gps-jamming-airplanes-critical-infrastructure/178993/>

The Russian invasion of Ukraine has coincided with the jamming of airplane navigation systems and hacks on the SATCOM networks that empower critical infrastructure.

- In a warning to aviation authorities and air operators on Thursday, the European Union Aviation Safety Agency (EASA) warned of satellite jamming and spoofing attacks across a broad swath of Eastern Europe that could affect air navigation systems.
- The warning came in tandem with a separate alert from the FBI and the U.S. Cybersecurity Infrastructure and Security Agency (CISA) that hackers could be targeting satellite communications networks in general.
- The navigation-jamming attacks affecting airplanes started Feb. 24, the first day of the Russian invasion of Ukraine, EASA said – and they've continued to proliferate. So far, the affected areas include the Black Sea airspace, Eastern Finland, the Kaliningrad region and other Baltic areas, and the Eastern Mediterranean area near Cyprus, Turkey, Lebanon, Syria and Israel, as well as Northern Iraq.
- “The effects of [Global Navigation Satellite Systems (GNSS)] jamming and/or possible spoofing were observed by aircraft in various phases of their flights, in certain cases leading to re-routing or even to change the destination due to the inability to perform a safe landing procedure,” EASA warned (PDF). “Under the present conditions, it is not possible to predict GNSS outages and their effects.”



HISTORY REMOTE SENSING



PIGEON'S AND CAMERAS

PIGEON IMAGE



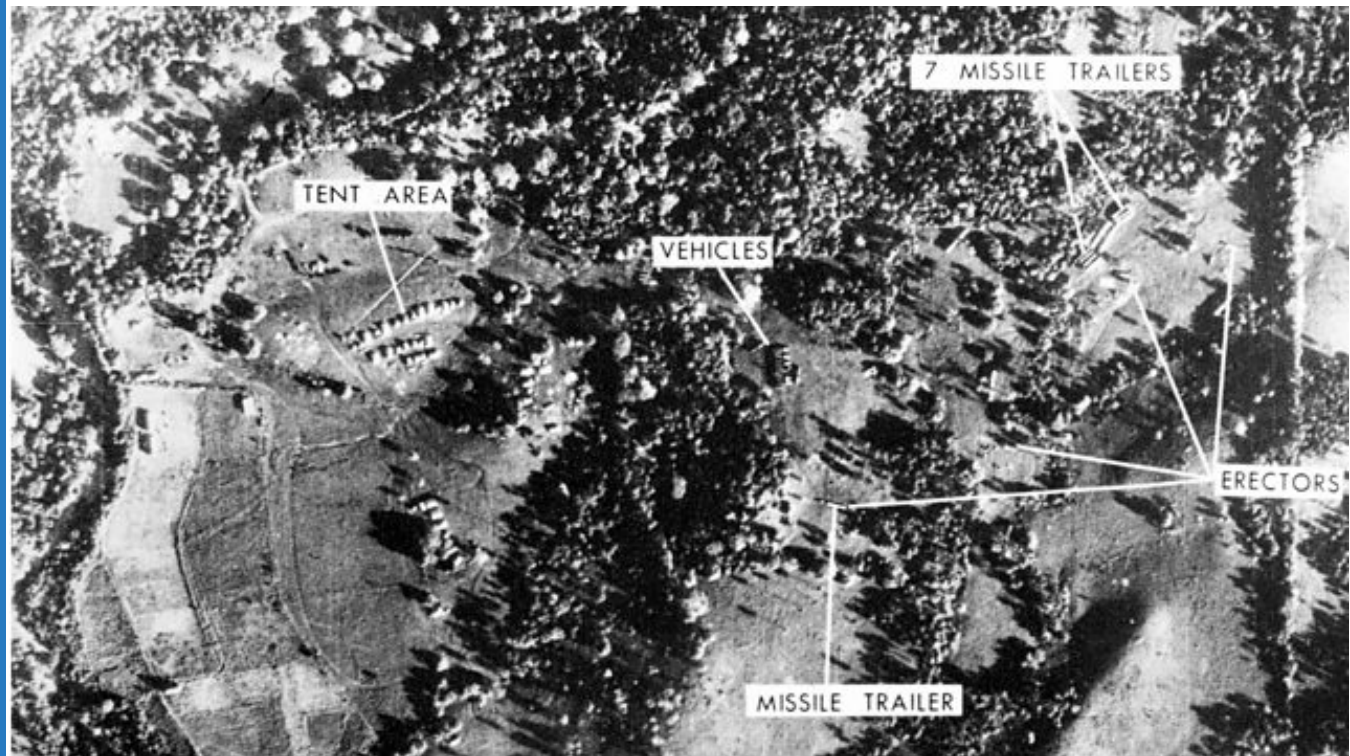
MANNED AIRCRAFT

U2 Spy Plane (70,000 feet)



