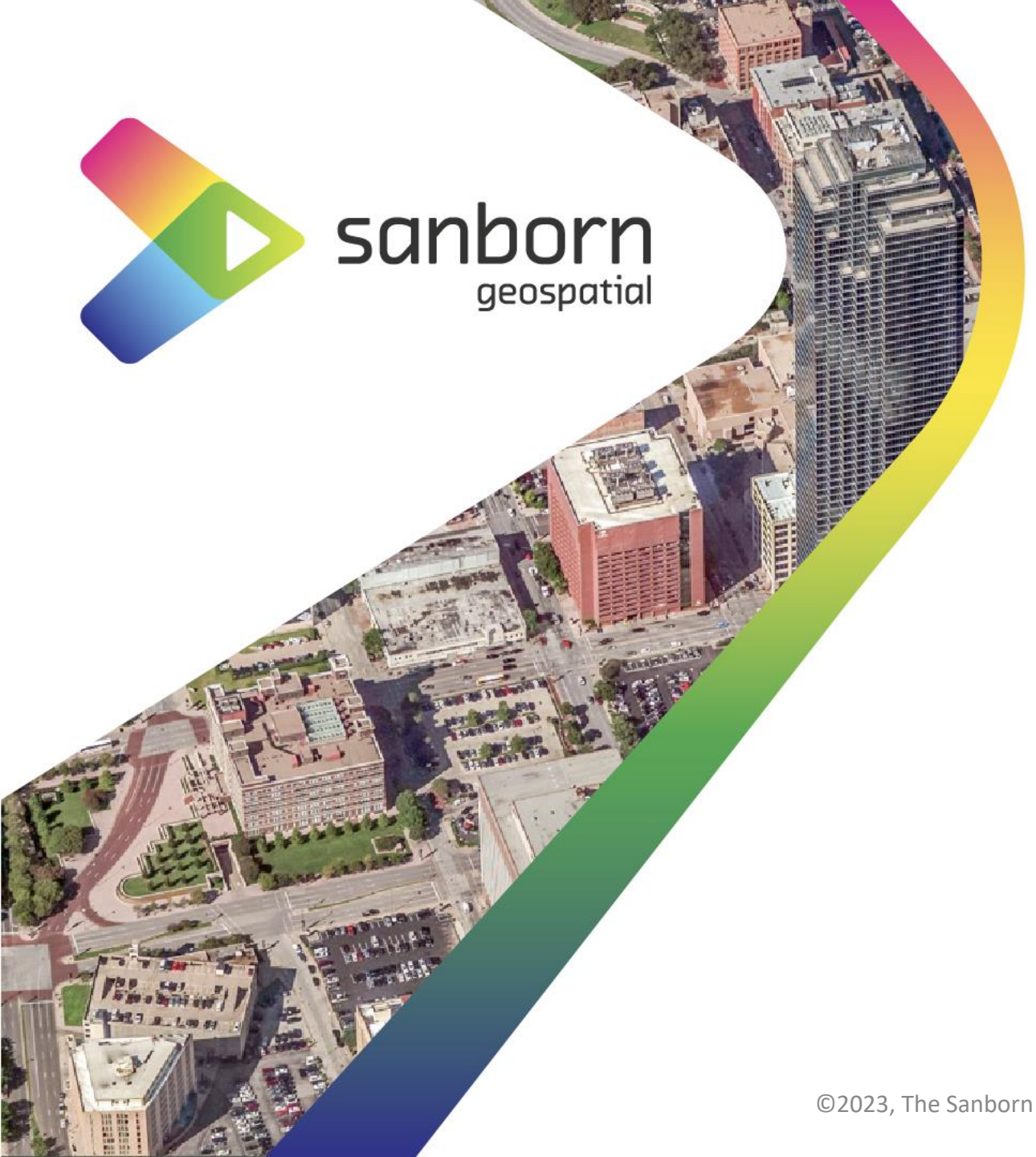

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Navigating the future:

Emerging Geospatial Technologies

With you today:

Morgen Healy

Vice President of
the AppGeo Division

Matt Hiland

Director of
Strategic Accounts,
Central Region

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Thank You TxGIO!!

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- ✓ **Have fun**
- ✓ **Show brand DNA**
- ✓ **Share some weird haircuts**

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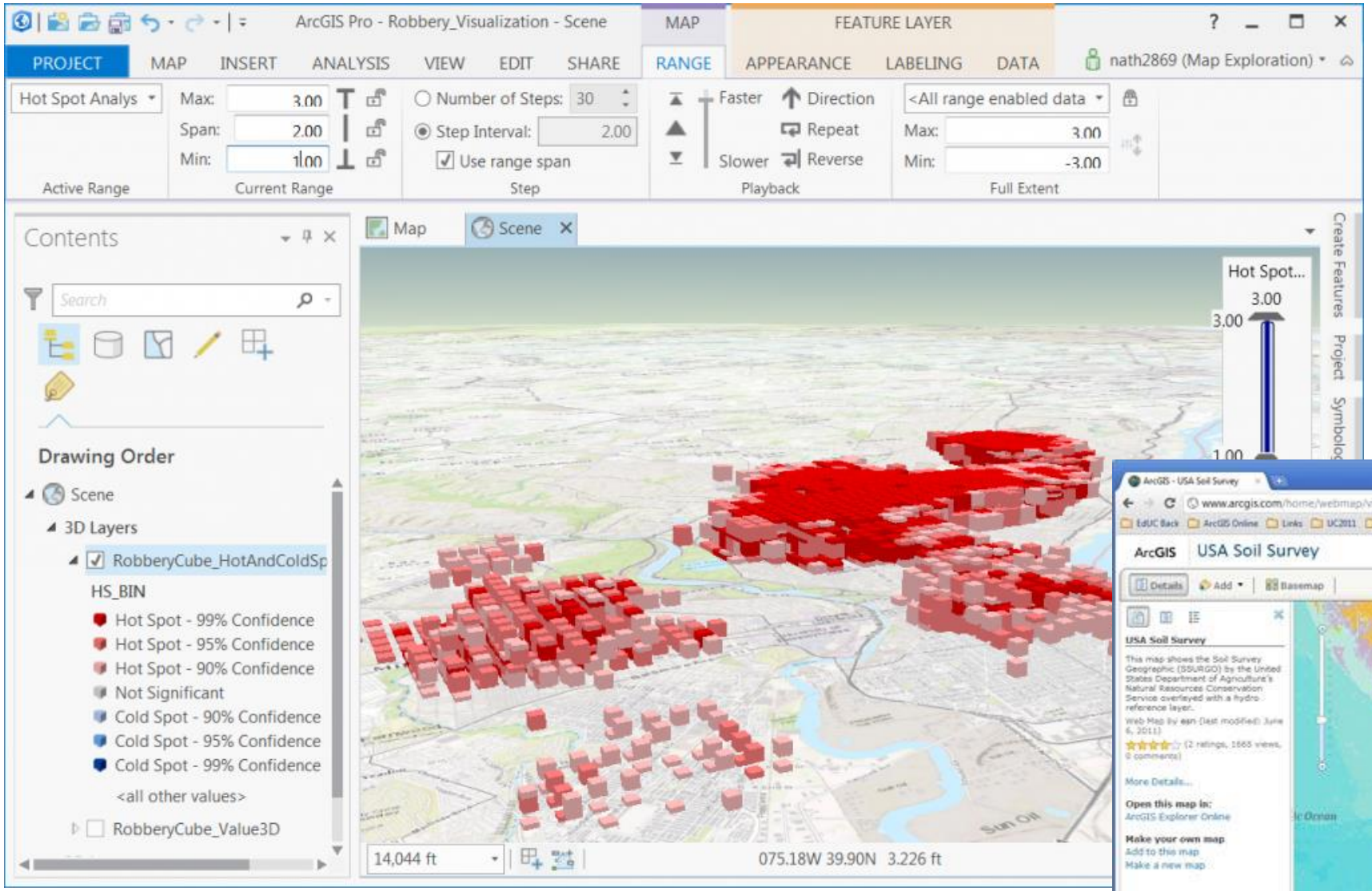
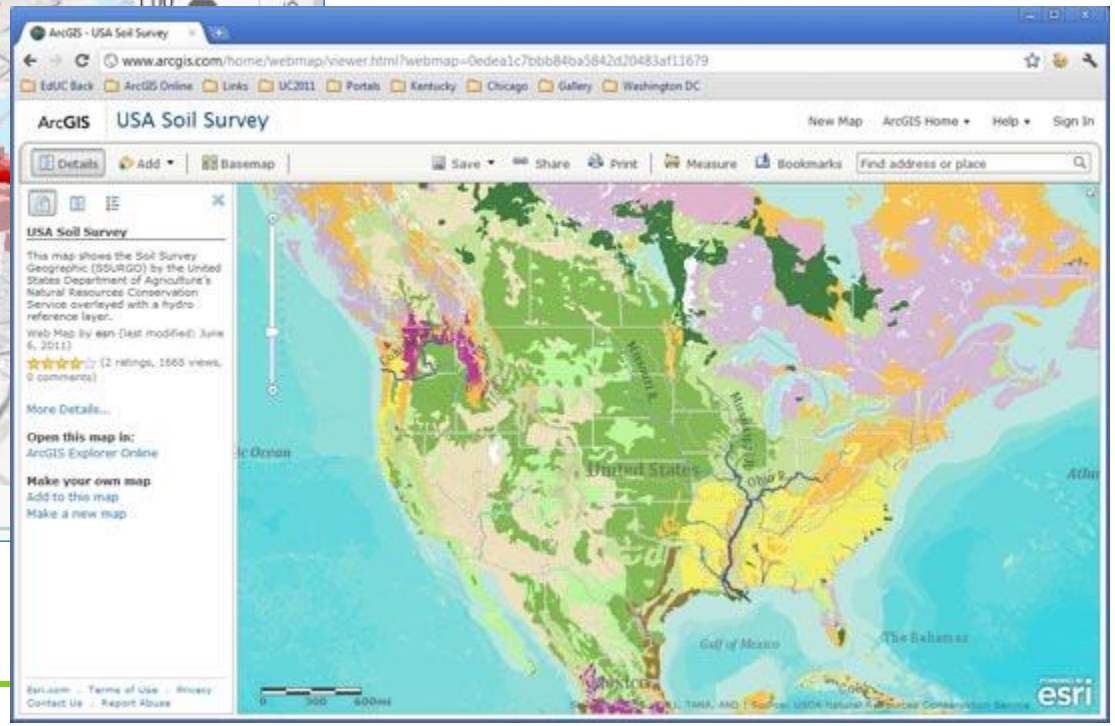
- ✓ **Have fun**
- ✓ **Consider our shared Geospatial DNA**
- ✓ **Share some weird haircuts**

