



Oregon Department of Transportation



Mount Hood, Oregon



Guidelines for Positioning the Oregon Real-time GPS Network

Ken Bays, PLS

Lead Geodetic Surveyor, Oregon DOT

CGSIC, Nashville, 16 September 2013



Overview

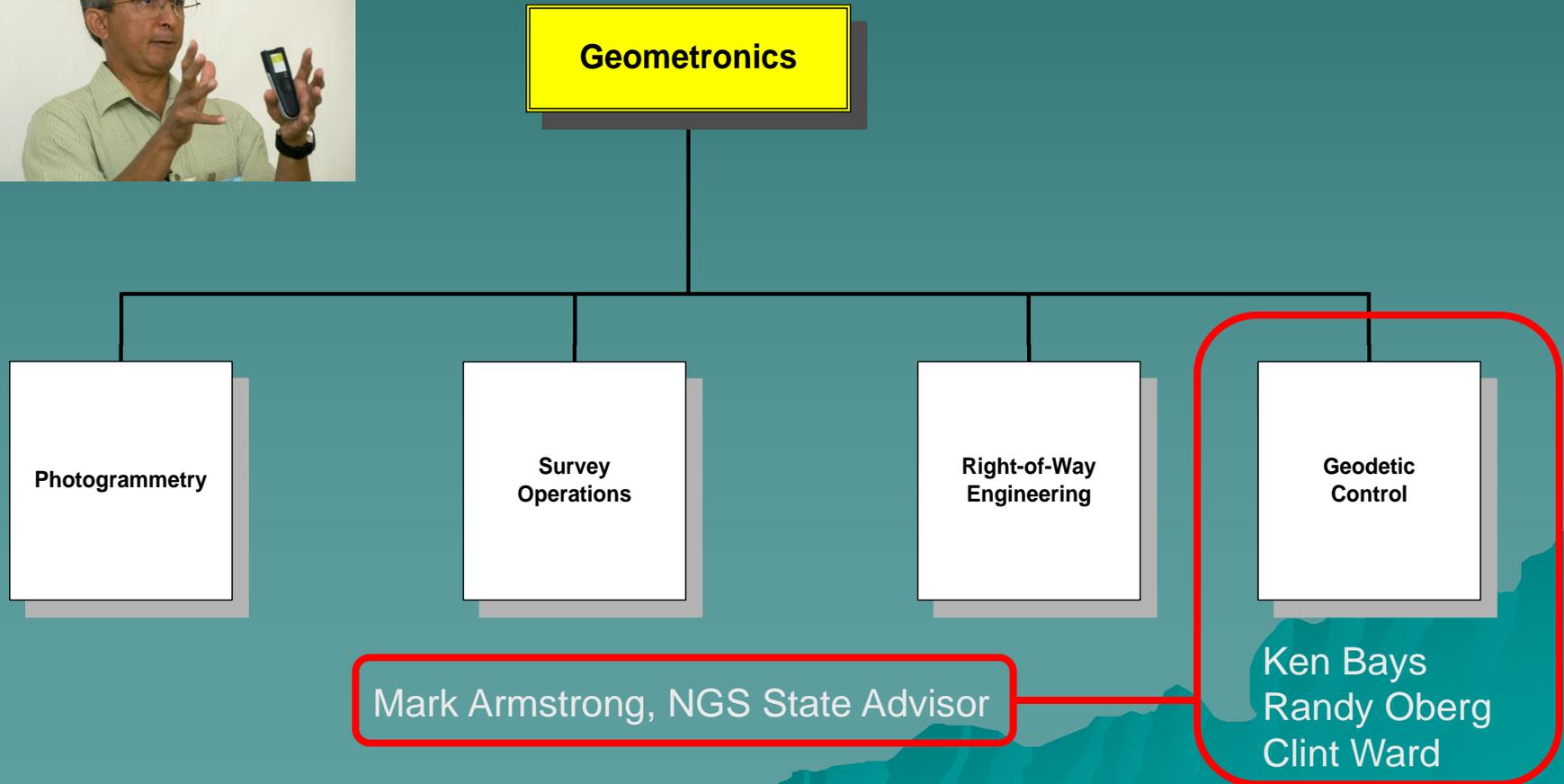
- ◆ Oregon DOT's plan to transition the Oregon Real-time GPS Network (ORGN) to NAD83(2011)epoch 2010.00
 - Background information on the ORGN
 - Determination of new coordinates for ORGN sites
 - Validation of the new coordinates
 - Customer education and support
 - Monitoring site coordinates



