# NOAA Special Publication NOS NGS 15

# 2019 Geospatial Summit Final Report

**Christine Gallagher**
**Silver Spring, MD**

**May 6-7, 2019**

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## 2019 Geospatial Summit Final Report
## Silver Spring, MD

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*NGS Director Juliana Blackwell pictured with the 2019 Geospatial Summit's Keynote speaker, RDML Timothy Gallaudet, Ph.D., USN Ret., Assistant Secretary of Commerce for Oceans and Atmosphere and Deputy NOAA Administrator.*

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# Introduction

The 2019 Geospatial Summit provided updated information about the planned modernization of the National Spatial Reference System (NSRS). Specifically, NGS' plans to replace the North American Datum of 1983 (NAD 83) and the North American Vertical Datum of 1988 (NAVD 88) in 2022.

The Summit provided an opportunity for NGS to share updates and discuss the progress of projects related to NSRS Modernization. NGS appreciated hearing feedback and collecting requirements from stakeholders across the federal, public, and private sectors. This event also helped to continue discussions from previous Geospatial Summits held in 2010, 2015 and 2017.

More extensive materials from the 2019 Geospatial Summit including PowerPoint presentation slides and webinar video recordings are available at *geodesy.noaa.gov*.

# Day One: May 6, 2019

## NSRS Modernization Overview

### Blueprint for 2022 Part 1: Geometric Coordinates
**Dan Roman, Ph.D.**
*Chief Geodesist, NGS*

In 2022, the entire National Spatial Reference System (NSRS) will be modernized. Geometrically, the NSRS currently contains three reference frames (historically "horizontal datums"), known as NAD 83(2011), NAD 83(PA11) and NAD 83(MA11) which are used to define the geodetic latitudes, geodetic longitudes and ellipsoid heights of all points in the USA. These three frames will be replaced with four new reference frames, called:

- North American Terrestrial Reference Frame of 2022 (NATRF2022)
- Pacific Terrestrial Reference Frame of 2022 (PATRF2022)
- Caribbean Terrestrial Reference Frame of 2022 (CATRF2022)
- Mariana Terrestrial Reference Frame of 2022 (MATRF2022)

Time-dependent coordinates will exhibit spatial stability in areas of the continent where motion of the tectonic plate is fully characterized by plate rotation. All remaining velocities (including horizontal motions induced directly or indirectly by adjoining tectonic plates, horizontal motions induced by Glacial Isostatic Adjustment, other horizontal motions and all vertical motions in their entirety) will be captured by an Intra-Frame Velocity Model (IFVM).

### Blueprint for 2022 Part 2: Geopotential Coordinates
**Dan Roman, Ph.D.**
*Chief Geodesist, NGS*

All geopotential aspects of the NSRS will be replaced with an internally consistent geopotential datum called the North American-Pacific Geopotential Datum of 2022 (NAPGD2022). Within NAPGD2022 four primary, interrelated time-dependent products will exist:

- A global model of Earth's geopotential field (GM2022)
- Regional gridded geoid undulation models (GEOID2022)
- Regional gridded deflection of the vertical models (DEFLEC2022)
- Regional gridded surface gravity models (GRAV2022)

Leveling in NAPGD2022 will retain its current role of providing high-accuracy local differential orthometric heights. The determination of absolute heights, however, which will provide the context of local differential heights, will reside in the GNSS domain (i.e., will be based on IGS ellipsoid heights).

### Blueprint for 2022 Part 3: Working in a Modernized NSRS
**Dru Smith, Ph.D.**
*NSRS Modernization Manager, NGS*

Blueprint for 2022 Part 3 is a document covering the re-invention of bluebooking, the improvement of the NGS toolkit and new ways of performing geodetic surveying within the modernized NSRS. This talk goes over the document in detail, outlining new terminology, new coordinate types and new ways of performing surveying which properly account for time dependency.

Beginning in 2022, points in the NSRS with defined coordinates will have epochs associated with them. Both leveling and classical surveys will require Global Navigation Satellite System (GNSS) components to ensure coordinates computed in those surveys are up-to-date and are connected to the NSRS through the NOAA CORS Network. In order to bridge users into a time-dependent NSRS, NGS will also be estimating, and providing to the public, coordinates on points at five-year reference epochs.

### *Designing a Data Delivery System for the Future*
*Boris Kanazir*
*Geodesist, NGS*

This presentation introduced the Data Delivery System (DDS) of future as a replacement for the existing NGS datasheets. The DDS will be an innovative and interactive system with established protocols for data delivery/display from the NSRS Database across different platforms.

# NSRS Modernization Outreach and User Engagement Efforts

### Recap 2018 Industry Workshop and Introduction of Alpha Products
**Dru Smith, Ph.D.**
*NSRS Modernization Manager, NGS*

In 2018, NGS hosted partners from the geospatial industry for two days of intense discussions about NSRS modernization. The intent was to assist our partners in preparing for the changes coming in 2022. This talk recaps that event and highlights the outcomes.

### The State Plane Coordinate System of 2022: Making It Your Way
**Michael Dennis, Ph.D.**
*Geodesist, NGS*

The State Plane Coordinate System (SPCS) will change, and NOAA's National Geodetic Survey (NGS) encourages your input!  A new version (SPCS2022) will replace the existing version (SPCS 83), and NGS is making an unprecedented effort to incorporate customer feedback in SPCS2022 development.

This presentation gives an overview of NGS outreach activities, summarizes customer responses to the release of draft SPCS2022 Policy & Procedures, explains the most relevant parts of the recently released final policy & procedures, and gives instructions on how stakeholders can make requests or proposals, and even submit their own SPCS2022 designs. The goal is that SPCS2022 be a technically sound and practical component of the nation's spatial data infrastructure of tomorrow.  Stakeholder input will help ensure it also best meets the diverse needs of the geospatial community in every state.