ArcGIS Pro
ArcGIS Online





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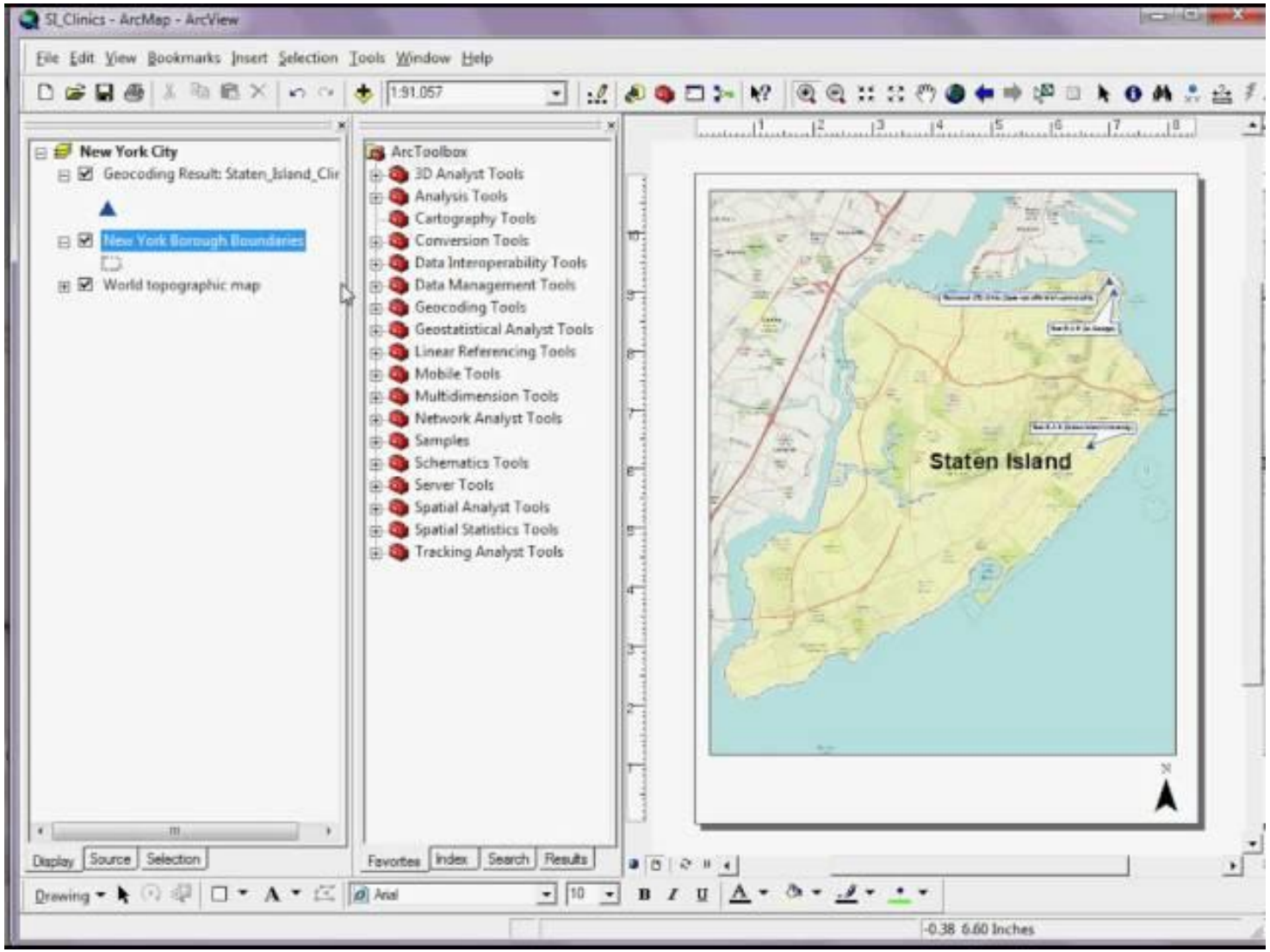
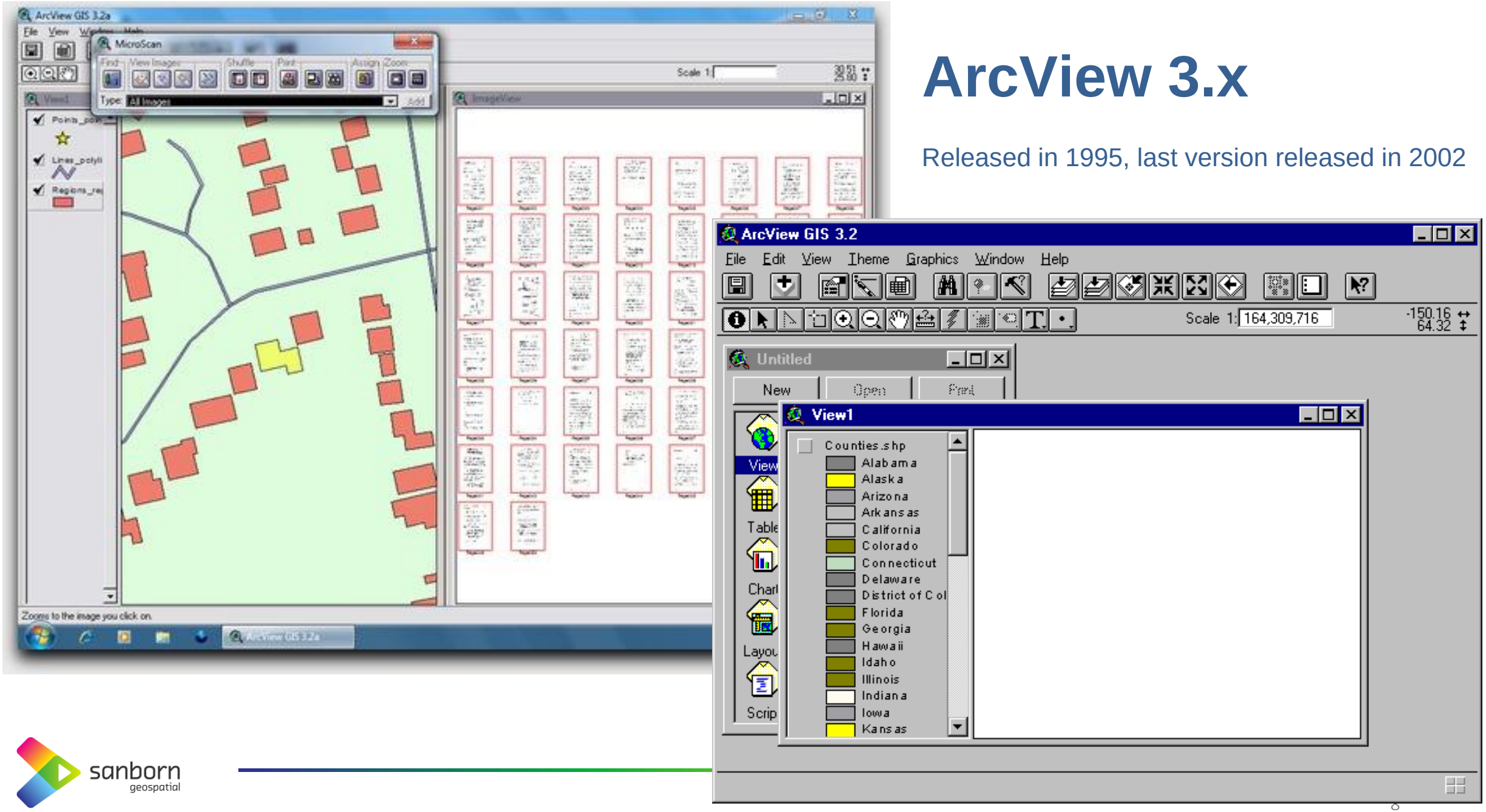


ArcGIS 8.x

Released 1999

ArcView 3.x

Released in 1995, last version released in 2002



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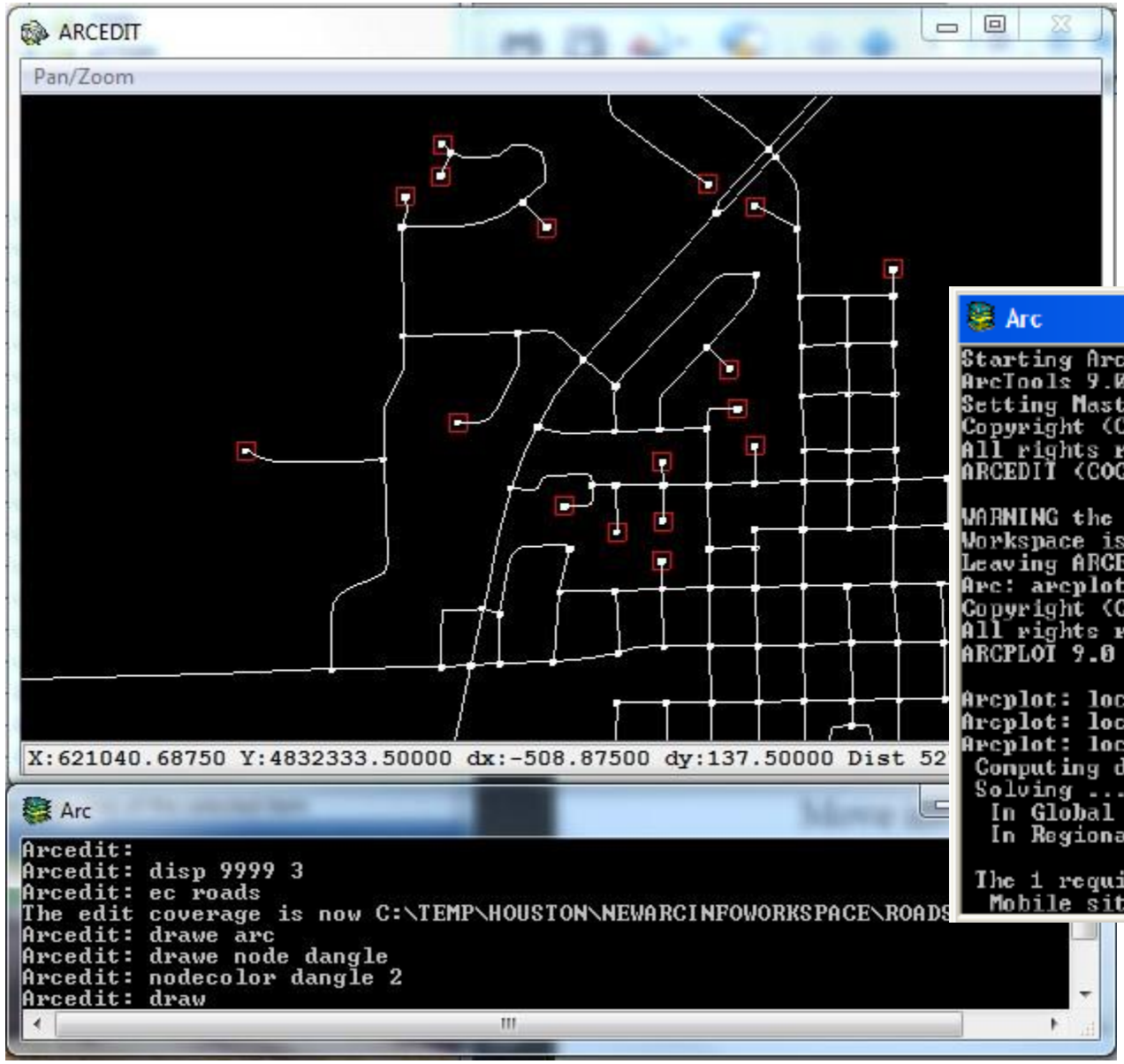
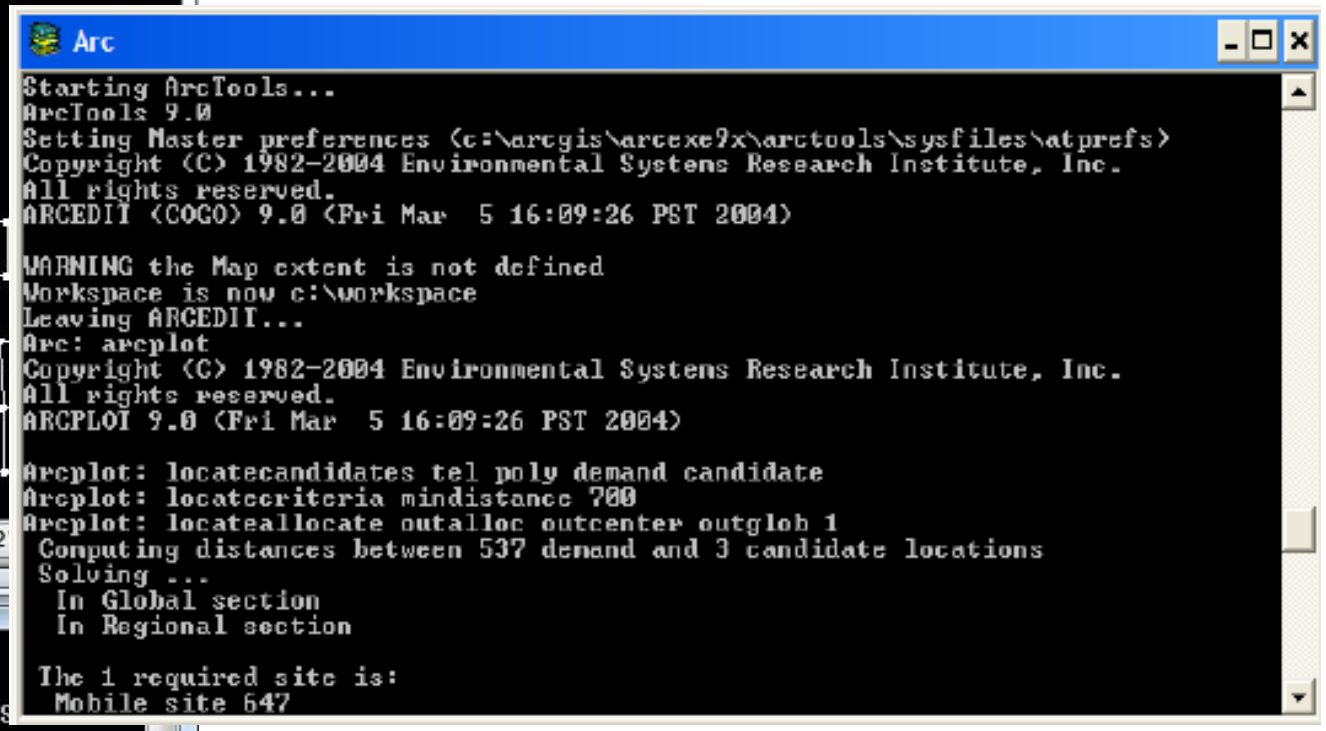
Digitizing Tablet