Oregon DOT Geometronics Unit



Ron Singh, ODOT Chief of Surveys





**Ken Bays, Oregon DOT
Lead Geodetic Surveyor**



**Randy Oberg, Oregon DOT
Geodetic Surveyor**



**Mark Armstrong, NGS
Oregon Geodetic Advisor**



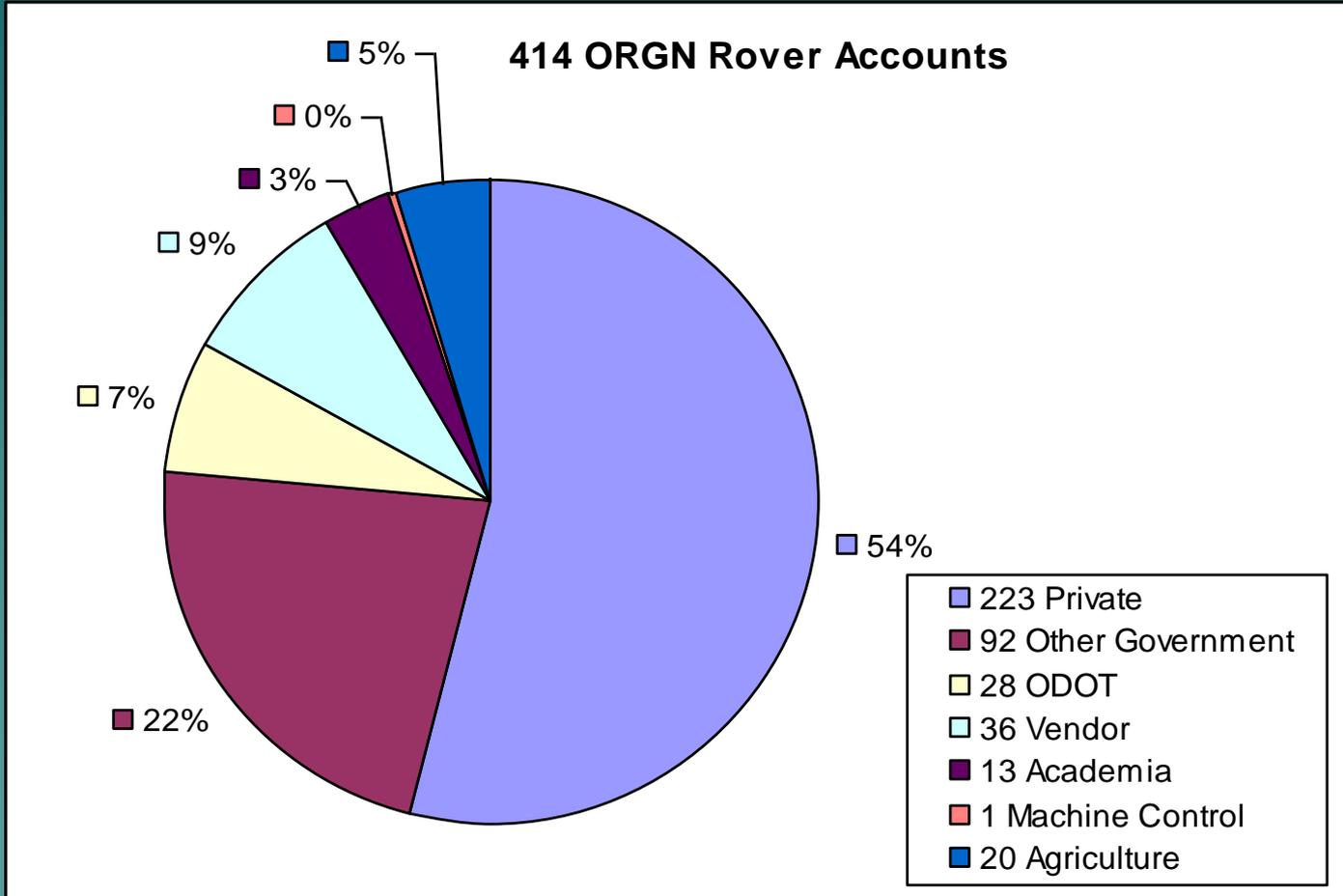
Oregon Real-time GPS Network

- ◆ ORGN startup in 2006 aligned to the NSRS
 - Originally NAD83(CORS96)epoch 2002.00
 - **8 March 2013**: transitioned to NAD83(2011)epoch 2010.00
- ◆ 93 reference stations
- ◆ Leica GNSS Spider operating software (Master-Auxiliary)
- ◆ Leica Spider QC site monitoring software
 - Leica Support Team



