National Geodetic Survey

NGS SUPPORT FOR REAL-TIME POSITIONING

SPACE-BASED POSITIONING NAVIGATION & TIMING
NATIONAL EXECUTIVE COMMITTEE

2008 CORS USERS FORUM
CGSIC - SAVANNAH, GA
SEPTEMBER 16, 2008

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National Oceanic and Atmospheric Administration

OVERALL PROGRAM OBJECTIVE

- Ensure that geodetic issues are adequately addressed in operation and use of real-time positioning systems

APPLICATION: TO ENSURE THE PROPER GEODETIC BASIS FOR *ACCURATE RT POSITIONING ALIGNED TO THE NSRS*

The National Geodetic Survey 10 Year Plan Mission, Vision and Strategy 2008-2018

http://www.ngs.noaa.gov/INFO/tenyearfinal.shtml

The mission of NGS is hereby understood to be:

1) To define, maintain and provide access to the **National Spatial Reference System** to meet our nation's economic, social, and environmental needs

and

2) To be a world leader in geospatial activities, including the development and promotion of **standards, specifications, and guidelines**.

http://www.ngs.noaa.gov/INFO/StrategicPlan_20080810.pdf

GPS/GNSS POSITIONING

PASSIVE MONUMENTS

ACTIVE STATIONS

STATIC

NGS 58/59 GUIDELINES

FGDC ACCURACY STDS.

MFTRS. SOFTWARE & DOCS.

RTN

VRS MAC FKP

½ COST OR DOUBLE WORK DONE

OPERATORS DRAFT GUIDELINES

≈ 75 IN USA, 200+WORLDWIDE

"***OPERATING AN RTN–CHAP. 1" DRAFT***

REAL-TIME

SINGLE BASE MONUMENTS

CLOSEST BASE CORS

NGS CLASSICAL USER GUIDELINES-DRAFT

REAL-TIME ACTIVITIES AT THE NGS

I. **OPERATE AN NTRIP CASTER.**
(Fed. Owned/operated – currently 7 - soon 9. RTCM 2.3 & 3.x, From Foundation CORS. NO CORRECTORS)

II. **DEVELOP AND PUBLISH GUIDELINES DESCRIBING BEST PRACTICES IN RTK & RTN .**
(RTK Users draft, RTN Operators draft, etc.)

III. **PARTICIPATE IN MEETINGS, FORUMS, WORKSHOPS, ETC., CONCERNING REAL-TIME NETWORKS. SEEK LEADERSHIP ROLES.**
(FIG, FGCS, ESRI, ACSM, RTCM, etc.)

IV. **RESEARCH PHENOMENA AFFECTING ACCURATE REAL-TIME POSITIONING.**
(Orbits, refraction, multipath, antenna calibration, and crustal motion.

NGS SUPPORT FOR REAL-TIME POSITIONING WHAT'S HAPPENED THE LAST YEAR?

- APPROVED NGS POLICY
- STREAMING RTCM 2.3 & 3.0 DATA VIA NTRIP – 7 CORS
- DRAFT USER GUIDELINES FOR CLASSICAL RT POSITIONING RELEASED
- DRAFT RTN OPERATORS GUIDELINES IN-HOUSE VETTING
- FIG COLLABORATION ON INTERNATIONAL GUIDELINES
- NGS= ANALYSIS CENTER FOR IGS ORBITS
- RTN TEAMS FORMED – WORKGROUPS, FGCS
- REAL-TIME NGS WEB SITE IN PRODUCTION
- RELEASED HTDP 3.0
- "IDOP" INTRODUCED
- 20 WORKSHOPS (ESRI, ACSM, FIG, STATES, ETC.)

I. NGS Real Time Stream Team

Product Manager

Richard Snay

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Outreach and User Relations

Bill Henning

Pam Fromhertz

CORS Data Streams

Charlie Schwarz

Neil Weston

Giovanni Sella

IT / Software Development Team

Bruce Sailer

Hong Chen

Sky Chaleff

NGS HEADQUARTERS

HNPT

MDSI

VAGP

NGS TESTING SITES – CORS STATIONS HNPT, MDSI, VAGP, VITH,PRMI, BARH

ON LINE SOON = ESPT, CORB

DAILY REPORTS

NTLOGPARSER Report
==========
======= - Generated
realtime:/usr/local/ntrip
First Log Message: Sun
Mon Jan 7 03:00:00 200
==========
======= STREAM AV
---
01. MOUNT: /HNPT Tota
Percentage: 100.00% U
wgeorg)
02. MOUNT: /HNPT1 To
Percentage: 100.00% U
03. MOUNT: /MDSI Tota
Percentage: 100.00% U
04. MOUNT: /MDSI1 To
Percentage: 100.00% U
05. MOUNT: /PRMI Total
Percentage: 99.99% Uni
MOUNT: /VAGP Total Ti
Percentage: 100.00% U
07. MOUNT: /VIKH Total
Percentage: 99.91% Uni
Total Time Available: 14
Unique Users: 2 (rcarlos

Mount Logins Time Connected
----- ------ --------------
/HNPT 2 2879 min 45 sec*
/MDSI 3 4319 min 26 sec*
/VAGP 2 2879 min 37 sec*