Circa 1980s – early 2000s

Esri ARC/INFO

Initial release 1982





https://repository.aip.org/islandora/object/nbla:296317

Intergraph Display (1978)

Intergraph Workstation (1981)

Intergraph Workstation

https://ohiostate.pressbooks.pub/graphicshistory/chapter/10-5-intergraph-bentley-dassault/

Stereoplotter

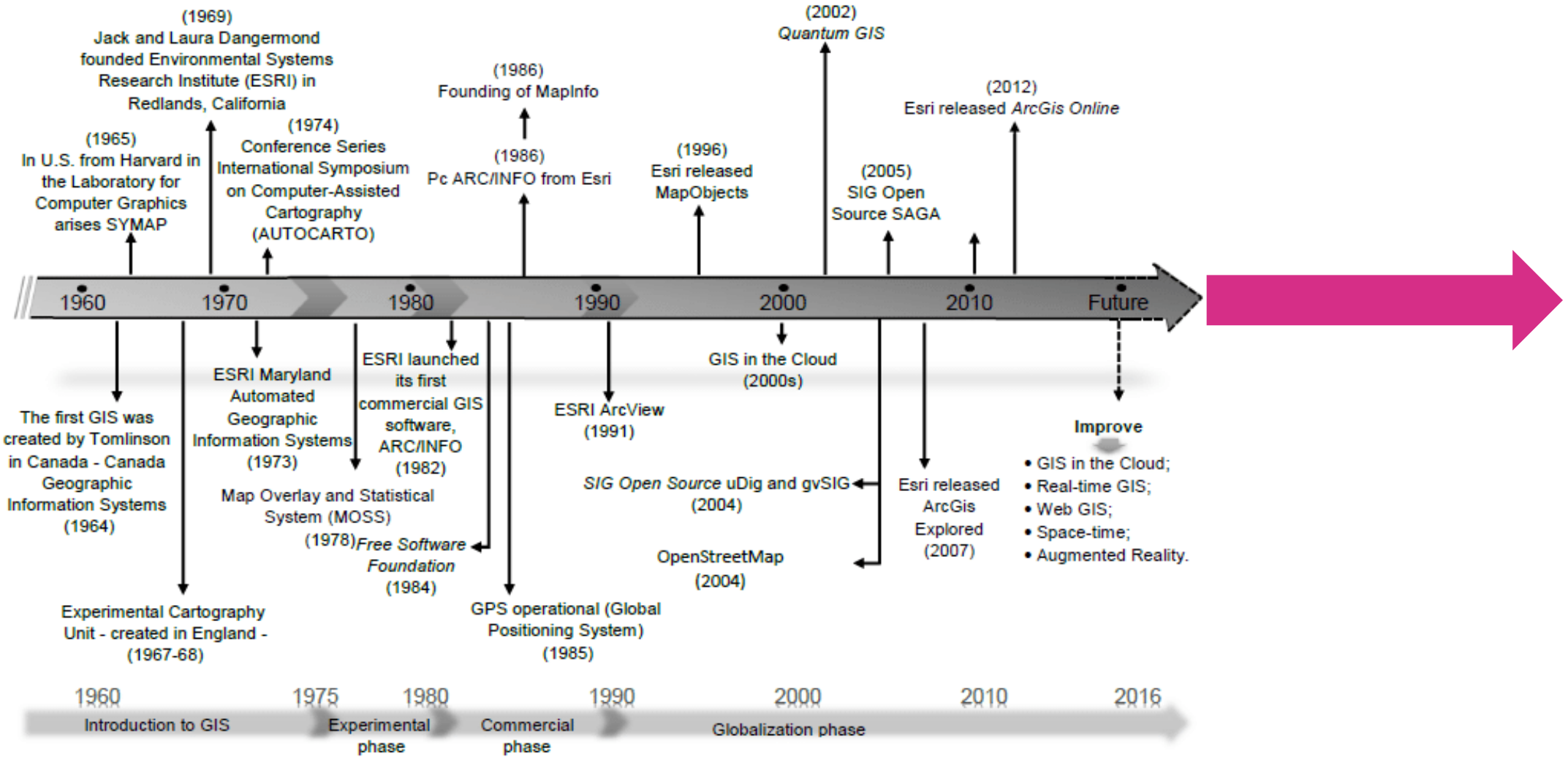
Galileo Santoni model III analog stereoplotter.
Photo by W. Mayo

Wild A-10 analog stereoplotter.
Photo By W. Mayo

A stereoplotter (early use in 1930s) uses overlapping images to map topographic contour elevations.

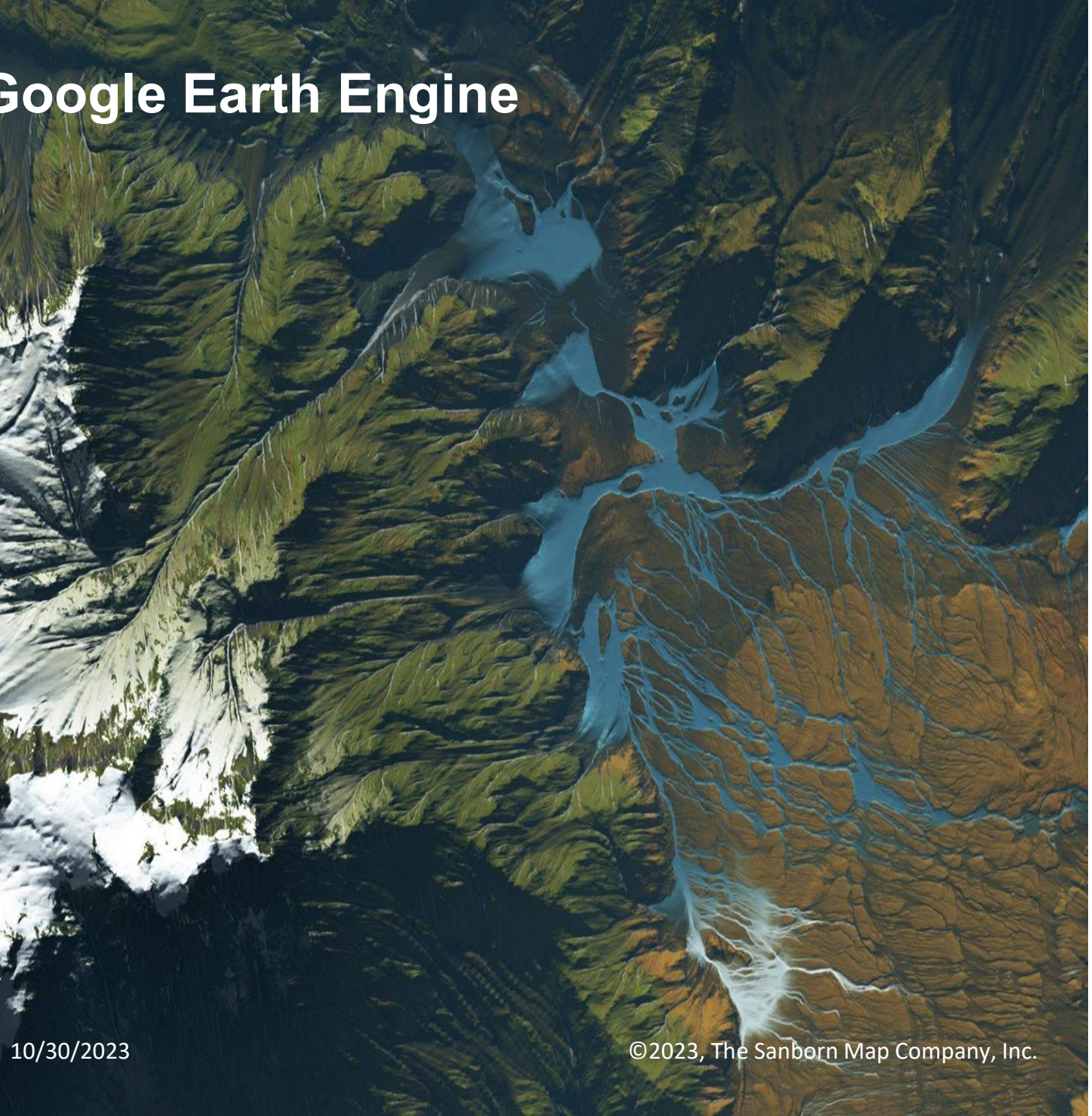
The photos are put onto transparent media and projected, overlapping each other. The operator, using a special set of optics, would then see the image as three-dimensional due to the differing perspective of each photo.