Oregon Real-time GPS Network

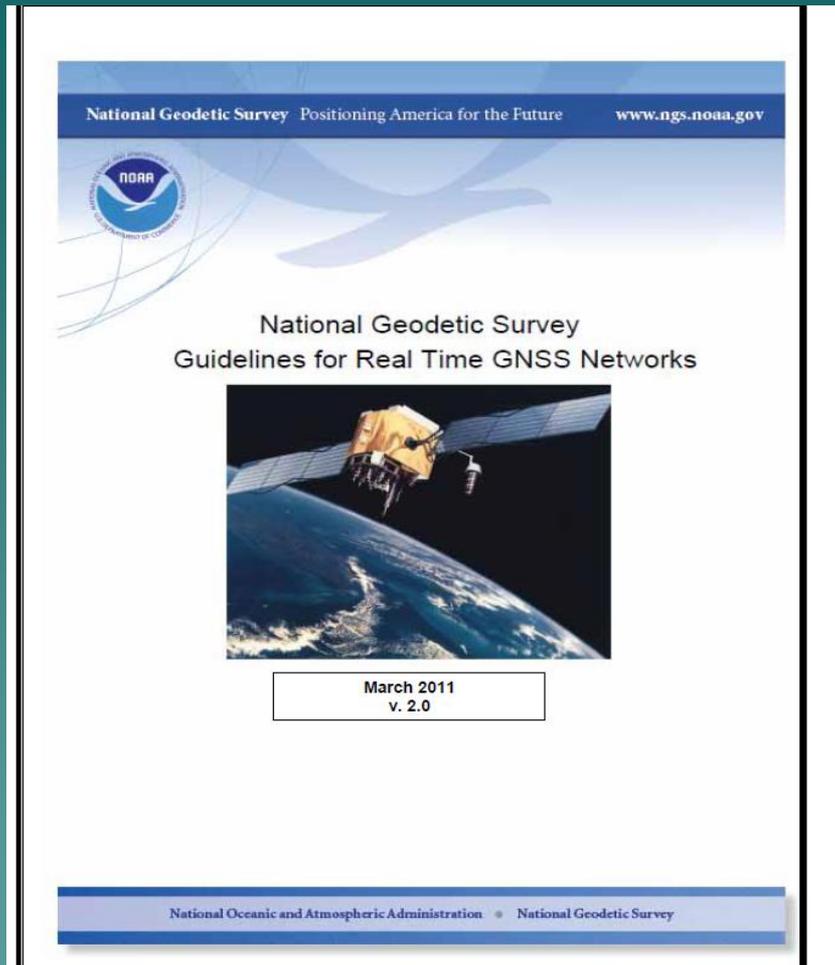
- ◆ ORGN Products:
 - Real-time correctors:
 - ◆ 450 registered rover accounts
 - ◆ Multi-base (network) and single base correctors
 - ◆ RT corrector formats
 - RTCM 3.x for network correctors, RTCM 2.3 single base
 - CMR+ format for some agriculture users
 - RINEX files for post-processing
- ◆ Partners: counties, cities, private, other RTNs
- ◆ Major partners:
 - Washington State Reference Network
 - UNAVCO Plate Boundary Observatory





ODOT Geometronics Policy

- ◆ The Oregon DOT Geometronics Unit will keep the Oregon Real-time GPS Network (ORGN) aligned to the National Geodetic Survey (NGS) National Spatial Reference System (NSRS) to help surveying, mapping, and other professionals determine positional coordinates that are compatible with coordinates derived by others.
- ◆ The use of a common coordinate base allows project coordinates to be exchanged freely and ensures projects match up on the ground, thus saving time, money, and possibly costly mistakes by geospatial professionals.



- Oregon DOT goal for positioning the ORGN to align with the NSRS:
- follow NGS Guidelines for RTNs:
 - http://www.ngs.noaa.gov/PUBS_LIB/NGS.RTN.Public.v2.0.pdf



OREGON DEPARTMENT OF TRANSPORTATION - GEOMETRONICS UNIT



House Mountain PBO/ORGN Station

Guidelines for Positioning the Oregon Real Time Network With NGS National Spatial Reference System Validation

ODOT: Ron Singh, Ken Bays, Randy Oberg
NGS: Mark Armstrong, NOAA

Oregon DOT's written guidelines for positioning the ORGN
- closely follow the NGS guidelines.