### National Society of Professional Surveyors (NSPS) Coordinated Efforts to Change State Legislation
**Curtis Summer**
*Executive Director, National Society of Professional Surveyors*

NSPS is grateful for its long-standing relationship with NGS through which we share information, collaboration, and outreach to the surveying profession, and to the public. Our participation in the NGS 2019 Geospatial Summit provided an opportunity for us to begin collaboration regarding NSRS 2022 "profession-wide", and with the public in general. NSPS is working with its State Affiliate organizations in the development of "layman's terms" language to assist state and local government officials (elected and career), and non-technical stakeholders, in preparing legislation for the adoption of NSRS 2022.

### "Keeping Coordinates Moving:" California Example and Case Study
**Scott Martin**
*California Geodetic Coordinator, California Department of Transportation*

This presentation focused on the challenges of working in the positionally dynamic environment of California and the measures California has taken to manage their geodetic fabric. Topics included the development of the NAD83(2011) epoch 2017.50 realization and the production of the conceptual design of a robust 3-D dynamic datum modeling tool.

# Education and Training to Prepare Surveyors for NSRS Modernization

### NGS Educational Offerings
### Erika Little
*Training Coordinator, NGS*

This presentation covered NGS's educational and training resources and some numbers on their usage. Resources discussed include: Educational Videos, Online Lessons, Regional Geodetic Advisors, the monthly Webinar Series, and the Presentation Library. Also discussed were plans for the creation of additional resources, and a call for input and feedback from our constituents was made.



What are Geodetic Datums?

### NOAA - University of Puerto Rico at Mayagüez Memorandum of Understanding: An Overview of 20 Years of Partnership
### Linda Velez
*Professor, University of Puerto Rico*

In 1999, NOAA and the University of Puerto Rico at Mayagüez signed an agreement to collaborate on research and support the geodetic infrastructure of Puerto Rico. This presentation is an update on NGS collaboration over the last 20 years. It includes a history of surveying in Puerto Rico going back to the 19th Century and leads into the present day, showing improvements to geodetic infrastructure and hands-on student involvement in projects related to leveling, GPS, gravity, tide gauges, and more.

### Mastery Paths Learning in Geosciences
### Stacey D. Lyle, Ph.D., RPLS
*Professor of Practice, College of Geosciences, Texas A&M University College Station*

Texas A&M University offers a Master's degree program in Geoscience that includes training in surveying, geodesy, geophysics, and GIS, specifically designed for applications to the oil and gas industry. Every person learns differently and encounters a topic at a different point, but in the end, the goal is the same - it just requires each student to follow a different path. Dr. Lyle explains how to approach learning in geoscience through a mastery paths concept, where the students are led along the most appropriate route and their knowledge is checked along the way to ensure they master the material in the best manner possible.

### Engaging the Unengaged - How to Reach the Professional
### Patrick Tami
*Immediate Past President, National Council of Examiners for Engineering and Surveying*

There are five generations in the workplace right now and members of each of them learn, communicate, and interpret information differently than the others. This presents challenges for broadcasting information to the public. As NGS prepares to release new datums and survey techniques and standards for 2022, it is necessary to inform the public of these changes in the

most effective ways possible. This will be challenging given how much communication technology has changed in recent years, leaving impacts on our society as a whole.

This presentation addresses these concerns as they relate to the currently practicing professional. This person is busy with day-to-day life and generally is not able to go back for long term training due to these commitments. This presentation sheds light on how to reach this person.

# Day 2: May 7, 2019

## NGS Ongoing Efforts / Interim Products (Part 1 of 2)

### *Gravity for the Redefinition of the American Vertical Datum (GRAV-D)*
***Jeffery Johnson***
*Acting GRAV-D Project Manager, NGS*

Gravity for the Redefinition of the American Vertical Datum (GRAV-D) is the National Geodetic Survey's (NGS) ambitious ~15 year project to collect airborne gravity data for the entire United States and all of its territories. The project, mandated by congress, is intended to be completed by the middle of fiscal year 2022.

This presentation begins with a brief and elementary explanation of airborne gravity data collection and how it helps to calculate geoid heights for a geoid model. A discussion of the target area and how much has been accomplished is followed by looking at yearly percent complete goals as we move towards 2022. Historically, GRAV-D has consistently met its yearly goals, and hopefully the project will continue to perform well over the next few years. However, as the project comes to a close, challenging surveying locations, weather conditions or special use airspace restrictions, and other factors could delay completion of the project. Two high impact surveys from 2019 where reported: Hawaii and American Samoa.

### *Experimental GEOID Modeling (xGEOID19)*
***Yan Wang, Ph.D.***
*Geodesist, NGS*

A gravimetric geoid will serve as the zero-height surface of the next geopotential (vertical) datum for the North America. NGS has been conducting an ambitious project "Gravity for the Redefinition of the American Vertical Datum (GRAV-D)" since 2008. By combining GRAV-D airborne gravity data, millions of surface gravity observations, the latest satellite gravity models, and altimetric gravity over oceans, an experiment geoid (xGEOID) has been computed annually since 2014. The geoid covers three regions: a. America-Pacific: (Latitude: 0° to 90°, Longitude: 170°E to 350°E); b. Guam and CNMI: (Latitude: 11° to 22°, Longitude: 143°E to 148°E) and c. American Samoa: (Latitude: -10° to -16°, Longitude: 186°E to 193°E). The expected accuracy of the geoid is 1-2 cm in flat areas and 2-3 cm in mountainous region. The quality of the geoid models is validated by other independent data sets, such as GPS on Bench Marks, and Geoid Slope Validation Surveys in 2011, 2014 and 2017. Starting from 2019, the model will be a joint model between NGS, CGS and INEGI.