Timeline of Major GIS Events



Remoaldo, Paula & Ribeiro, Vítor & Lopes, Hélder & Silva, Sara. (2017).
Chapter 301: Geographical Information Systems: The past, present and future.

Google Earth Engine



Google Earth Engine

GEE is a cloud-based geospatial processing platform for executing large-scale geospatial data analysis.

Large volume of geospatial data in an Archive

Petabytes of data in one location

Powerful Image Analysis software

Google Earth Engine

The Classic Remote Sensing Workflow

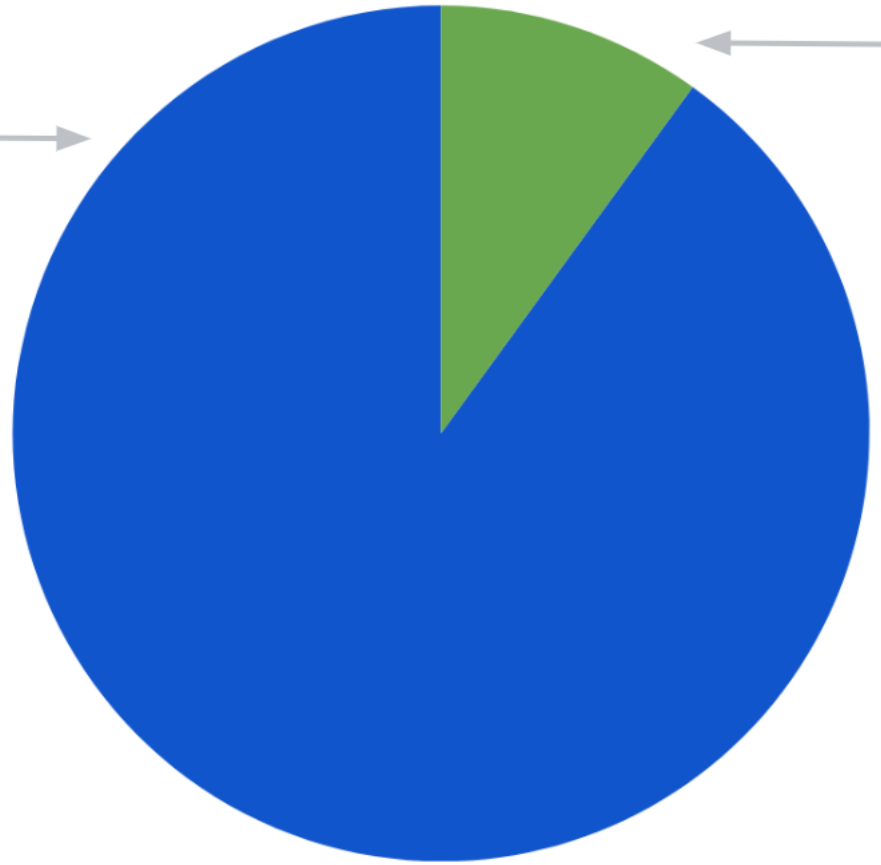
Google Earth Engine

Infra. /

Data Prep

Provision Infra.
Download data
Odd file formats
Metadata
Bad/missing data
Clouds & shadows
Atmosphere & haze
Calibration
...

Google can do all this stuff once...



Data science!

...so our users can focus on this.

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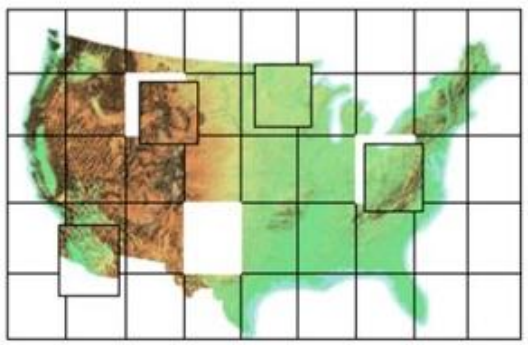
Earth Engine Public Data Catalog

- Imagery (Landsat, MODIS, Sentinel, NAIP)
- Elevation (Digital terrain)
- Geophysical
- Climate & Weather
- Demographic
- Vector Data
- GEE contains over 80 petabytes of data

Computation Engine

A **cloud-based processing infrastructure** that automatically **parallelizes analyses on many CPUs across many computers** in Google's data centers.



Divides data in independent grids

Storage clusters & Computing clusters

Unprecedented speed: reduce processing times.

Merges all grid calculations

Ease of use/lower costs: online platform with easy access

A Powerful Image Analysis Software Enables Collaboration

Public data catalog:

Users can access vast amounts of publicly available data.

Processing power:

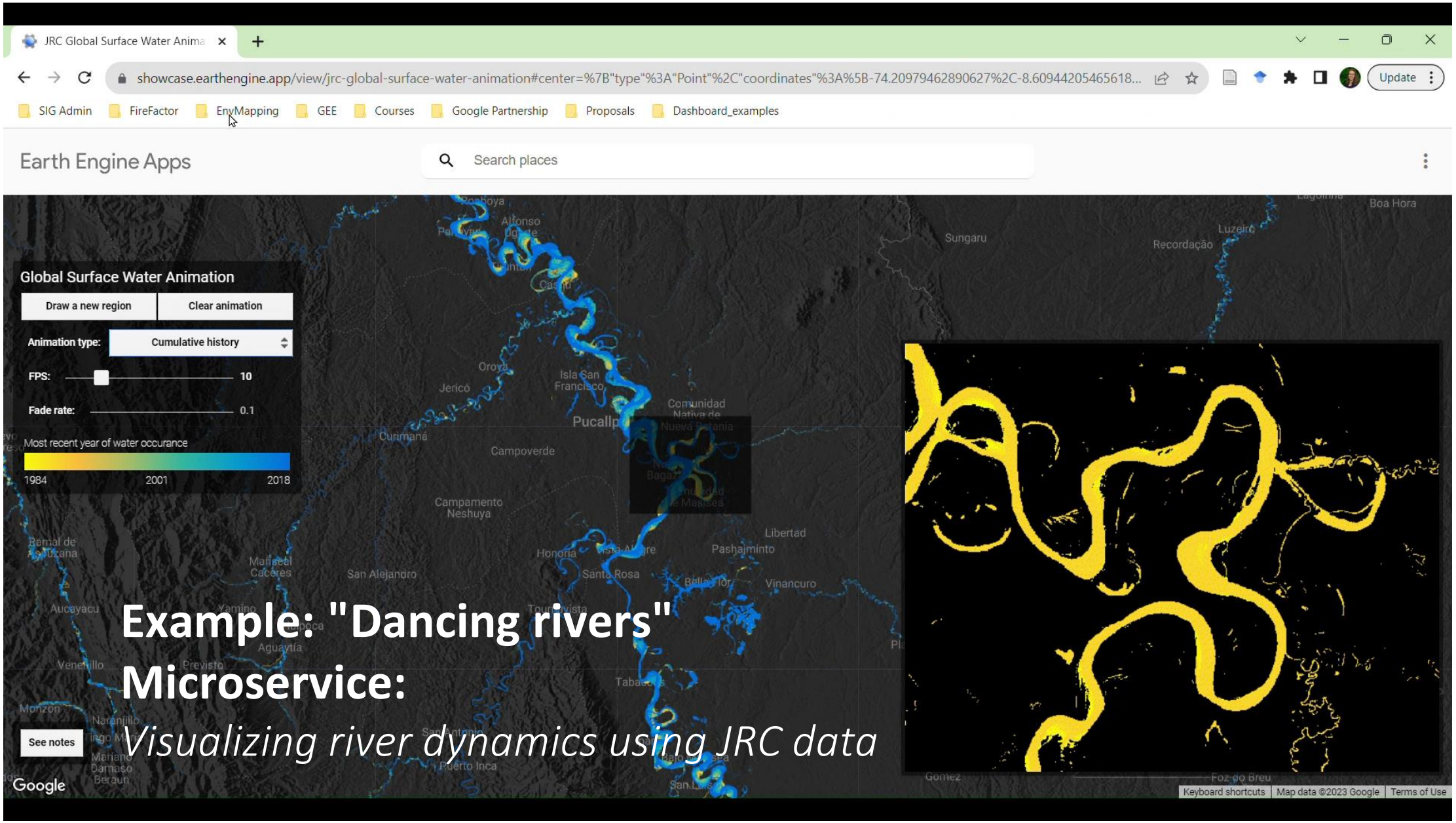
- Distributed computation power
- Cloud processing
- Comprehensive data analysis toolset

Interactive development platforms:

- Explorer
- Code editor

Save & share work routines.

Google Earth Engine



Example: "Dancing rivers" Microservice:

Visualizing river dynamics using JRC data

A wide range of customer use cases can be unlocked with geospatial imagery

Google Earth Engine

Sustainable Sourcing

Enable global **supply chain transparency** and **traceability** to footprint.

Protecting Natural Resources

Enable **sustainable forest management** and **monitor land cover change** and climate events response.