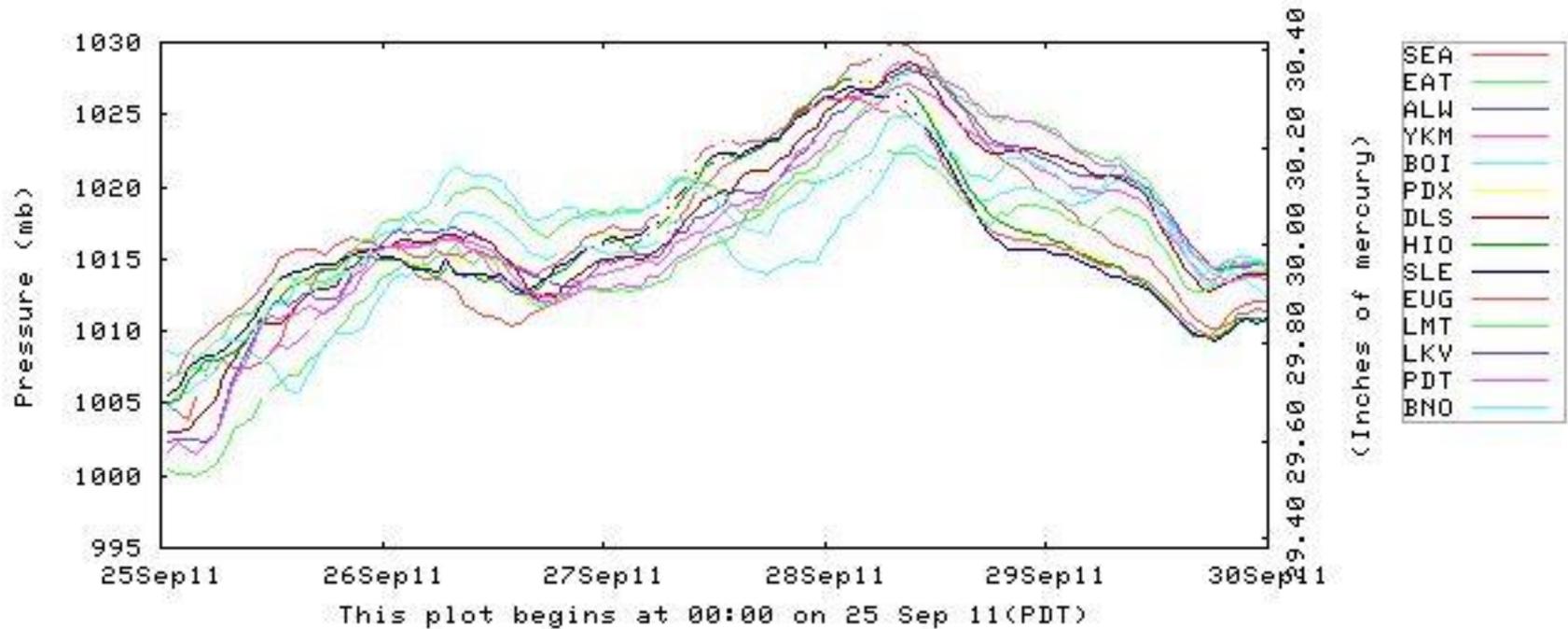
Major Elements of ODOT's Plan

- ◆ Goal: Minimum of 10% of the stations in the ORGN will be NGS CORS; actually 15% of ORGN sites are NGS CORS
- ◆ Process/Adjust with NGS **OPUS Projects** online
- ◆ Process 5 days of data collected during a period of high barometric pressure over the NW United States
- ◆ Fixed control in the OPUS-Projects:
 - NGS multi-year CORS sites that have "**computed velocities**" (minimum 2 ½ years data)
 - ◆ AND
 - Have long term antenna mount and location stability.
- ◆ Float NGS CORS sites with "modeled velocities"
- ◆ Overall Goal: compatibility with the NSRS and with existing and planned neighboring RTNs.



5 Days of Data with High Pressure Across the Area of Adjustment

Pressure (millibars)

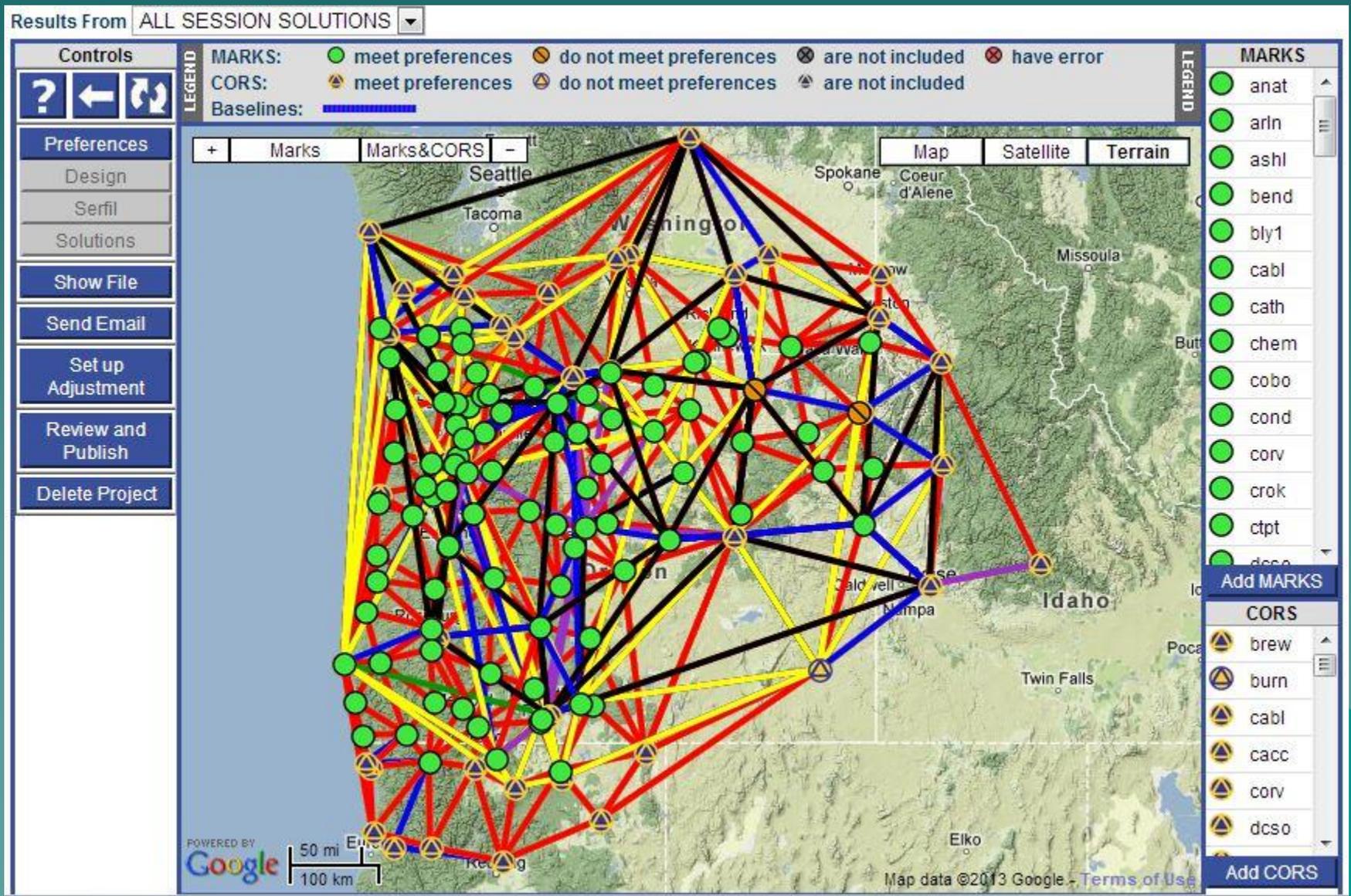




Network Adjustment of ORGN

- Several adjustments performed in both overlapping clusters and all-in-one using same control stations.
- Each active station dataset contained 5 days of 24 hour files = 120 hours for each station
 - Each day = 1 session
 - So 5 sessions for each station
 - RINEX data downloaded
 - Log files checked for accuracy
 - Processing and adjustment in OPUS-Projects