CUBA MISSILE CRISES

- In October of 1962, missiles were discovered via high flying aircraft, but the resolution was not to the level that President Kennedy he could share with the public, thus Navy and Airforce Planes flying at 1000 feet moving at 500 mph took the imagery that was shared with the public. There tons of film stored in the National Archives that have never been fully analyzed.



https://www.nga.mil/history/Cuban_Missile_Crisis.html,
<https://www.archives.gov/>, and <https://jfklibrary.org>

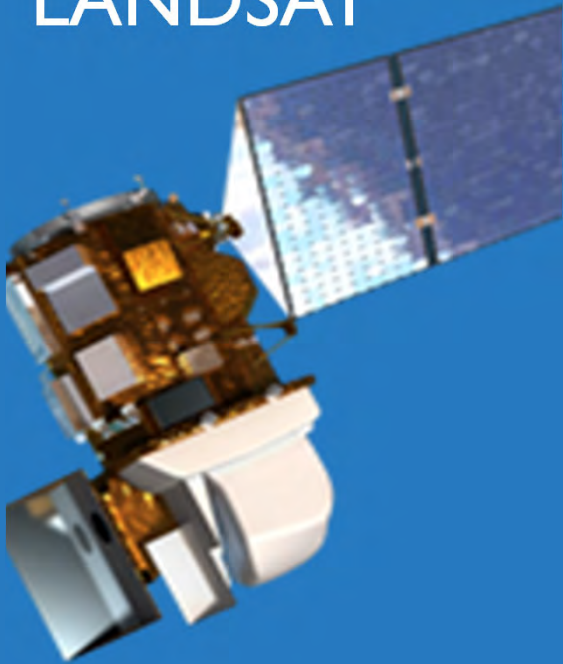
EARLY SATELLITE IMAGERY



GROWTH OF RESOLUTION

- Landsat is 30 meters, 900 square meters; a football field would be four pixels
- Sentinel is 10 meters 9 x more data, 100 square meters; a football field would be about 44 pixels
- Digital Globe .31 m 9375 x more data, a football field would be about 7000 pixels
- Aircraft 2 – 6 inches .15 m 40,000 x,
- UAS .012 m 6,250,000 x more information
- Steerable vs. set pathway
- Color Depth
 - 8-bit resolution– 256 bits
 - 10-bit resolution – 1024 bits
- Weather
- Multiple sensors and bands which can generate an automatic classification of imagery. With as few as three bands. Near-infrared, thermal infrared.

LANDSAT



SENTILE



DIGITAL GLOBE



LOJIC

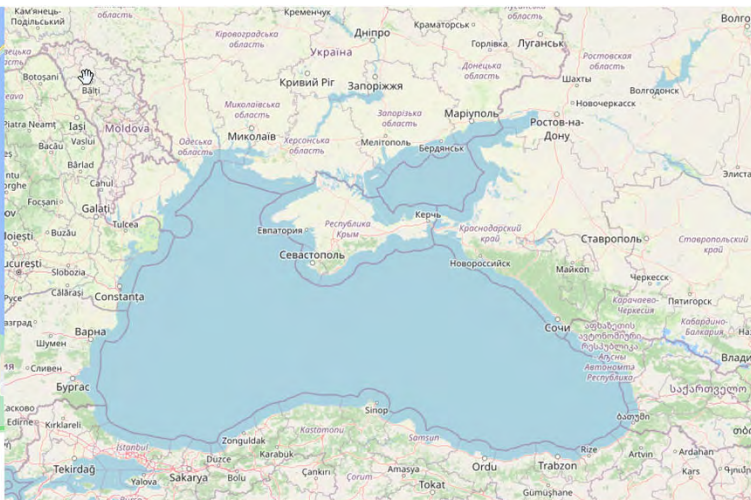
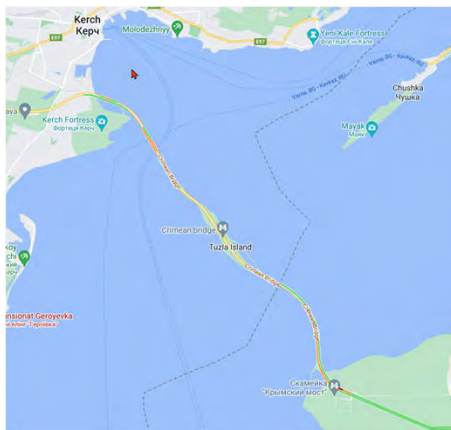