Environmental Impact

Monitor and act (ex. **Methane Detection**)

Climate Risk

Understand **climate risk exposure** for operations (eg. flood, wildfire, drought, etc)

Agricultural Technology

Precision Agriculture, Increase Yield, improved visibility of the Food Supply Chain

Health Related Applications

Mosquito Forecasting to prevent spread of disease.
Algae Bloom Monitoring for clean water

Land use change over time enables many GEE commercial use cases

An extensive variety of use cases are possible subject to customer data availability and goals

Digital Twins

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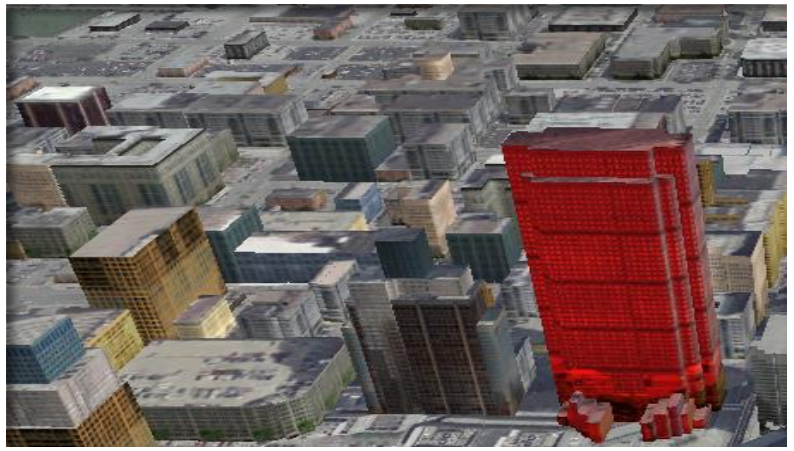
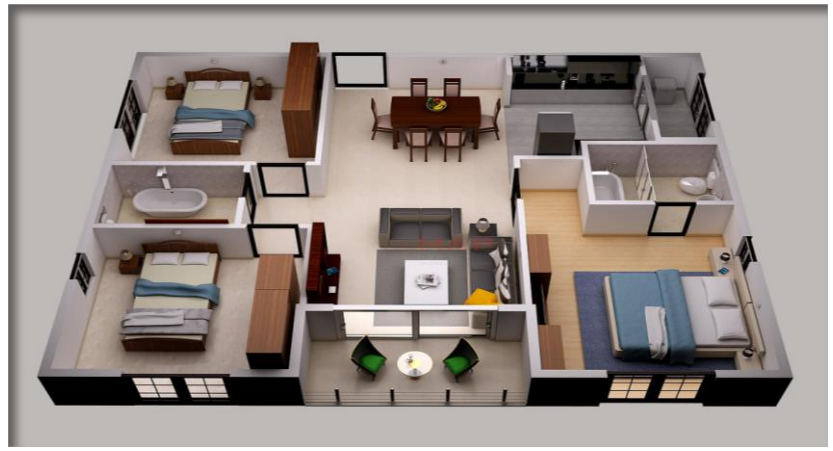
What is a Digital Twin

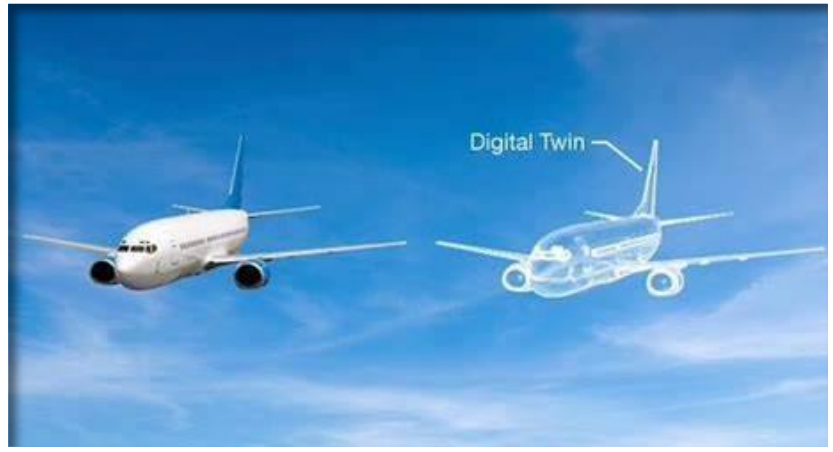
According to July 12, 2023 article published by McKinsey:

"A digital twin is a digital representation of a physical object, person, or process, contextualized in a digital version of its environment. Digital twins can help an organization simulate real situations and their outcomes, ultimately allowing it to make better decisions."

Many Types of Digital Twins







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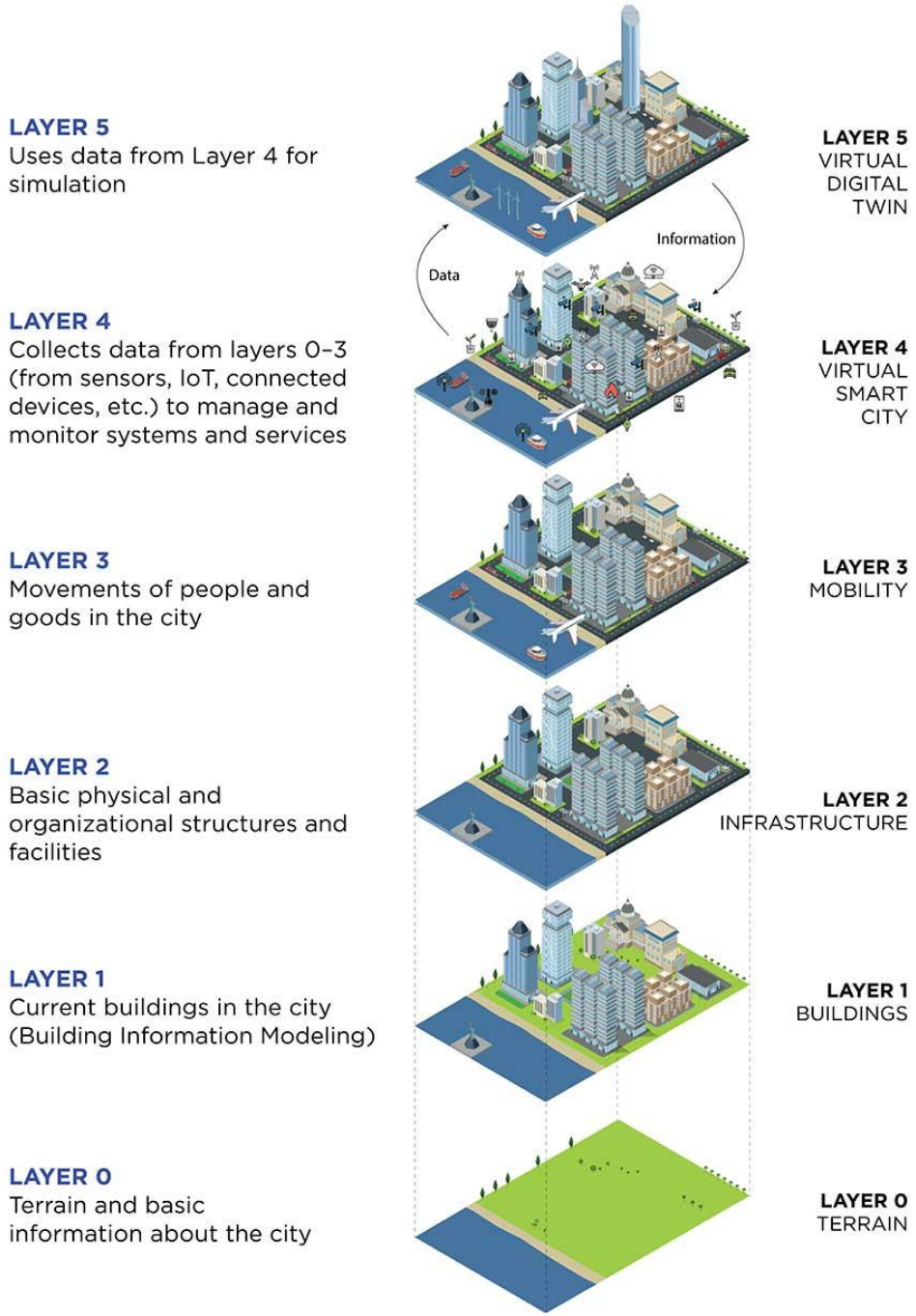
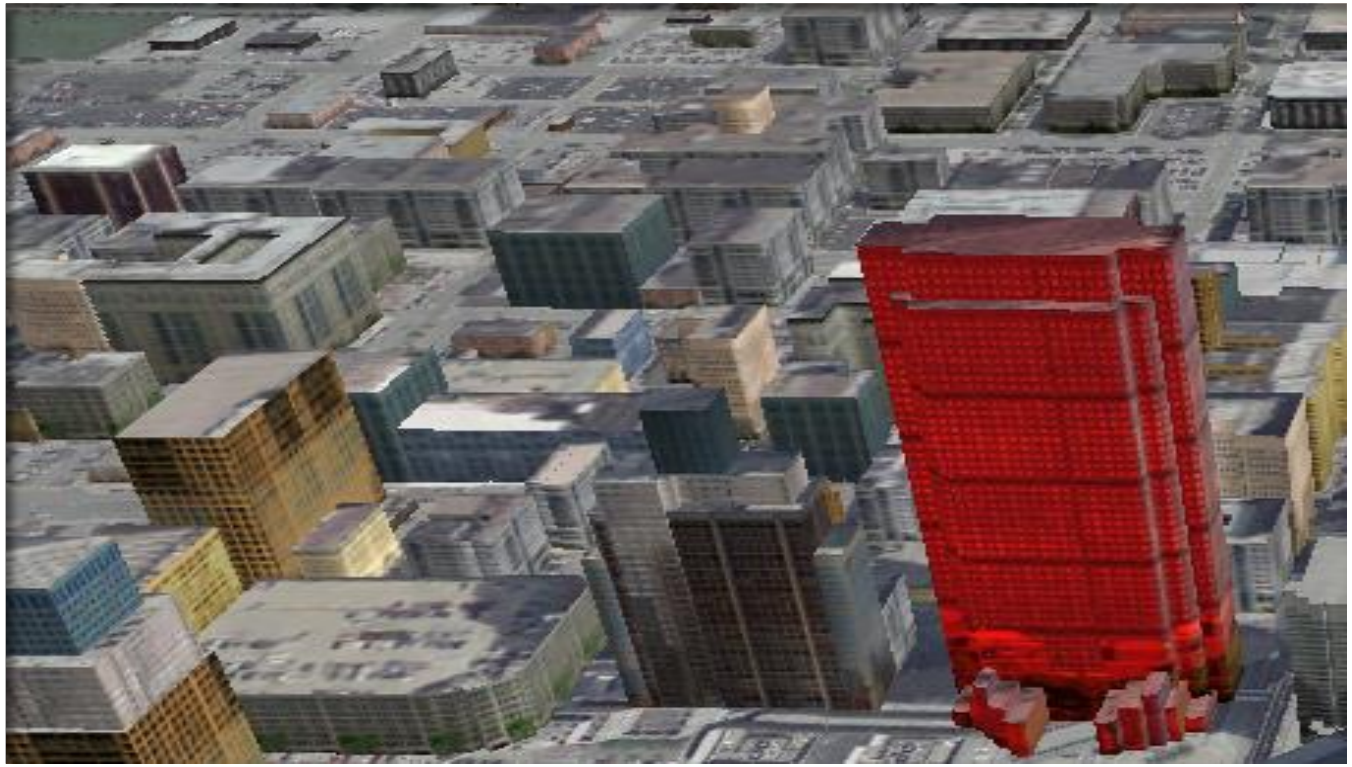
Digital Twin:
Highly Accurate 3D Geospatial model

- Digital realistic representation of a physical object, product, entity, or place (neighborhood, city, etc.)
- Digital twins are deployed to analyze and determine how changes can make urban areas more livable, navigable and sustainable
- Provide seamless ability to analyze, plan and react in real time
- Typically requires connection to the real world (often via real-time data feeds)
- Enables Smart Government - Allows for scenario modeling, risk mitigation, increased operational awareness and efficiency



https://www.planning.org/planning/2021/spring/smart-city-digital-twins-are-a-new-tool-for-scenario-planning/