All vectors in ORGN OPUS-P Adjustment





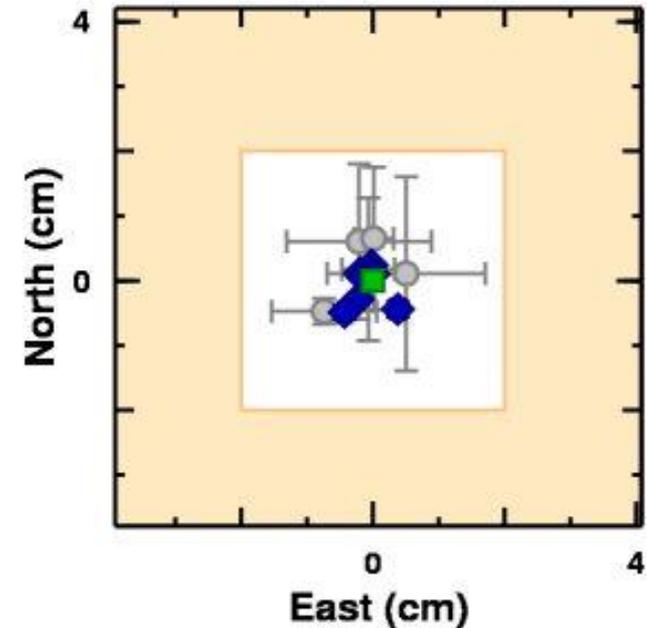
Active Station Mark Results (horiz.)

MARK dcso Plotted Solution Results From All Sources

Shaded (orange) areas in the plots are outside the project's preferences. ■ are network solutions. ◆ are session solutions. ● are OPUS solutions.

■ NETWORK SOLUTION	EAST (cm)	NORTH (cm)
network-Final ORGN South Coast Cluster	0.0 ±0.0	0.0 ±0.0
◆ SESSION SOLUTION	EAST (cm)	NORTH (cm)
2011-269-A	-0.2 ±0.1	-0.3 ±0.1
2011-269-A-1	-0.4 ±0.1	-0.5 ±0.1
2011-270-A	0.4 ±0.1	-0.4 ±0.1
2011-271-A	-0.1 ±0.0	0.1 ±0.1
2011-271-A-1	0.0 ±0.0	0.2 ±0.0
2011-272-A	0.0 ±0.0	0.1 ±0.1
2011-272-A-1	0.0 ±0.0	0.1 ±0.1
2011-273-A	-0.2 ±0.0	0.1 ±0.1
2011-273-A-1	-0.2 ±0.0	0.1 ±0.1
● OPUS SOLUTION	EAST (cm)	NORTH (cm)
dcso2690.11o	0.0 ±0.3	0.7 ±1.1
dcso2700.11o	-0.7 ±0.8	-0.5 ±0.2
dcso2710.11o	-0.2 ±1.1	0.6 ±1.2
dcso2720.11o	-0.1 ±0.4	0.2 ±1.1
dcso2730.11o	0.5 ±1.2	0.1 ±1.5

The (0, 0) point represents W123:20:29.45080 by N43:12:39.63099.

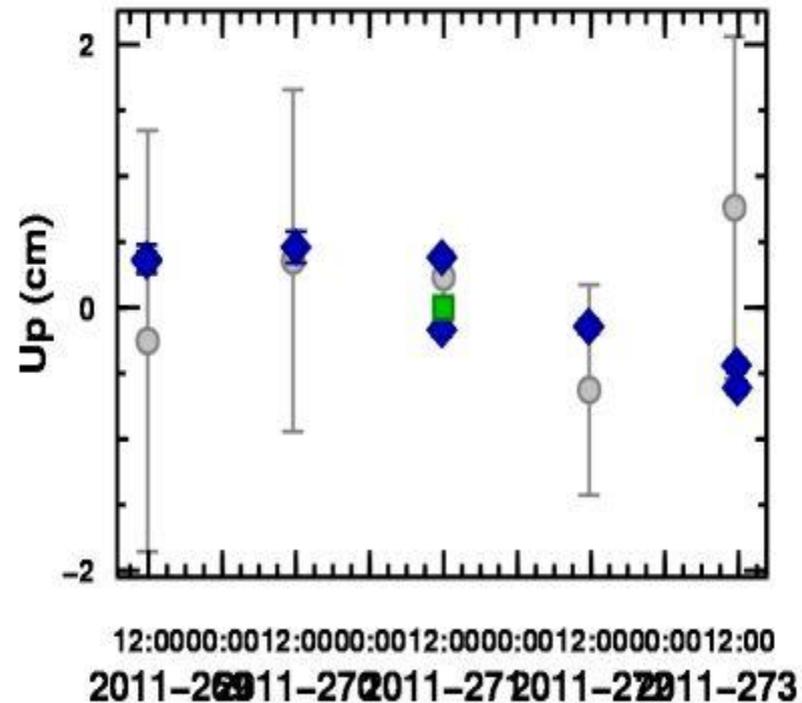




Active Station Mark Results (vert.)

