Impact of Datum Update on Spatial Data Providers and Consumers

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Who am I?

- Towfique Ahmed
- Denver, CO

- B.Sc. in Geomatics Engineering from the University of Calgary
- Trimble - 7 years
  - Graduate Rotation Program - 2 years
  - Correction Services Product Management - 5 years
Who are you?

- Data providers
- Service providers
- Software developers

- Dealing with data that has a spatial aspect

- What coordinate system is your data in? What datum? Realization? Epoch?
Agenda

- Background on Geospatial Data
  - Datums, and Coordinate Systems
  - Geographic, Cartesian, and Projected Coordinates
  - GNSS Basics and Correction Services

- Data
  - What dictates the datum and coordinate system of my data?
  - What do I need to consider when using Geospatial Data?

- Preparing for a datum transition
  - Users
  - Providers and Consumers
Geospatial Data

- Data that identifies geographic location of features, such as points, lines, and polygons

Point: Asset
Line: A-B lines
Polygon: Boundary

Represented by one or more coordinates
Geographic, Cartesian, and Projected Coordinates

- Coordinates: set of numbers that define the location of a point

  Geographic: Latitude $\phi$, Longitude $\lambda$, Height
  Cartesian: $X_{ecef}$, $Y_{ecef}$, $Z_{ecef}$
  Projected: East, North, Up
Coordinate Systems

Datum

Projection

Geoid Model

Elevation

Height

MSL
A better coordinate

- Coordinates: set of numbers that define the location of a point
- Time when coordinate was captured
- Coordinate System of the coordinate
  - Datum, realization, and epoch
  - Projection
  - Geoid Model
- Source of coordinate
- Transformations applied
GNSS Basics and Correction Services
GNSS Positioning
GNSS Error Sources

- Orbit + clock error
- Ionosphere
- Troposphere
- Multipath
- Space Weather

Error Sources:
- Satellite orbit and clock
- Atmosphere
- Biases
- Solar effects
Types of GNSS Correction Sources

SBAS

RTK-level accuracy without the need to set up your own base station

Centimeter-level accuracy within range of a base station
What datum and coordinate system is my data in?

- Datum and coordinate system of data is dependent on the correction source, along with any transformations taking place.

\[
\begin{align*}
\text{GNSS Correction Source (Accuracy?)} & \quad + \quad \text{Transformations (Accuracy?)} \quad => \\
\text{Datum and Coordinate System of Data}
\end{align*}
\]
SBAS (e.g. WAAS)

- “WGS84”
- Which realization?
- Epoch?

Transformed:
- NAD83(2011) 2010.0
- Accuracy?

Corrections in “WGS84”

“WGS 84” position at rover

Transformation

Local position at rover (e.g. NAD83(2011) 2010.0)
Differential positioning (RTK and VRS) - 1

"WGS 84" position at base

Datum transformation

(e.g. NAD83(2011) 2010.0)

Local position at base

WGS 84 vector dX dY dZ

"WGS 84" position at rover

Datum transformation

(e.g. NAD83(2011) 2010.0)

Local position at rover
Differential positioning (RTK and VRS) - 2

“WGS 84” position at base

WGS 84 vector \( dX \) \( dY \) \( dZ \)

Datum transformation

(e.g. NAD83(2011) 2010.0)

Local position at base

Datum transformation

(e.g. NAD27)

Local position at rover

“WGS 84” position at rover
Differential positioning (RTK and VRS) - 3

Local position at base (e.g. NAD83(2011) 2010.0)

Local position at rover (e.g. NAD83(2011) 2010.0)

\[ \text{NAD83(2011) 2010.0 vector } dX \, dY \, dZ \]
Differential positioning (RTK and VRS) - 4

NAD83(2011) 2010.0 vector $dX$ $dY$ $dZ$

(e.g. NAD83(2011) 2010.0)

Local position at base

NAD83(2011)
Epoch 2010.0
position at rover

Datum transformation

Local position at rover
Differential positioning (RTK and VRS) - 5

Unknown system vector $dX \ dY \ dZ$

(unknown system)
Local position at base

(?????)
Local position at rover
Trimble RTX

- ITRF2014 Current Epoch Transformed:
  - NAD83(2011) 2010.0
  - Accuracy?

Corrections in ITRF2014 Current Epoch position at rover

ITRF2014 Current Epoch

Local position at rover (e.g. NAD83(2011) 2010.0)

Transformation
What do I need to consider when using Geospatial Data?

- Source of the GNSS correction data
  - Accuracy of position
  - Datum and Coordinate System
  - Accuracy of datum and coordinate system

- Intermediate transformations
  - What transformations are applied
  - Final datum and coordinate system
  - Accuracy of transformations → accuracy of datum and coordinate system
Coordinate Transformation

**ITRF coordinates**
- RTX Position or NATRF2022
  - (Xecef, Yecef, Zecef)
  - ITRF2008 (epoch 2019.60)
  - NATRF2022 (epoch 2019.60)
  - NATRF2022 (epoch 2020)

**GLOBAL coordinates**
- RTK Position
  - (Xecef, Yecef, Zecef)
  - NAD83 2011 (epoch 2010)
  - NATRF2022 (epoch 2020)

**LOCAL coordinates**
- (Lat., Long., Height)
  - NAD83 or NAD27

**GRID coordinates**
- (East., North., Up)
  - Colorado Central 0502

**Time Dependent Datum Transformation**
- Fourteen parameter + displacement models (NNR-MORVEL56 today)

**Static Datum Transformations**
- Molodensky
- Seven Parameter
- Multiple Regression
- Datum Grid
- RTCM Datum

**Projection & Site Calibration**
- Standard Projections
- Projection Grid
- Geoid Models
- Ground Coordinates
- Snake Grid
- Horz.& Vert. adjustments
Preparing for a Datum Transition
Preparing for a datum transition as a user

- Do I need to switch datums or coordinate systems?
- What geospatial data am I currently using? What will I use in the future?
- What are my accuracy requirements?
- What is my GNSS Correction service provider doing?
  - Maybe I don’t have one
- What are my data providers doing?
- What are the capabilities of my current software and/or hardware?
Who doesn’t need to switch?

- Single local base station user
- Network RTK user, where network isn’t switching
- No outside data sources

or

- No high-accuracy requirements (~3 metres)
Strategies for transition

- Switch at next opportune moment
- Transform existing data
  - What can my software do?
- Upgrade software and/or hardware
Preparing for a datum transition as a data provider

- Do I need to switch datums or coordinate systems?
- ....
- What are my customers doing?
- What are the capabilities of my customers’ software and/or hardware?
Preparing for a datum transition as a data provider

- Do I need to switch datums or coordinate systems?
- ....
- What are my customers doing?
- What are the capabilities of my customers’ software and/or hardware?
- Store accurate and complete metadata
- Transform existing data
- How will new data be collected?
- Provide a transition plan
Preparing for a datum transition as a data consumer (i.e. software)

- Do I need to switch datums or coordinate systems?
- ....
- What are my customers doing?
Preparing for a datum transition as a data consumer (i.e. software)

- Do I need to switch datums or coordinate systems?
- ....
- What are my customers doing?
- Provide transformation tools
  - Real-time
  - In-office for existing data
- Automate transformations
Contact Info

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