City Planning



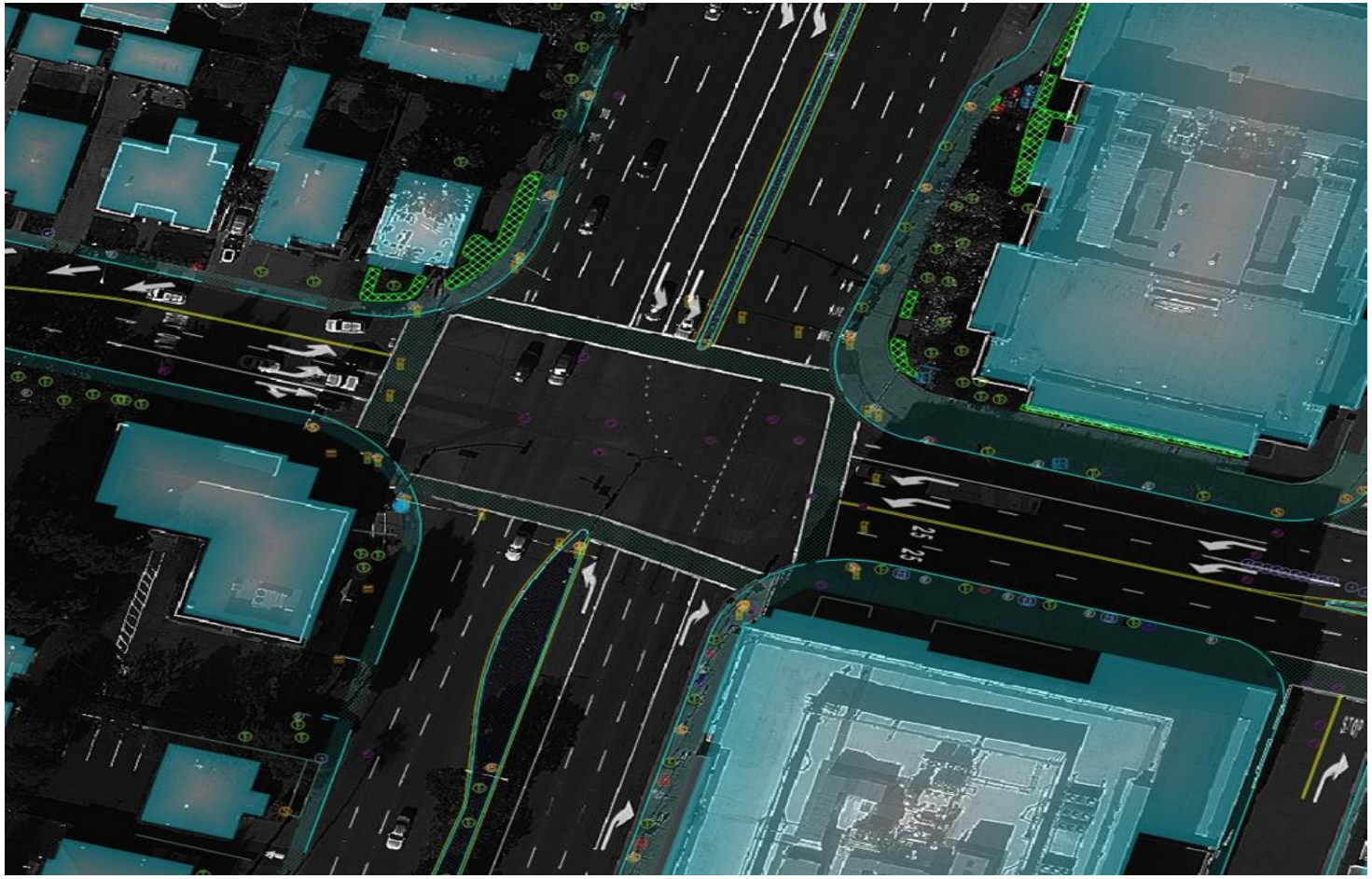
Visualizing how a proposed new building impacts the surrounding area

Noise pollution modeling (Image courtesy: Hexagon)

Traffic Planning & Autonomous Vehicles

Full 3D inventory of all street-level assets and infrastructure:

- Roads, Lanes, paint/markings
- Signs and poles
- Sidewalks/crosswalks, Parking
- Overpass, Barriers

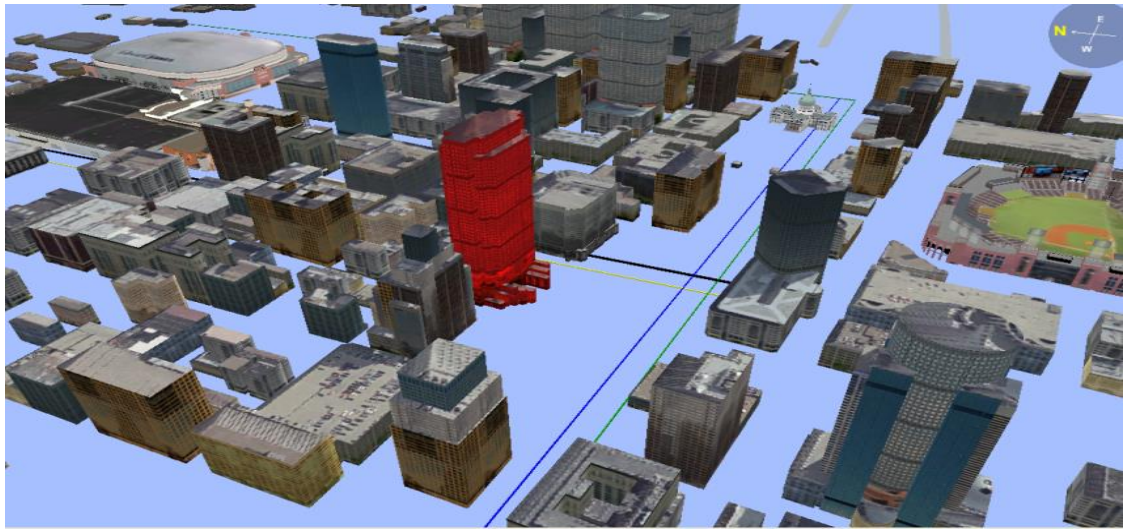


Traffic simulations and route planning

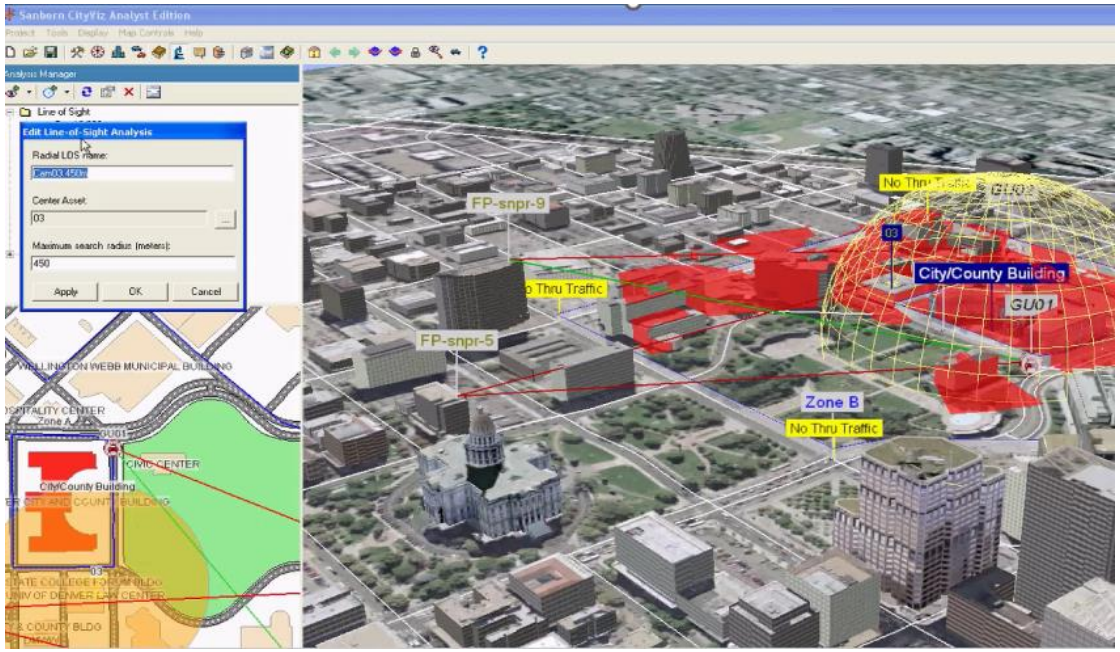
Real-time traffic mitigation responses

Modeling impacts of proposed roadway construction / lane closures

Emergency Response and Hazard Mitigation



Flood Hazard Vulnerability



Emergency Response Planning and Operations

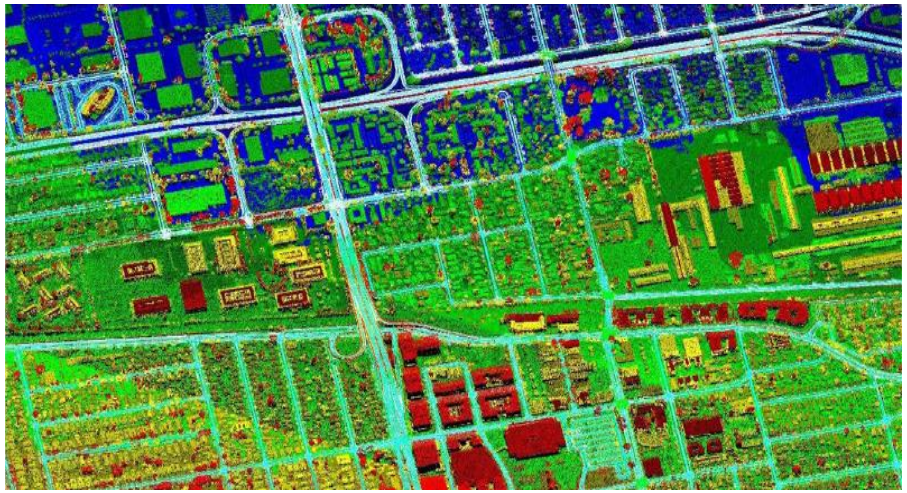
Basic Components for a Digital Twin Base Map

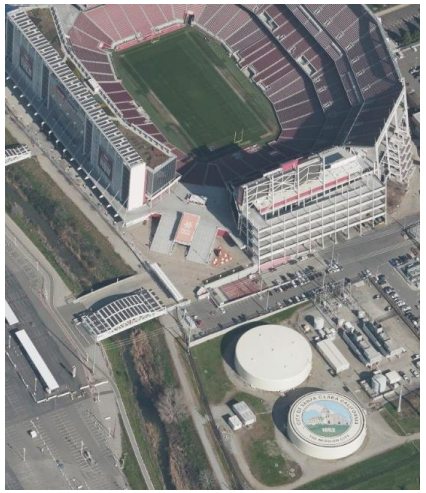
Geometry

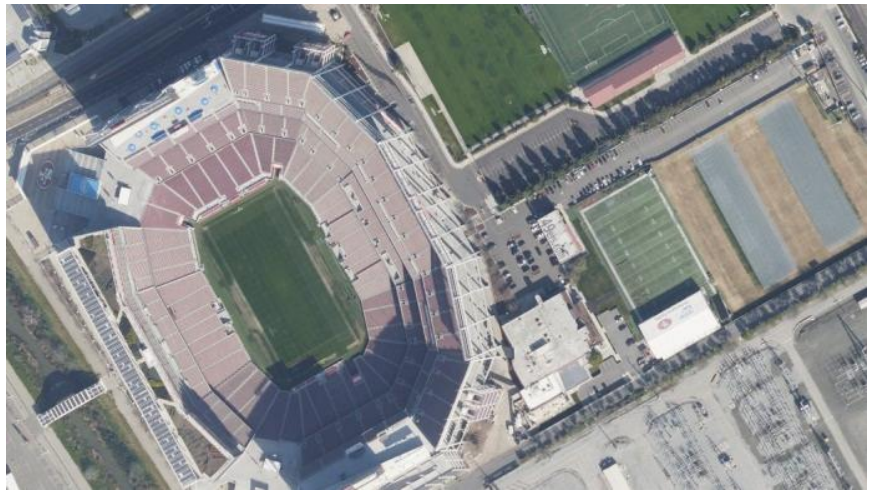
Texture/Facade

What Data Do You Need to get started?