### *Geoid Monitoring Service (GeMS)*
***Kevin Ahlgren, Ph.D.***
*Geodesist, NGS*

The Geoid Monitoring Service (GeMS) is an NGS project with the goal of defining and maintaining the dynamic components of NAPGD2022.  This presentation will provide a brief

overview of what GeMS is concerned with, a status update on the project, and when and which alpha products will be provided to NSRS users.

### Hybrid Geoid Models (GEOID18)
**Kevin Ahlgren, Ph.D.**
*Geodesist, NGS*

GEOID18 is the last of NGS's Hybrid Geoid Models and will be released as an official product in calendar year 2019.  This model utilizes an enormous amount of newly acquired GPS on Bench Mark data provided by hundreds of external partners.  The model also utilizes new satellite gravity models, GRAV-D airborne gravity, and new terrain models.

### Modernizing Continuously Operating Reference Stations (CORS)
**Theresa Damiani, Ph.D.**
*Spatial Reference System Division Chief, NGS*

The NOAA CORS Network (NCN) is a multi-purpose cooperative network of GNSS stations from over 200 government, academic, and private organizations. Its primary objective is to enable GNSS users by providing precise positioning relative to the U.S. National Spatial Reference System (NSRS). This presentation provides a brief overview of the NOAA CORS Network highlighting its value and accuracy for surveying and mapping applications. It also described plans to modernize the network in the future.

### Foundation CORS
**Theresa Damiani, Ph.D.**
*Spatial Reference System Division Chief, NGS*

To maintain long-term consistency between the NSRS and the ITRF, a specific set of stations must be operated at the highest standards and federally-owned to ensure longevity. NGS has identified a set of 36 stations across the U.S. and its territories that meet this criteria and provide consistent national access to the NSRS. This subnetwork of the NCN will be known as the NOAA Foundation CORS Network, or NFCN. This presentation provides a brief introduction to the NFCN, describes differences from other CORS, and the current status of Foundation CORS.

### Turning the Page on PAGES: NGS's Next Generation, Multi-Global Navigation Satellite System (GNSS) Software
**Bryan Stressler**
*Geodesist, NGS*

With the rapidly increasing number of satellites available from other Global Navigation Satellite Systems (GNSS) in addition to GPS, NGS is developing new software for geodetic positioning and orbit determination to replace the existing PAGES software suite. This software is being designed to incorporate all available GNSS signals and to be extensible and easily maintained using modern programming languages and development tools. Ultimately, these efforts will provide multi-GNSS processing capabilities for OPUS, for the daily monitoring of the NOAA CORS Network, and for GNSS orbit production for the International GNSS Service (IGS).

The addition of new satellite systems, along with the modernization of GPS and GLONASS, presents the opportunity to improve upon our existing dual-frequency, GPS-only processing algorithms (e.g., triple-frequency methods for ambiguity fixing and ionospheric corrections). Furthermore, the improved satellite geometry afforded by the new constellations has the potential to improve upon GPS-only positioning and shorten the requisite session lengths, particularly in poor surveying conditions (e.g., urban canyons, steep topography). This presentation briefly discusses the status of modern GNSS constellations, the potential benefits of multi-GNSS processing, and NGS's plans for deploying multi-GNSS processing software as we proceed with NSRS modernization.

# NGS Ongoing Efforts / Interim Products (Part 2 of 2)

### OPUS Projects Improvements
### *Mark Schenewerk, Ph.D.*
*Geodesist, NGS*

OPUS is constantly evolving: adapting to an ever changing IT security environment, upgrading hardware, enhancing software and incorporating improved models. In this presentation, I will summarize a handful of enhancements in the latter two categories, enhancements that are directly useful for OPUS users, that are underway or planned for OPUS-Projects - and OPUS too!

### OPUS-Projects for Uploading Real-time Kinematic GNSS Vectors
### *Dan Gillins, Ph.D.*
*Geodesist, NGS*

The National Geodetic Survey (NGS) is currently developing OPUS-Projects so that users can upload previously processed GNSS vectors. This includes GNSS vectors derived from post-processing in vendor software, single-base real-time kinematic (RTK) vectors, and vectors from real-time networks (RTNs). In order to complete this development, NGS is proposing a standardized file format known as the "GNSS Vector Exchange Format" or GVX. GVX has been drafted in extensible markup language, and both a sample and schema for GVX are available for review and commenting. NGS hopes that GVX is adopted by industry as a means of exchanging vector data. In the near future, a GVX file will be able to be uploaded to OPUS-Projects for inclusion in a survey network for evaluation and adjustment. Results of such an adjustment can then be submitted to NGS for review and publication.

### OPUS Projects for Everything
### *Krishna Tadepalli*
*Geodetic Applications Branch Chief*

This presentation is an overview of how different types of surveys are brought together into a unified web-centric workflow. As discussed in Blueprint Part 3, NGS will be providing tools to users, under the catch-all name "OPUS," for uploading, processing, analyzing, and submitting survey data of all types, such as: GNSS, RTK (Real Time Kinematic), RTN (Real Time Network), leveling, gravity, or classical. Additionally, OPUS will have tools for ingesting and analyzing continuous data (e.g. GNSS, gravity). The tool will be browser-based and will fully integrate all data types, whereby a single project, containing both GNSS and leveling could be uploaded and processed under the same project name.

### NGS Coordinate Conversion and Transformation Tool (NCAT)
### *Krishna Tadepalli*
*Geodetic Applications Branch Chief*

NGS Coordinate Conversion and Transformation Tool (NCAT) allows users to easily convert between different coordinate systems and/or transform between different datums, in a single step.

- For coordinate conversion, NCAT allows conversion between latitude/longitude/height, State Place Coordinates (SPC), Universal Transverse Mercator (UTM), XYZ, and U.S. National Grid (USNG) systems.