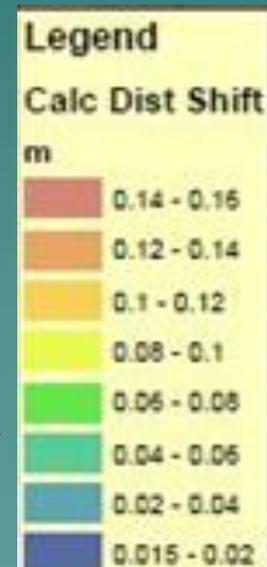
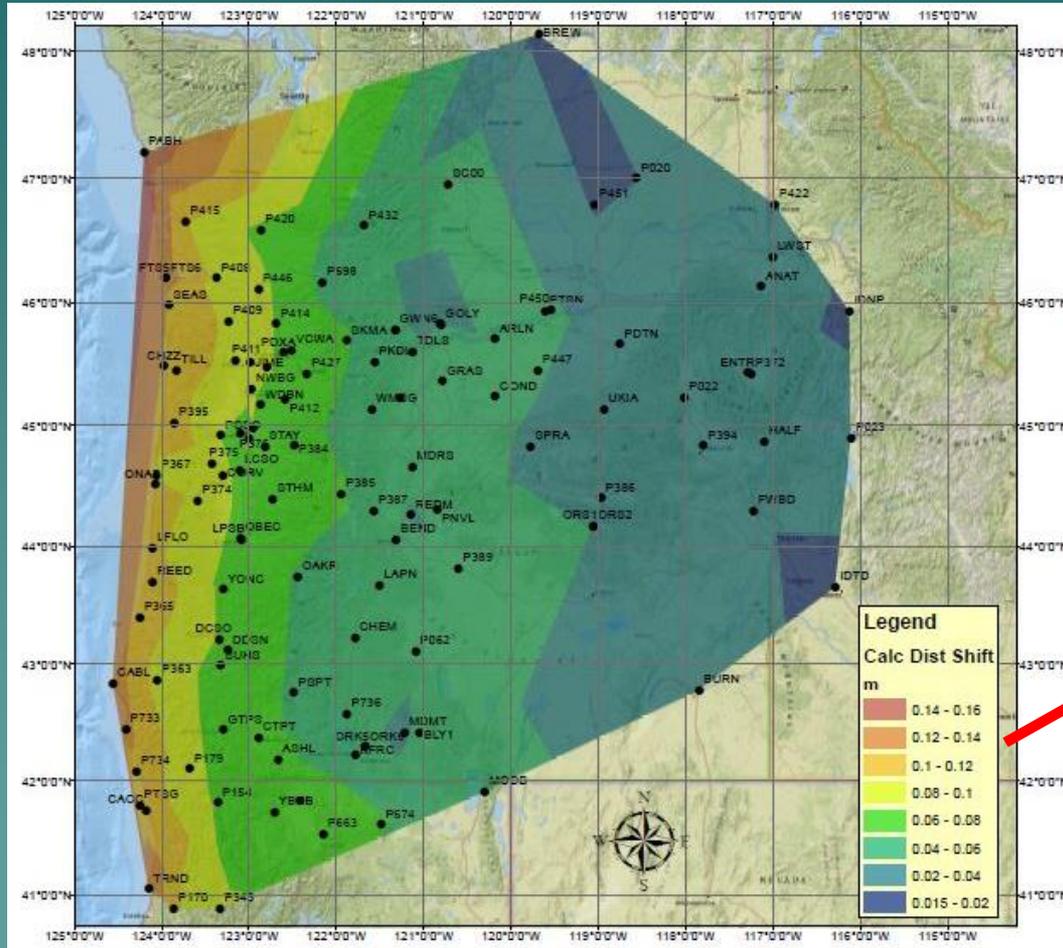
■ NETWORK SOLUTION	EPOCH	UP (cm)
network-Final ORGN South Coast Cluster	2011-271T11:59:45GPST	0.0 ±0.0
◆ SESSION SOLUTION	EPOCH	UP (cm)
2011-269-A	2011-269T11:43:01GPST	0.4 ±0.1
2011-269-A-1	2011-269T11:42:58GPST	0.4 ±0.1
2011-270-A	2011-270T11:59:45GPST	0.5 ±0.1
2011-271-A	2011-271T11:43:31GPST	-0.2 ±0.1
2011-271-A-1	2011-271T11:43:24GPST	0.4 ±0.0
2011-272-A	2011-272T11:37:17GPST	-0.1 ±0.1
2011-272-A-1	2011-272T11:37:39GPST	-0.1 ±0.1
2011-273-A	2011-273T11:46:02GPST	-0.6 ±0.1
2011-273-A-1	2011-273T11:38:56GPST	-0.4 ±0.1
● OPUS SOLUTION	EPOCH	UP (cm)
dcso2690.11o	2011-269T11:51:21GPST	-0.3 ±1.6
dcso2700.11o	2011-270T11:30:28GPST	0.4 ±1.3
dcso2710.11o	2011-271T12:02:09GPST	0.2 ±0.2
dcso2720.11o	2011-272T11:41:16GPST	-0.6 ±0.8
dcso2730.11o	2011-273T11:20:23GPST	0.8 ±1.3

The UP 0 point represents 136.78328 m.



