Coordinate System Standards
A Primer to Understanding the Standards and Their Implementation in the ArcGIS Platform

Melita Kennedy and Keith Ryden
Problem

- Old CRS WKT1 standard (ISO 19125-1:2004) inconsistent
- The text representation WKT1 is also inconsistent
- Different vendors implement it in different ways
- This leads to incompatibilities in data exchange
Text representation is called WKT2
Official name is “Geographic information - Well-known text representation of coordinate reference systems” (OGC 12-063r5 and ISO 19162:2015)
Updated version of original standard
Defines both structure and content
- Names are from the EPSG Geodetic Parameter Registry
Does NOT specify any implementation
New standard goes into effect January 1, 2018
Backward Compatibility

- WKT2 implementation must be able to read WKT1 strings
- WKT1 implementations are NOT required to be able to write out WKT1 strings
- Does NOT require old parsers of WKT1 strings to be able to read WKT2 strings
Differences between CRS1 and CRS2

- Additional CRS types are defined
  - Geodetic (geocentric Cartesian) CRS
  - Geodetic (geographic 2D) CRS
  - Geodetic (geographic 3D) CRS
  - Engineering CRS
  - Temporal CRS
  - Parametric CRS
  - Image CRS
  - Compound CRS
- Internal structures changed
Differences between CRS1 and CRS2 (continued)

• Additional metadata attributes added
  - Area
  - Bounding box
  - Scope
  - Remarks
• Units added to some attributes
  - Ellipsoid
  - Parameter
• PARAMETERFILE attribute added
Differences between WKT1 and WKT2

- Many keywords changed
  - All top-level keywords changed to differentiate between WKT1 and WKT2 strings:
    - GEOGCS → GEODCRS or GEODETIICCRS
    - PROJCS → PROJCRS or PROJECTEDCRS
    - VERTCS → VERTCRS or VERTICALCRS
  - UNIT keyword deprecated in favor of specific unit types:
    - ANGLEUNIT
    - LENGTHUNIT
    - SCALEUNIT
  - Prime Meridian optional if 0 (Greenwich)
Differences between WKT1 and WKT2 (continued)

- Parameters now contained within a CONVERSION block in PROJCRS
- Coordinate system (CS) attribute added
- AUTHORITY changed to ID and multiple IDs may be specified
- COORDINATEOPERATION object added
  - Supersedes Esri objects GEOGTRAN and VERTTRAN
- PROJECTION keyword deprecated in favor of METHOD
Sample WKT1 projected CRS

PROJCS["WGS 84 / Pseudo-Mercator",
    GEOGCS["WGS 84",
        DATUM["World Geodetic System 1984",
            SPHEROID["WGS 84", 6378137.0, 298.257223563]],
        PRIMEM["Greenwich", 0.0],
        UNIT["Degree", 0.0174532925199433]],
    PROJECTION["Popular Visualization Pseudo Mercator"],
    PARAMETER["False easting", 0.0],
    PARAMETER["False northing", 0.0],
    PARAMETER["Longitude of natural origin", 0.0],
    PARAMETER["Latitude of natural origin", 0.0],
    UNIT["meter", 1.0]]
Sample WKT2 projected CRS

PROJCRS["WGS 84 / Pseudo-Mercator",
    BASEGEOIDCRS["WGS 84",
        DATUM["World Geodetic System 1984",
            ELLIPSOID["WGS 84", 6378137.0, 298.257223563, LENGTHUNIT["meter", 1.0]],
            ANGLEUNIT["Degree", 0.0174532925199433]],
        CONVERSION["Popular Visualization Pseudo-Mercator",
            METHOD["Popular Visualization Pseudo Mercator"],
            PARAMETER["Latitude of natural origin", 0.0, ANGLEUNIT["degree", 0.01745329252]],
            PARAMETER["Longitude of natural origin", 0.0, ANGLEUNIT["degree", 0.01745329252]],
            PARAMETER["False easting", 0.0, LENGTHUNIT["meter", 1.0]],
            PARAMETER["False northing", 0.0, LENGTHUNIT["meter", 1.0]]],
        CS[cartesian, 2],
        AXIS["easting (X)", east, ORDER[1]],
        AXIS["northing (Y)", north, ORDER[2]],
        LENGTHUNIT["meter", 1.0],
        ID["EPSG", 3857]]}
Sample WKT1 coordinate operation

GEOGTRAN["NAD_1927_To_WGS_1984_85",
   GEOGCS["GCS_North_American_1927",
      DATUM["D_North_American_1927",
         SPHEROID["Clarke_1866",6378206.4,294.9786982]],
      PRIMEM["Greenwich",0.0],
      UNIT["Degree",0.0174532925199433]],
GEOGCS["GCS_WGS_1984",
   DATUM["D_WGS_1984",
      SPHEROID["WGS_1984",6378137.0,298.257223563]],
   PRIMEM["Greenwich",0.0],
   UNIT["Degree",0.0174532925199433]],
METHOD["NADCON"],
PARAMETER["Dataset_alaska",0.0]
Sample WKT2 coordinate operation

COORDINATEOPERATION["NAD27 to WGS 84 (85)",
    SOURCECRS[ GEODCRS["NAD27", 
        DATUM["North American Datum 1927", 
            ELLIPSOID["Clarke 1866", 6378206.4, 294.9786982, LENGTHUNIT["metre", 1.0]], 
            CS[ellipsoidal, 2], 
            AXIS["latitude", north, ORDER[1]], 
            AXIS["longitude", east, ORDER[2]], ANGLEUNIT["degree", 0.01745329252], 
            ID["EPSG", 4267]]], 
    TARGETCRS[ GEODCRS["WGS 84", 
        DATUM["World Geodetic System 1984", 
            ELLIPSOID["WGS 84", 6378137, 298.257223563, LENGTHUNIT["metre", 1.0]], 
            CS[ellipsoidal, 2], 
            AXIS["latitude", north, ORDER[1]], 
            AXIS["longitude", east, ORDER[2]], ANGLEUNIT["degree", 0.01745329252], 
            ID["EPSG", 4326]]], 
    METHOD["NADCON", ID["EPSG", 9613]], 
    PARAMETERFILE["Latitude difference file", "alaska.las"], 
    PARAMETERFILE["Longitude difference file", "alaska.los"], 
    ID["EPSG", 15864]]
Esri implementation of WKT2

- WKT2 support added in ArcGIS Desktop 10.5.1 and ArcGIS Pro 2.0
  - GeoPackages only

- Require ANGLEUNIT attribute in BASEGEODCRS
  - The official WKT2 spec omits this

- Only one ID attribute supported

- AXIS attributes not yet supported

- CONVERSION and METHOD attributes in PROJCRS identical
Please Take Our Survey on the **Esri Events App**!

**Download the Esri Events app and find your event**

**Select the session you attended**

**Scroll down to find the survey**

**Complete Answers and Select “Submit”**
Aspect Ratio Test

If this shape does not appear as a perfect circle, adjust the aspect ratio of your display until it does.

Try the resolution 1920x1080 for 16:9 displays.