- For coordinate transformations, NCAT uses NADCON 5.0 to perform three-dimensional (latitude, longitude, ellipsoid height) coordinate transformations for a wide range of datums and regions in the National Spatial Reference System.

- Upcoming improvements include the integration of VERTCON 3.0 to perform vertical datum transformations between the National Geodetic Vertical Datum of 1929 (NGVD 29) and the North American Vertical Datum of 1988 (NAVD 88).

- Transformations in NCAT are consistent with transformations in VDATUM, another NOAA transformation tool product.

## *"GPS on Bench Marks" Efforts*
### *Galen Scott*
*Acting Constituent Resource Manager, NGS*

The GPSonBM program's 2018 campaign was very successful in engaging partners across the country in submitting GPS data on leveled bench marks to provide data for GEOID18. This effort drove OPUS Share participation to break the previous submission records for nearly every month in 2018. Building upon that success, the GPSonBM team is working on a new set of priority bench marks to encourage partners to submit data over the next three years to support the development of NCAT and VDatum as well as to derive other benefits such as automatic reprocessing and updated coordinates when the new datums are released.

# Panel Discussion

*Chair*
**Andria Bilich, Ph.D.**
*Geodesist, NGS*

*Panelists*
**Kevin Ahlgren, Ph.D.**
*Geodesist, NGS*

**Theresa Damiani, Ph.D.**
*Spatial Reference System Division Chief, NGS*

**Dan Roman, Ph.D.**
*Chief Geodesist, NGS*

**Mark Schenewerk, Ph.D.**
*Geodesist, NGS*

**Dru Smith, Ph.D.**
*NSRS Modernization Manager, NGS*





Although Summit attendees asked questions following each of the sessions, an additional 1.25 hour session was dedicated to a panel discussion with NGS subject matter experts. The panelists answered oral questions from audience members, as well as written questions submitted to the "question box" at the Summit or online via the webinar interface. While the majority of questions focused on the 2022 datums, some of the topics discussed included:

- NGS services in the event of a government shutdown
- Connecting to the NSRS from offshore areas
- How users and state geodetic coordinators can help NGS prepare for 2022
- Datum transformations for large datasets
- If, how, and when 2022 datums will be updated
- Differences between 2022 datums and ITRF
- Limits on the addition of new CORS
- NCAT
- State Plane Coordinate System and the US Survey Foot
- Geodetic Reference Points (GRPs) for Continuously Operating Reference Stations (CORSs) in the NOAA CORS Network
- The future of OPUS

# NSRS Modernization Case Studies and User Perspectives

### *Lidar Case Study - Alaska Geoid*
**Nicole Kinsman, Ph.D.**
*Alaska Regional Geodetic Advisor, NGS*

NSRS modernization is a boon to positioning and geospatial products nationwide, but especially in remote and active geophysical places such as Alaska. Here, a case study is presented in which GIS flow accumulation analyses were performed on a lidar-based elevation model in Fairbanks Alaska to illustrate differences between hybrid Geoid12B and gravimetric Geoid17B results.

### *National Park Service Case Study - Assateague Island National Seashore*
**Neil Winn**
*GIS Specialist, National Park Service*

The National Park Service collects a wide variety of spatial data which is improving in accuracy thanks to advancements in GNSS positioning. This presentation highlights an example long-term geomorphological monitoring program using oceanic shoreline monitoring on Assateague Island in Maryland and Virginia. This program measures trends in shoreline position in support of park resource and facility management. That trend requires comparable data collection and is subject to any challenges introduced by reference frame changes. When NATRF2022 is our datum of choice users will need to be able to update old data in order to continue these types of trends.

### *U.S. Geological Survey Case Study - Impacts to 3D Elevation Program (3DEP)*
**Barry Y. Miller**
*GIS Applied Researcher, U.S. Geological Survey*

The United States Geological Survey manages the 3D Elevation Program, a systematic effort to collect high resolution elevation data over our nation. USGS delivers lidar point clouds, 1 meter elevation bare-earth rasters, and seamless elevation rasters at the 1/3, 1 and 2 arc-second resolution. All of these products will be affected by the migration to the new National Spatial Reference System in 2022. This presentation describes the elevation products provided by USGS, what the anticipated impacts will be for each product, and how the new NSRS will change our national tiling index.

### *North Carolina's Floodplain Mapping Program*
**Gary Thompson**
*Chief, North Carolina Geodetic Survey*

North Carolina wanted to create a statewide program to acquire, process, and disseminate current, accurate, and detailed elevation data, flood hazard studies, and Digital Flood Insurance Rate Maps. The state signed a Cooperating Technical State (CTS) agreement on September 15, 2000 that established formal overall partnership between State, Federal, and Local partners. The objectives of the North Carolina Floodplain Mapping Program are:

- Define boundary and base flood elevation for 1% annual chance flood

- Minimize long-term losses through better floodplain management
- Time and cost-efficient FIRM updates
- Provide 24-hour online access to GIS data and maps
- Use accurate, detailed, digital data to make more precise flood risk determinations.

Because so many products are digitized, the biggest hurdle that NSRS Modernization will create in North Carolina is largely related to communication, outreach and public relations.

# Summary and Next Steps

The 2019 Geospatial Summit was the first public introduction to Blueprint for 2022, Part 3: Working in a Modernized NSRS. NGS anticipates that working with time-dependent coordinates will create both new challenges and opportunities. A successful roll-out to this new paradigm will rely on the development of new tools, close partnership with industry, and as well as continued education and communication efforts.



Additionally, to meet our 2022 deadline, many scientific projects must make significant progress. These projects include, but are not limited to:

- Foundation CORS
- Intra-Frame Velocity Model (IFVM)
- Gravity for the Redefinition of the American Vertical Datum or "GRAV-D"
- Geoid Monitoring Service (GeMS)

NGS' partners continue to express both their excitement and concern given the implications of adopting new reference frames and a new geopotential datum. NGS will continue its stakeholder engagement efforts, welcomes feedback from all end-users, and looks forward to working with all partner organizations to make transitioning to the modernized NSRS a success.