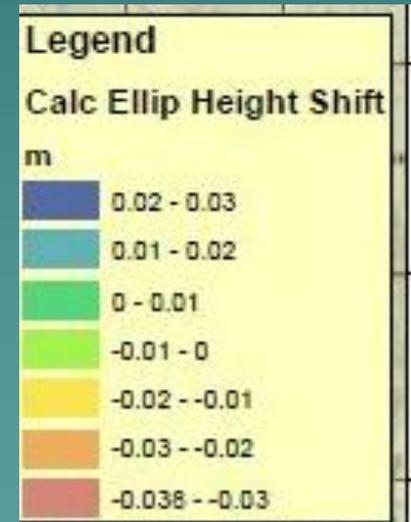
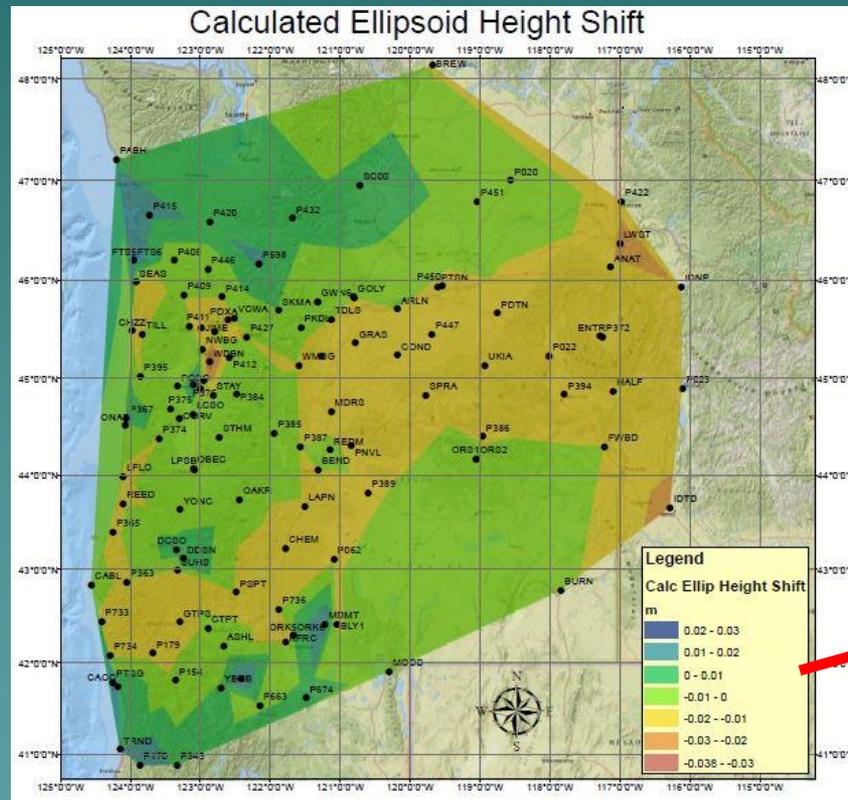


NAD83(CORS96)epoch 2002.00 to NAD83(2011)epoch 2010.00 Horizontal Shifts in the Northwestern US





NAD83(CORS96)epoch 2002.00 to NAD83(2011)epoch 2010.00 Verical Shifts in the Northwestern US



Graphic courtesy of Michael Olsen – Oregon State University



Coordinate Validation

- *Comparison of our OPUS Projects adjustment results with off-the-shelf least squares adjustment software:*
 - ◆ *Trimble Business Center*
 - ◆ *Agreement at the centimeter level*



Coordinate Validation

- Comparison of our adjustment results with the Washington State Reference Network positions, www.WSRN.org.
 - ◆ WSRN “officially” transitioned to NAD 83(2011) epoch 2010.00 on March 8, 2013.
- ORGN coordinates agree at the centimeter level with WSRN coordinates.



Coordinate Validation

- Comparison of our adjustment results with NGS CORS & NGS OPUS-Data Base published positions.*
- ORGN site coordinates checking into CORS and OPUS-DB sites at the +/- one centimeter level.*



Coordinate Validation

The NGS has acknowledged that regional real-time GPS networks such as the ORGN may require tighter internal consistency than NGS CORS policy provides for.

The NGS draft "Guidelines for Real-Time GNSS Networks", v.2.0, March 2011, state "For the sake of internal network consistency, the RTN administrator may want to adopt his/her adjusted values for the CORS coordinates rather than use the NGS-adopted values."

Therefore, the ODOT-adopted positions for some NGS CORS stations that are also in the ORGN may vary slightly from the NGS published positions for those stations.