- Ortho Imagery
- Oblique Imagery
- Aerial Lidar
- Ground Based Imagery
- Ground Based Lidar







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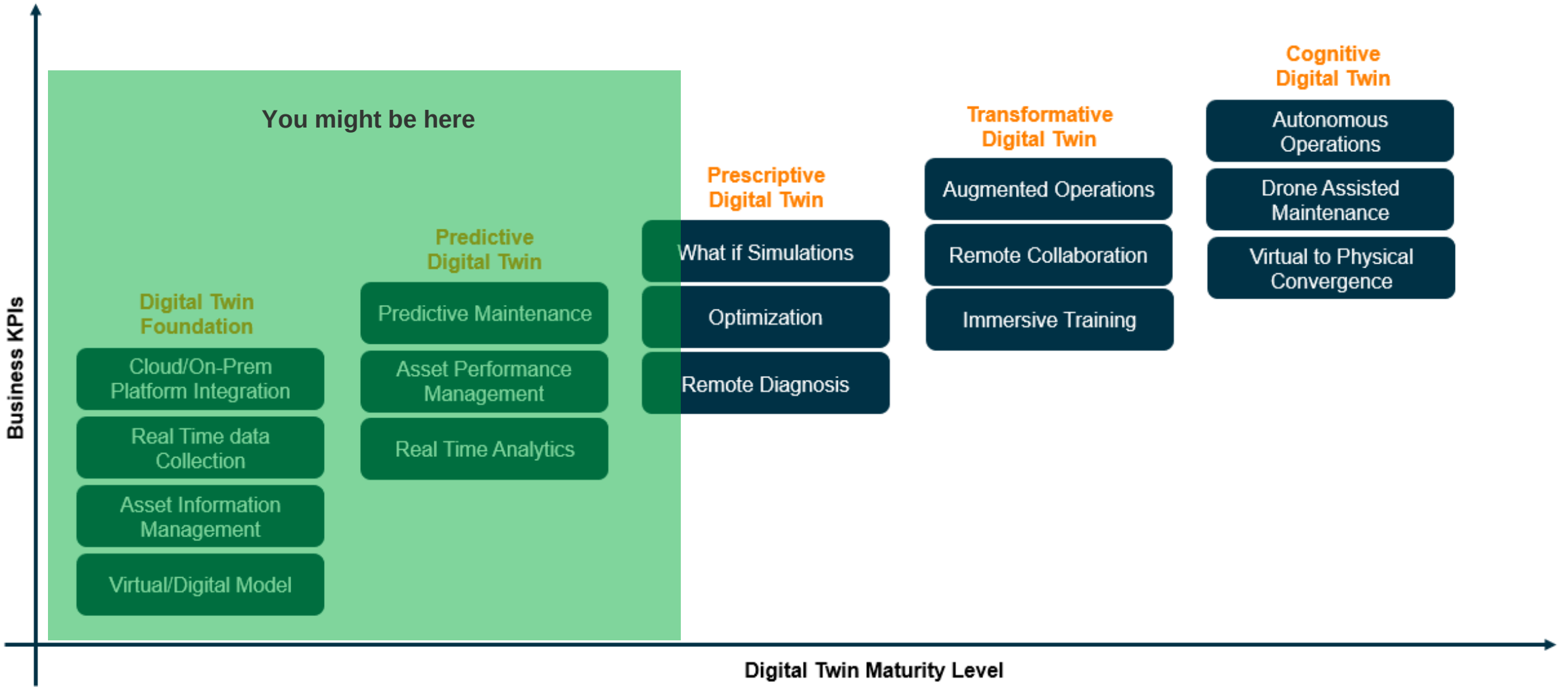


https://www.linkedin.com/pulse/digital-twin-maturity-vinayak-kharche/

Machine Learning

What is Artificial Intelligence?

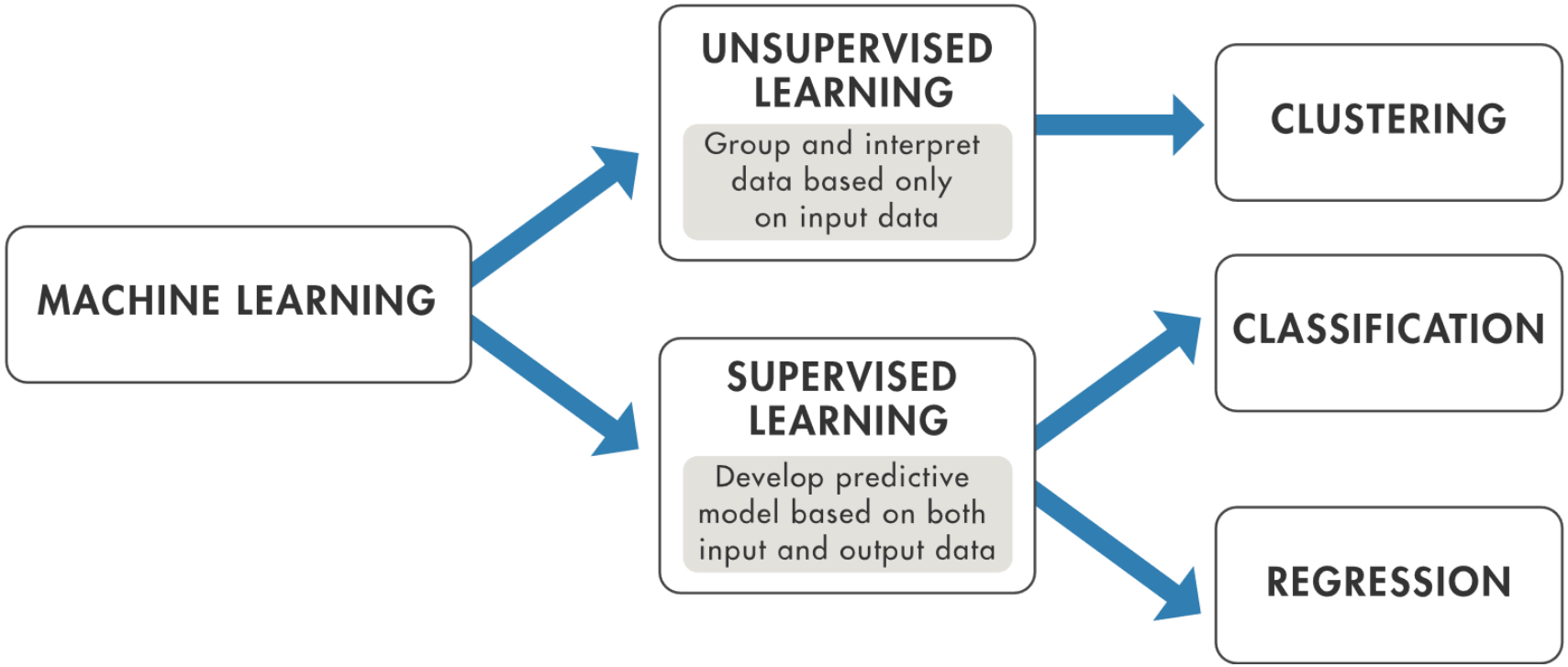
"Artificial intelligence, or AI, is a simulation of intelligent human behavior. It's a computer or system designed to perceive its environment, understand its behaviors, and take action. Consider self-driving cars: AI-driven systems like these integrate AI algorithms, such as machine learning and deep learning, into complex environments that enable automation."

-What Is Artificial Intelligence (AI)? - MATLAB & Simulink (mathworks.com)

What is Machine Learning?

"Machine Learning is an AI technique that teaches computers to learn from experience. Machine learning algorithms use computational methods to "learn" information directly from data without relying on a predetermined equation as a model. The algorithms adaptively improve their performance as the number of samples available for learning increases. "

-What Is Machine Learning? | How It Works & Tutorials - MATLAB & Simulink (mathworks.com)



Geospatial Applications of ML

- Feature extraction from imagery and/or lidar
- Tree canopy analysis
- 2D and 3D buildings
- Predictive analytics
- Damage assessment
- Marshals Fire:
  - Dec. 30, 2021
  - Boulder County, CO
  - >6,000 acres burned
  - >1,000 structures destroyed
  - Many flights completed by multiple vendors

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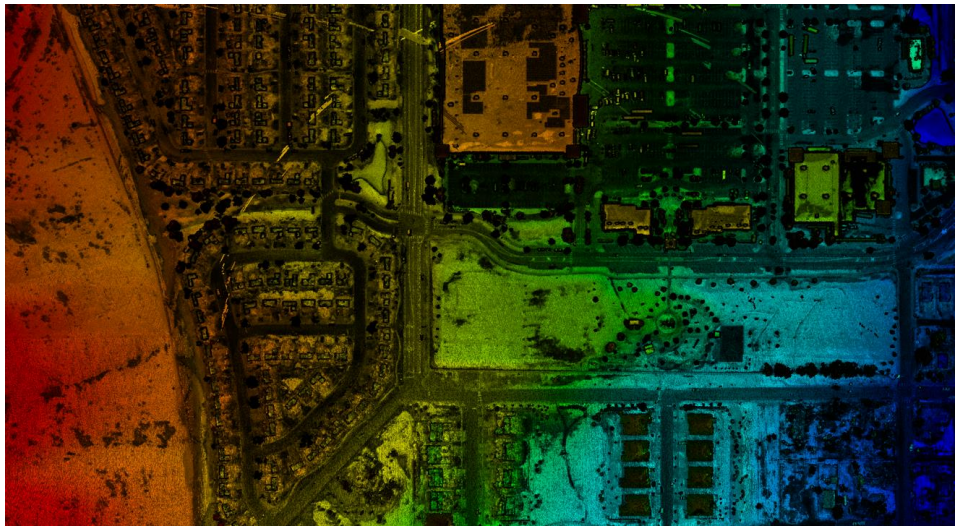
Remote Sensing Source Information

- Remote sensing and GIS modeling can be utilized to acquire information about impacted areas and to speculate about the extent of potential damage.