# Appendix A: 2019 Geospatial Summit Attendance

The 2019 Geospatial Summit had 474 unique attendees. Nearly half (47%) of attendees joined via webinar, and many in-person attendees (44%) were NGS employees.

Attendees spanned a variety of sectors, with nearly half (48%) coming from the public sector, that is a combination of federal, state and local after removing NGS employees. The next largest group was from the private sector, spanning large and small surveying, engineering, and software companies. Finally, a small part of the audience represented academia and the non-profit sector.
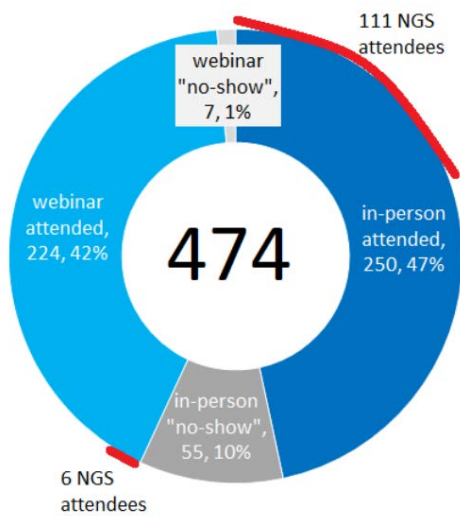


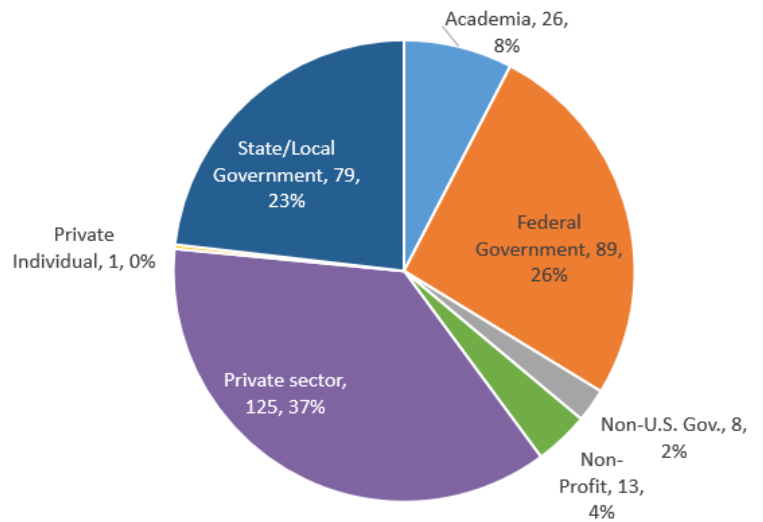*Figure A-1*: 2019 Geospatial Summit Unique Registrants and Attendees

*Figure A-2*: Summit Attendees by Sector (n=341); excludes NGS employees

# Appendix B: Live poll results

Live polls were asked of the audience to engage attendees and gather feedback. They were administered using PollEverywhere, so webinar and in-person attendees' responses could be combined in real-time. Questions were aimed at:

- "segmenting" the audience (e.g., NGS employee, webinar attendees);
- NSRS Modernization (note, identical questions were asked on Day 1 and Day 2);
- State Plane Coordinate System;
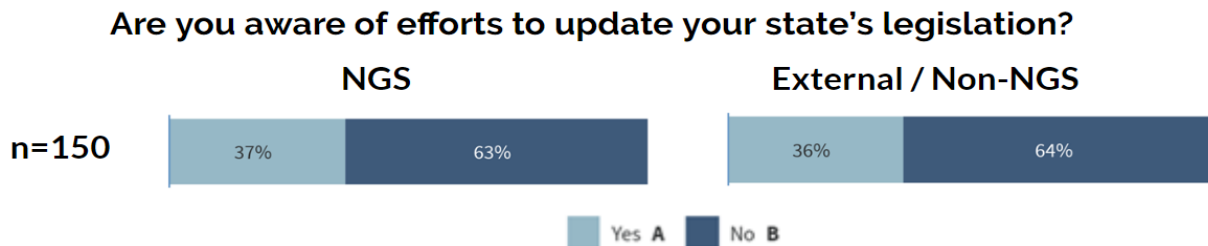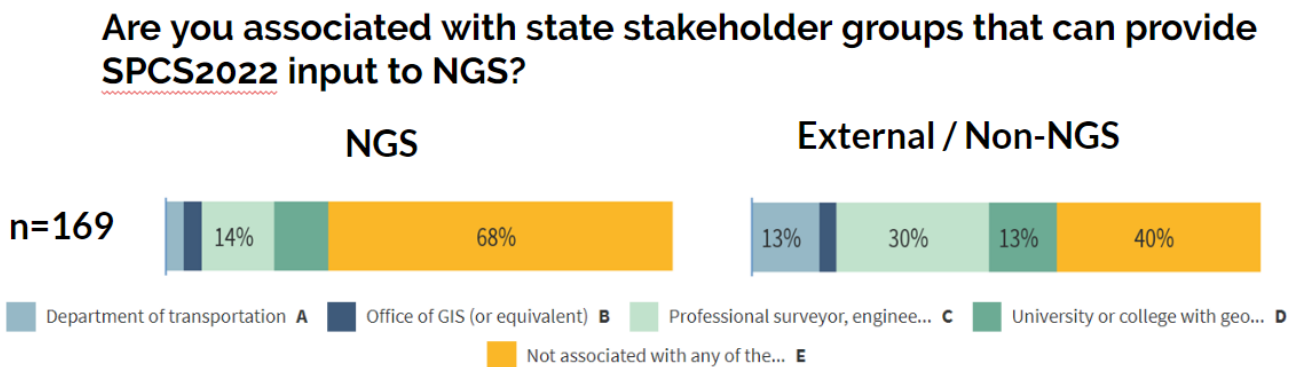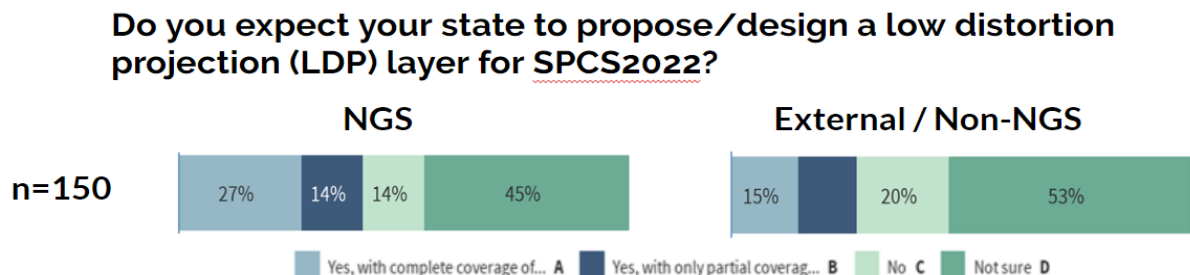- Education, and
- Use of NGS Tools.