User Support

- ◆ *Provided user education and support to ease changeover*
 - *Presentations during the preceding year to professional groups:*
 - ◆ *Professional Land Surveyors of Oregon*
 - ◆ *Oregon GPS Users Group*
 - *Pre-change Webinar for ORGN Users: 4 March 2013*
 - ◆ *Changes in ORGN real-time and RINEX products*
 - ◆ *Absolute IGS08 antenna calibrations*
 - ◆ *Geoid12A*
 - ◆ *Transitioning existing projects to the new datum realization*
 - *New coordinates web page at the ORGN website*



ODOT's Plan to Transition the ORGN to NAD 83(2011) epoch 2010.00

- Reminder: Even though the new ORGN site coordinates are different, this is **not** a new datum.*
 - ◆ It is a **new realization** of the NAD 83 datum*
 - ◆ Same reference ellipsoid (GRS80) as all other realizations of NAD 83*
 - Same origin*
 - Same orientation*
 - Same scale*



www.TheORGN.net/orgn_coordinates.html

Oregon Real-time GPS Network Coordinates

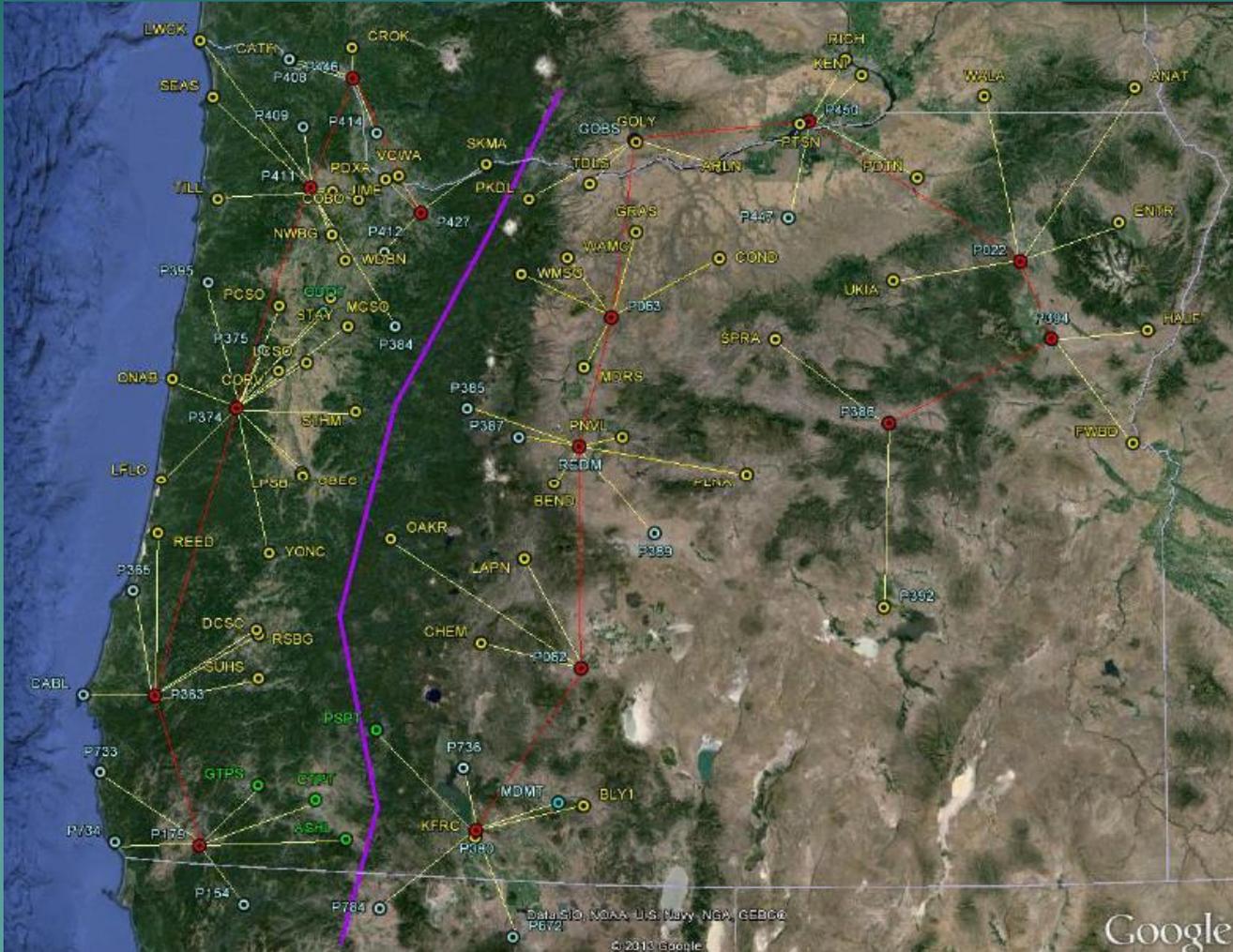
***NOTICE: NEW DATUM REALIZATION FOR THE OREGON REAL-TIME GPS NETWORK: NAD 83 (2011)
epoch 2010.00***

The Oregon DOT Geometronics Unit intends to keep the Oregon Real-time GPS Network (ORGN) aligned to the National Geodetic Survey (NGS) [National Spatial Reference System \(NSRS\)](#) to help surveying, mapping, and other professionals determine positional coordinates that are compatible with coordinates derived by others. This use of a common coordinate base allows project coordinates to be exchanged freely and ensures projects match up on the ground, thus saving time, money, and possibly costly mistakes by geospatial professionals.



Real-time ORGN Site Monitoring

– Leica Spider QC software





Summary

- ◆ Oregon DOT's plan to transition the Oregon Real-time GPS Network (ORGN) to NAD83(2011) epoch 2010.00
 - Determining new coordinates for sites
 - Validating the new coordinates
 - Customer education and support
 - Site monitoring

Smith Rock State Park, Oregon



Oregon Real-time GPS Network
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