UNCREWED AERIAL VEHICLE



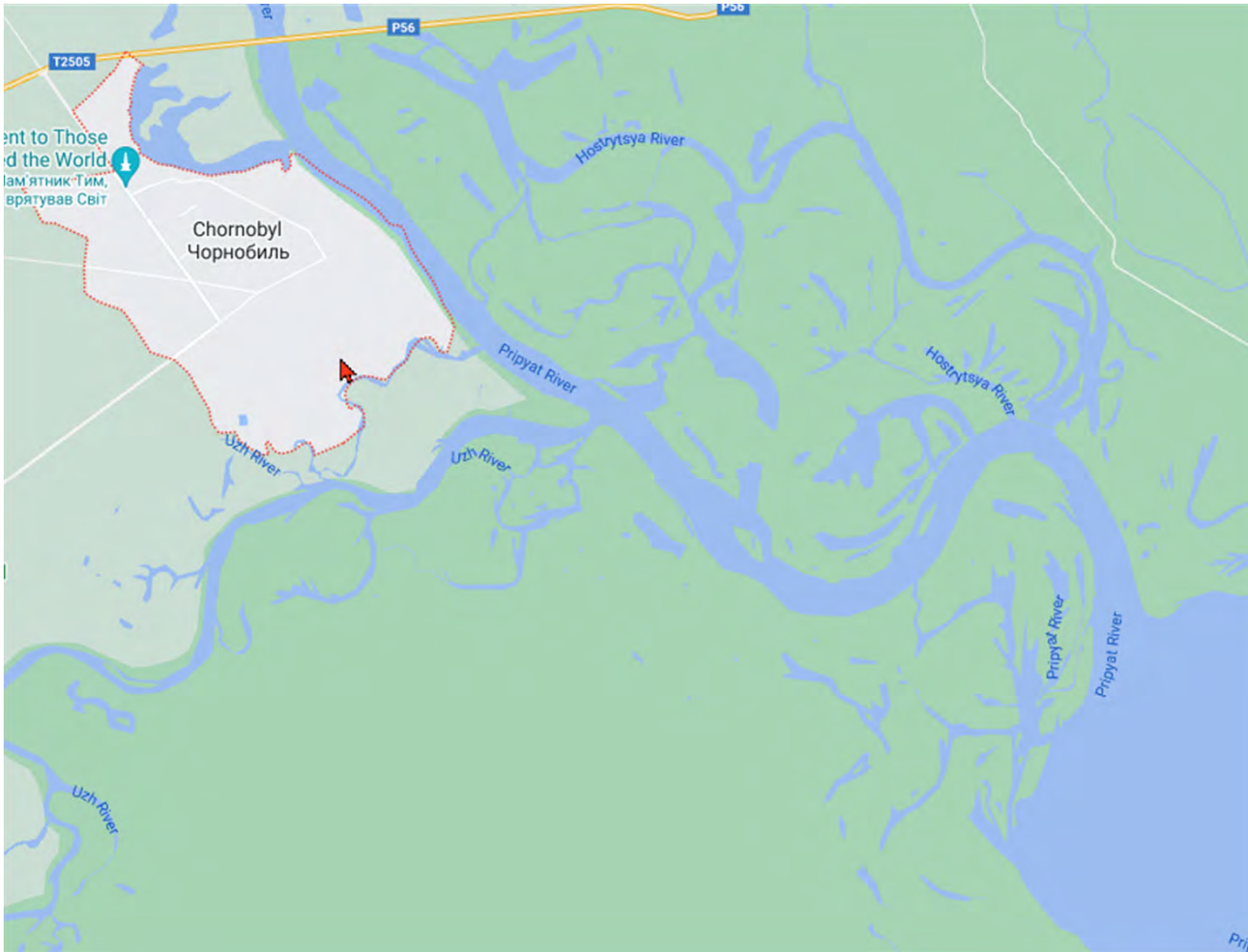
REAL TIME INFORMATION FROM UKRAINE



ETHICS

- Open Street Map View north of Kiev





GOOGLE MAP SAME REGION

THANK YOU

Vince DiNoto – Vince.dinoto@kctcs.edu

[GeoTech Center https://geotechcenter.org](https://geotechcenter.org)

Earth Observation Day: <https://storymaps.arcgis.com/stories/1bf617dd6f78452c8b62b9751ada394a>

Professional Development Events and a call for presentations:

<https://storymaps.arcgis.com/stories/2682476d0b0d46ca81f22ab0599a6188>

GeoEdC Certification for educators, registration opening in May more information in the above link