## Day 1

### Are you aware of efforts to update your state's legislation?

| | NGS | External / Non-NGS |
|---|---|---|
| n=150 | 37% Yes A / 63% No B | 36% Yes A / 64% No B |

Yes A ▢   No B ▣

**Figure B-1**

### Are you associated with state stakeholder groups that can provide SPCS2022 input to NGS?

| | NGS | External / Non-NGS |
|---|---|---|
| n=169 | 14% / 68% | 13% / 30% / 13% / 40% |

Department of transportation **A**   Office of GIS (or equivalent) **B**   Professional surveyor, enginee... **C**   University or college with geo... **D**   Not associated with any of the... **E**

**Figure B-2**

### Do you expect your state to propose/design a low distortion projection (LDP) layer for SPCS2022?

| | NGS | External / Non-NGS |
|---|---|---|
| n=150 | 27% / 14% / 14% / 45% | 15% / 20% / 53% |

Yes, with complete coverage of... **A**   Yes, with only partial coverag... **B**   No **C**   Not sure **D**

**Figure B-3**

**Having time dependent and/or low distortion coordinates have the potential of what economic impact?**

NGS                                    External / Non-NGS

n=114

| 14% | 14% | 73% |

| 28% | 70% |

■ $10k **A**   ■ $1,000k **B**   ■ $10,000k **C**
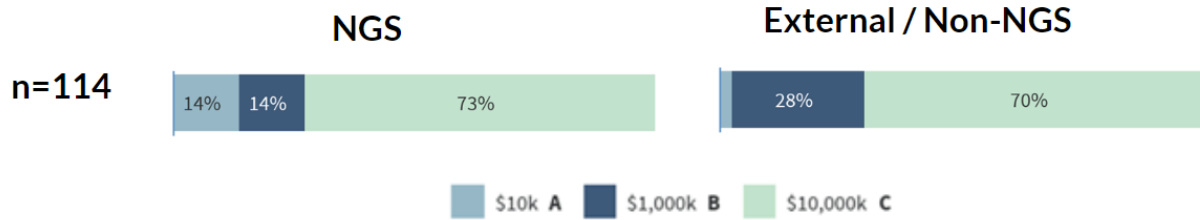
**What are the most important to learning outcomes?**

NGS                                    External / Non-NGS

n=120

| 70% | 15% | | |

| 52% | 34% | |

■ Experiential Learning **A**   ■ Mastery Paths **B**   ■ Examination **C**   ■ Professional Certifications **D**
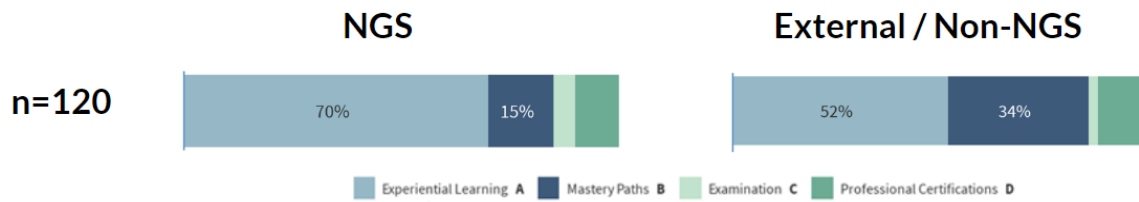
## Day 2

### What NGS tools do you use most often today?

**NGS**            **External / Non-NGS**

n=137



Datasheets or shapefiles **A**   CORS/OPUS **B**   NCAT or transformation softwar... **C**   SPCS **D**   Lidar or Imagery **E**

Other **F**
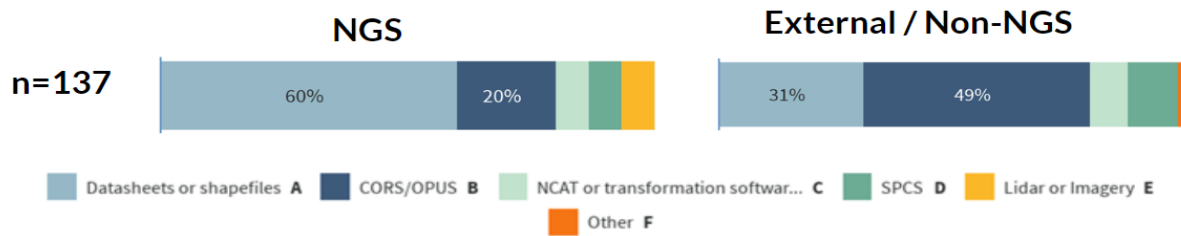
**Figure B-6**

### What NGS tools do you anticipate using most often in the future?

**NGS**            **External / Non-NGS**

n=141



Datasheets or shapefiles **A**   CORS/OPUS **B**   NCAT or transformation softwar... **C**   SPCS **D**   Lidar or Imagery **E**