Optical

- Limited canopy penetration
- Weather (snow) impacts
- Longer time of collection

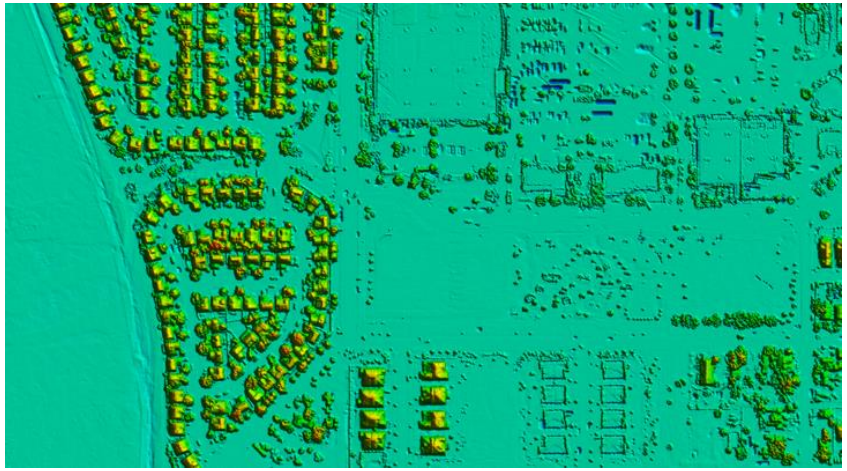


LIDAR

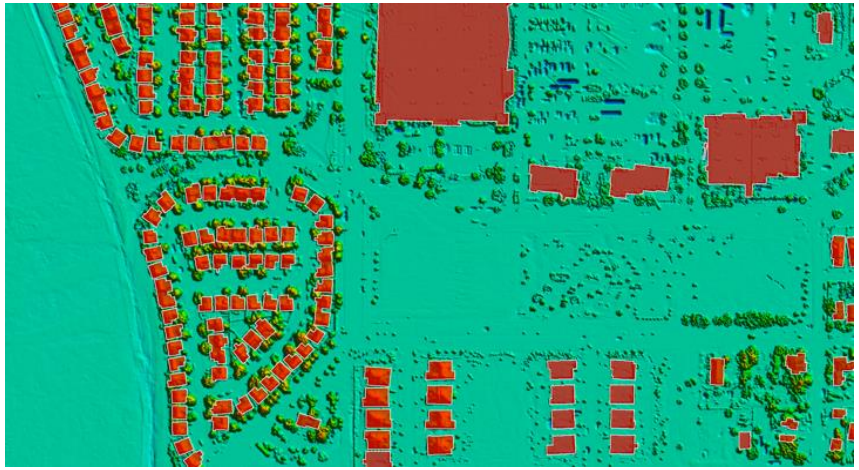
- Canopy/vegetation penetration
- Weather/light independent
- Higher surface density
- Vertical Accuracy

Data Processing Approach

- Baseline data
  - 3DEP (QL1 and QL2)
  - Additional classification required
  - Feature extraction required
  - Created ML based building footprints
- New data (QL1)
  - Normalized data to baseline
  - Automated change detection
- Volumetric change from 2020 vs 2022 building footprints
- Data Integration - Property Information
- Timelines
  - Collection – 1 day
  - Calibration – 1 day
  - Classification – 1 day
  - Analytics – 1 day
  - Total time: Less than one week

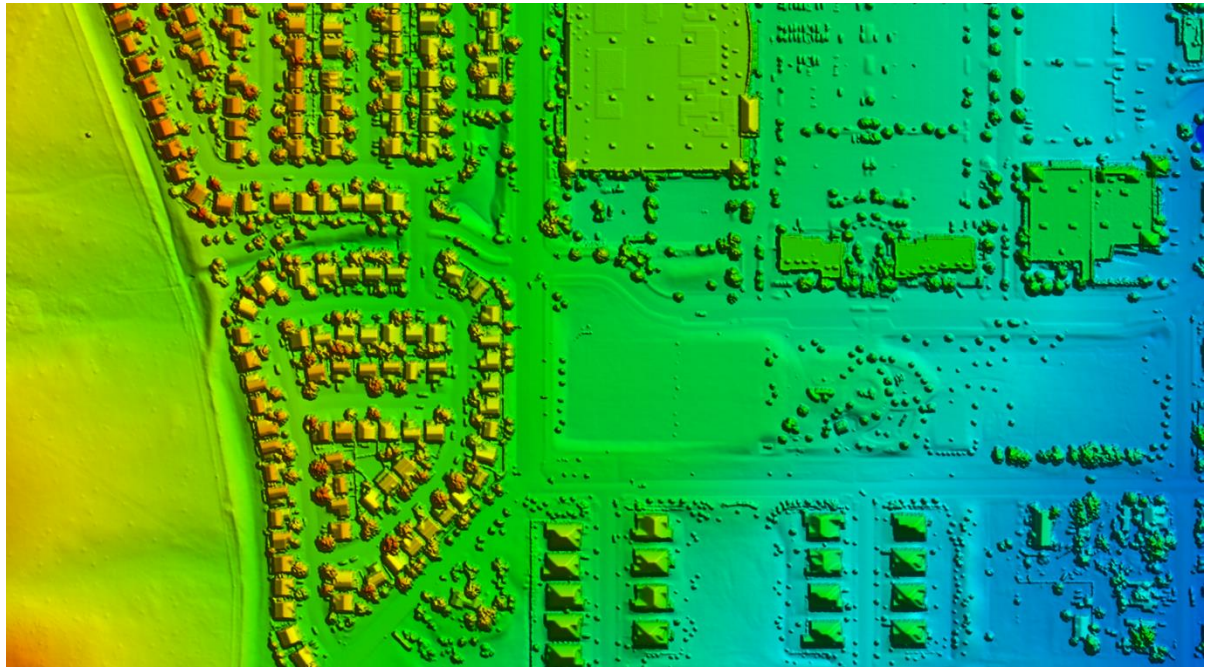


Digital Change Model

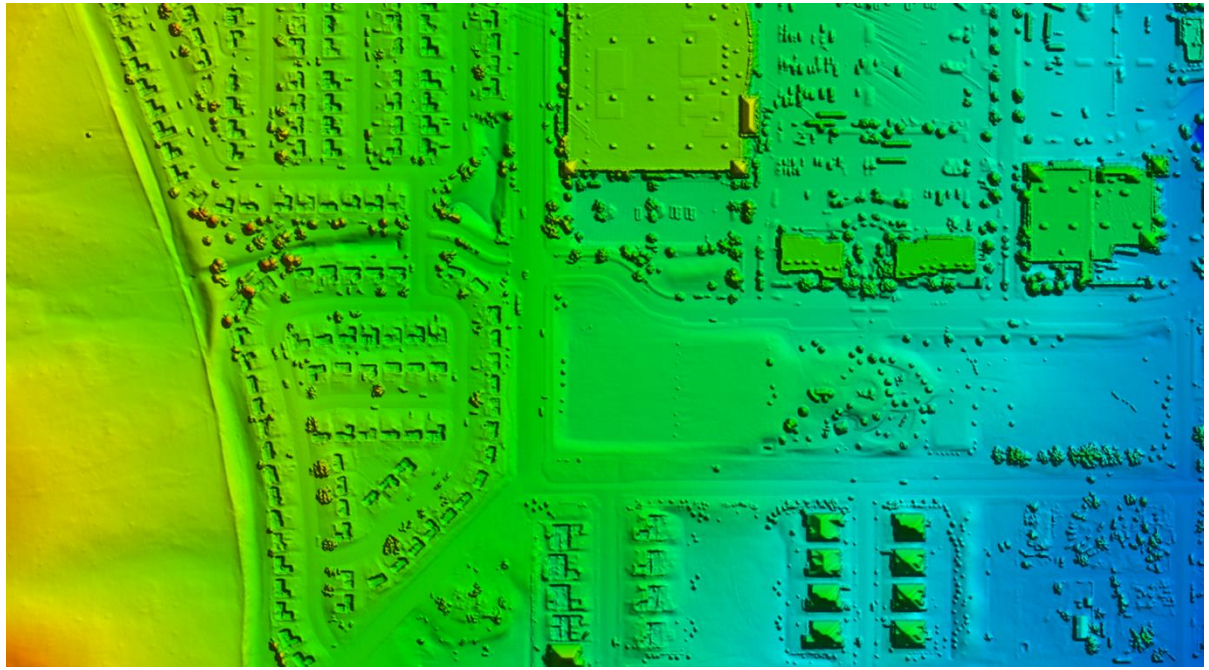


Automated Building Extraction Overlaid Change Model

PRE/POST EVENT DSM

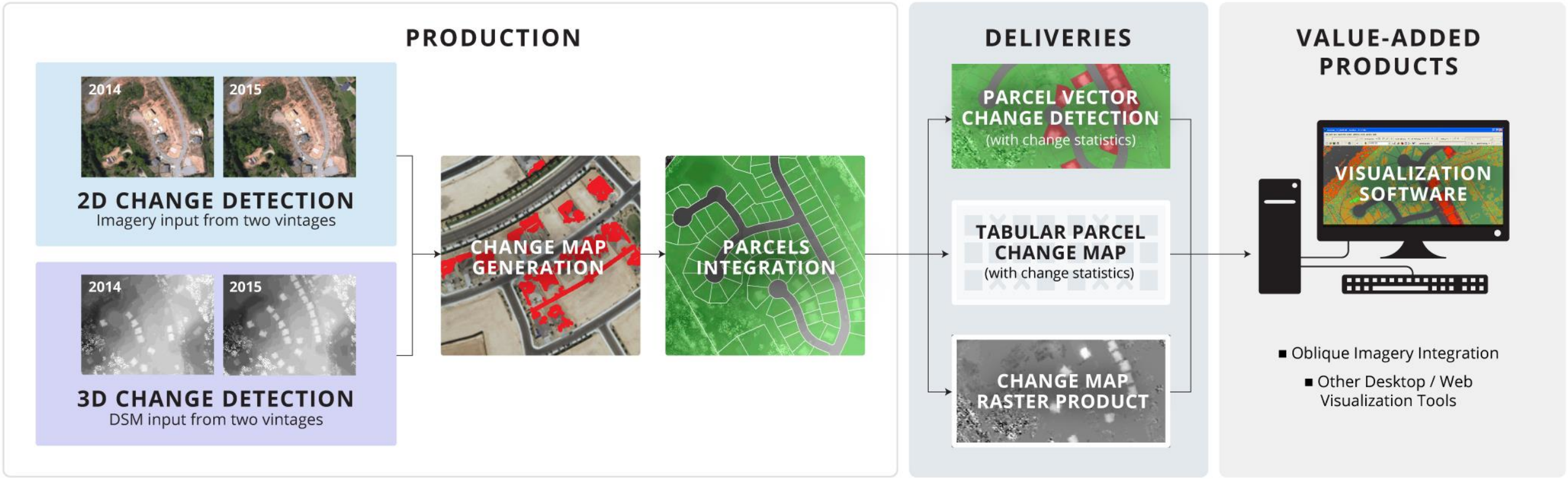


2020



2022

CHANGE DETECTION PROCESS



Wrap Up

Emerging Technologies – What can you be doing now?

- Understand your data and resource assets – what do you have? What do you need?
- Start with measurable goals (pilot project, proof of concept) and build
- Build a vision, goals, and strategy to get where you want to go

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Thank You!

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