Other **F**

**Figure B-7**

## Day 1 and Day 2 Combined

### How do you feel about NSRS Modernization?

**NGS**  |  **External / Non-NGS**

**Day 1**
**n=87**
NGS: 33% | 67%
External/Non-NGS: 38% | 44%

**Day 2**
**n=110**
NGS: 47% | 32%
External/Non-NGS: 48% | 42%

Legend: Concerned **A** | Excited **B** | Concerned and Excited **C** | Don't feel I have enough infor... **D**
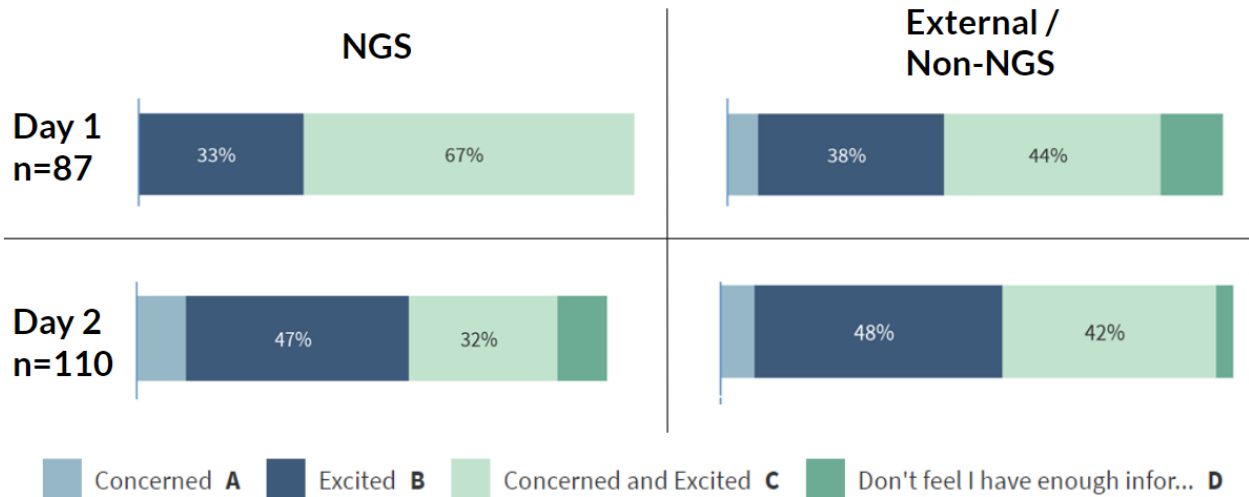
*Figure B-8*

### How prepared are you for NSRS Modernization?

**NGS**  |  **External / Non-NGS**

**Day 1**
**n=110**
NGS: 40% | 40%
External/Non-NGS: 22% | 44% | 24%

**Day 2**
**n=106**
NGS: 21% | 37% | 32%
External/Non-NGS: 16% | 41% | 37%

Legend: Not at all **A** | A little **B** | Very **C** | Don't feel I have enough infor... **D**
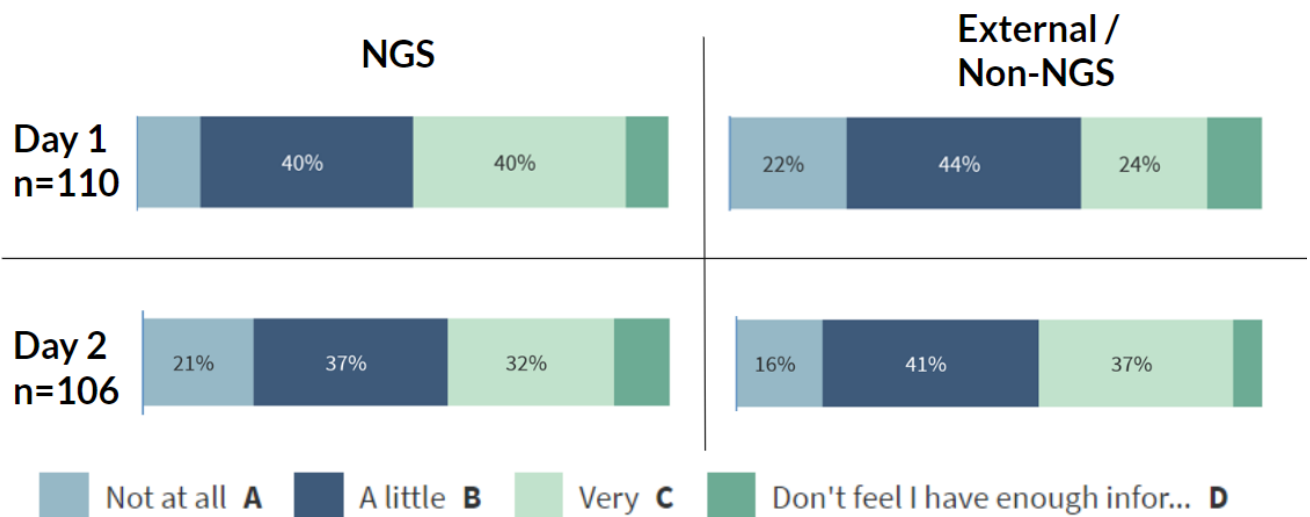
*Figure B-9*

# Appendix C: Summit Attendee Evaluations

Evaluation forms were distributed to all in-person and webinar attendees to help evaluate this event and inform planning of future events. Some of the evaluation summary charts are included below.
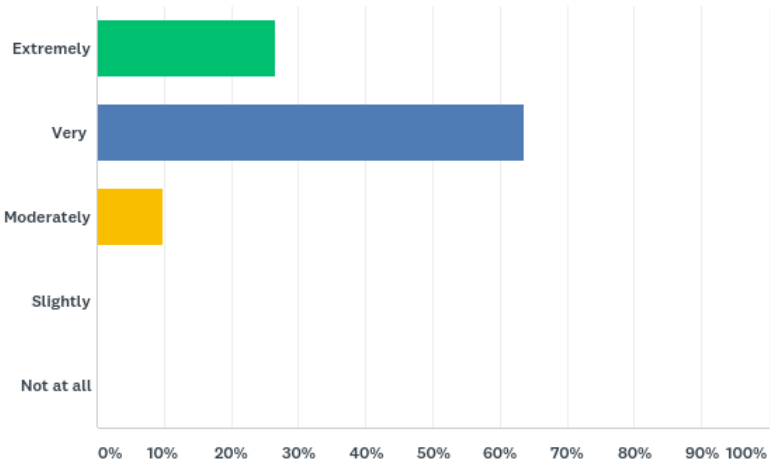


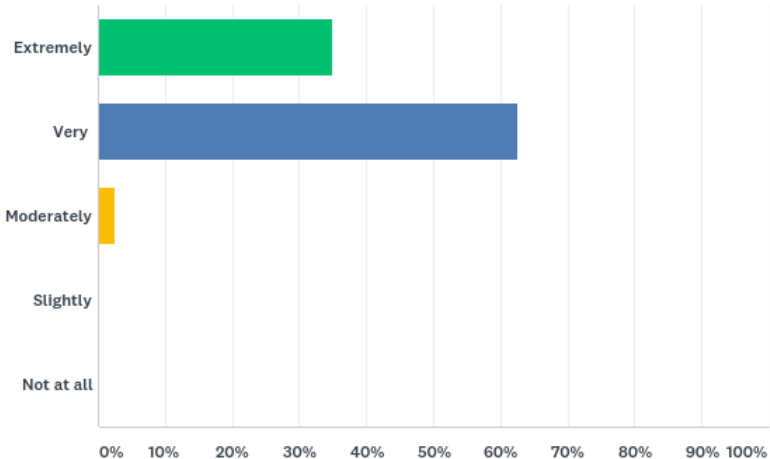*Figure C-1*



*Figure C-2*

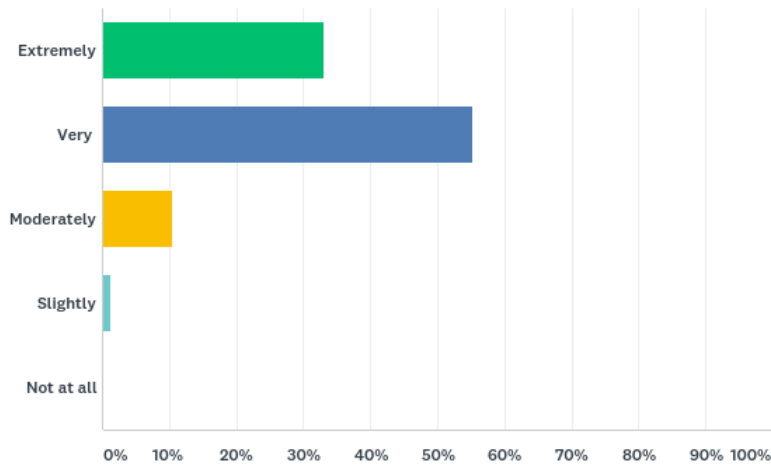## Q6 Overall, how satisfied were you with the event?



**Figure C-3**

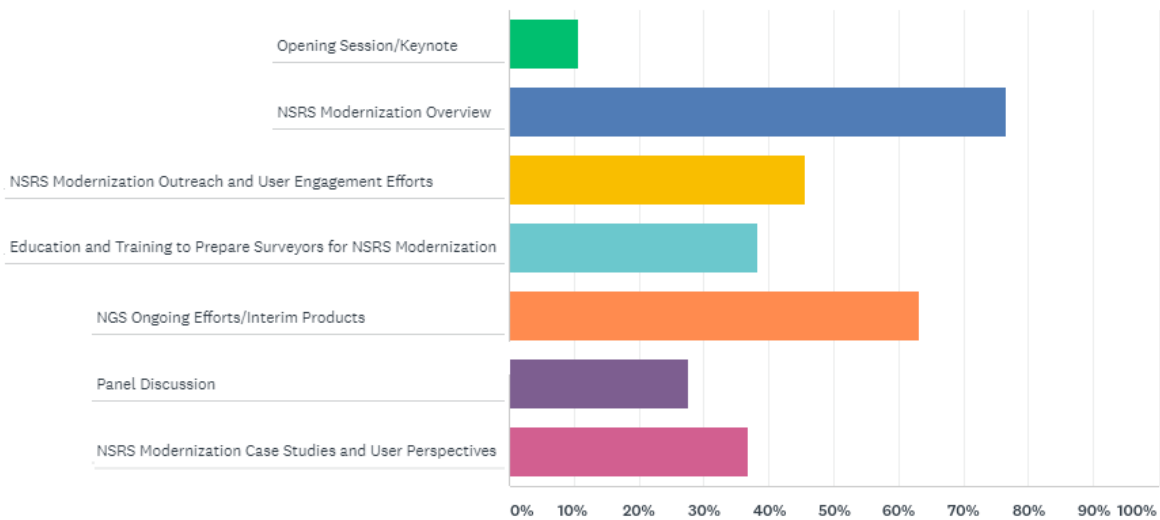## Q10 What sessions did you find most useful? (pick as many as you like)



**Figure C-4**