02. USER: mchris
Mount Logins Time Connected
----- ------ --------------
/MDSI1 1 1437 min 45 sec

03. USER: rcarlos
Mount Logins Time Connected
----- ------ --------------
/PRMI 14 1439 min 00 sec*
/VIKH 12 1438 min 47 sec*
/VITH 9 1437 min 34 sec*

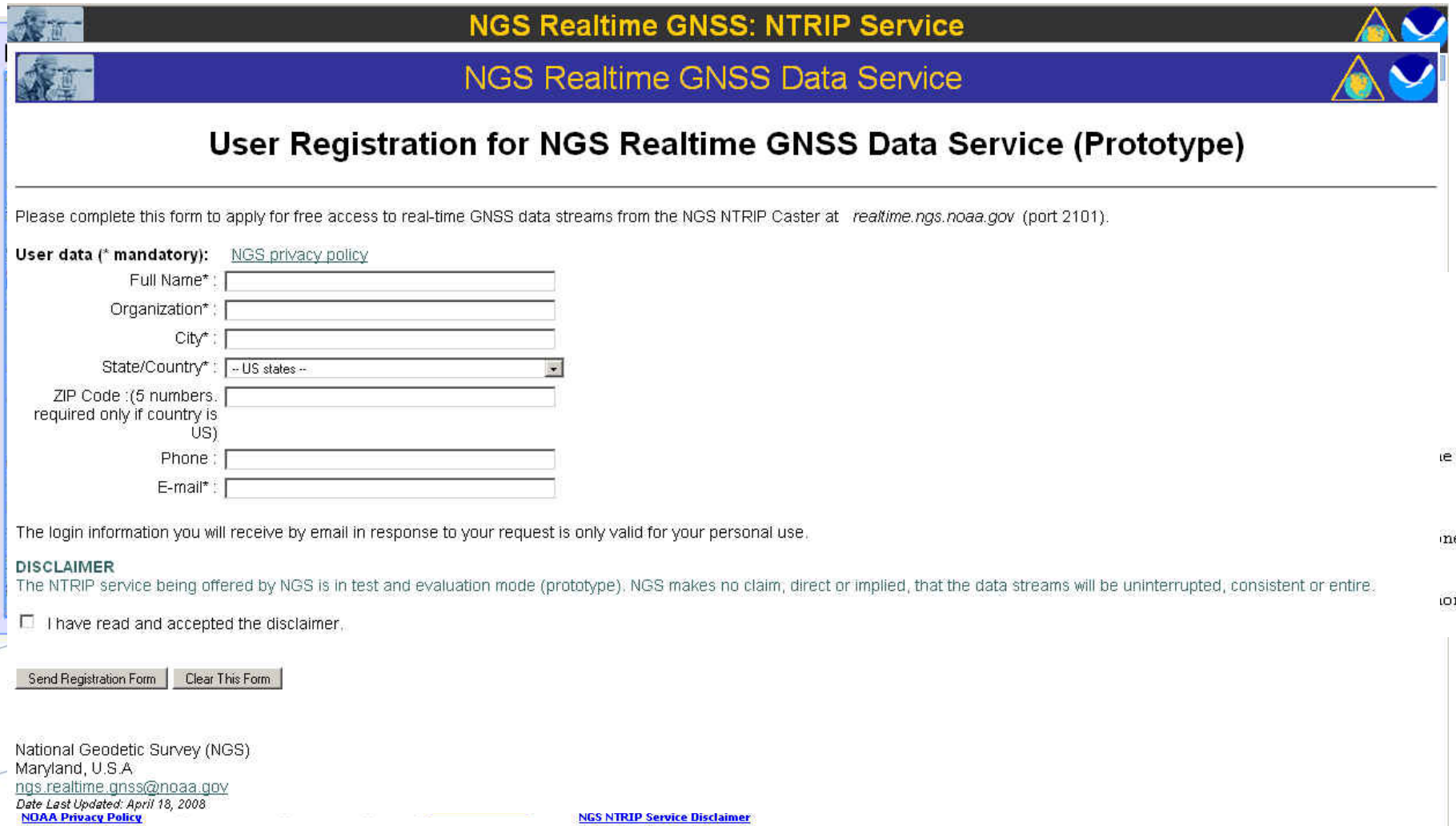
04. USER: sbruce
Mount Logins Time Connected
----- ------ --------------
/HNPT 1440 45 min 42 sec
/HNPT1 1440 18 min 13 sec
/MDSI 1440 47 min 25 sec
/MDSI1 1440 19 min 55 sec
/PRMI 1440 56 min 10 sec
/VAGP 1439 47 min 11 sec
/VIKH 1438 51 min 31 sec
/VITH 1436 63 min 45 sec

05. USER: ujeremy
Mount Logins Time Connected
----- ------ --------------
/HNPT 2 1439 min 55 sec
/MDSI1 3 1439 min 53 sec
/VAGP 2 1439 min 58 sec*

06. USER: wgeorg
Mount Logins Time Connected
----- ------ --------------
/HNPT 1 1439 min 24 sec

UNAUTHORIZED ACCESS ATTEMPTS ---------- ***
NO UNAUTHORIZED ACCESS ATTEMPTS TO REPORT ***

NGS WEB PAGES – CURRENTLY TEST/BETA



NGS Realtime GNSS: NTRIP Service

NGS Realtime GNSS Data Service

User Registration for NGS Realtime GNSS Data Service (Prototype)

Please complete this form to apply for free access to real-time GNSS data streams from the NGS NTRIP Caster at *realtime.ngs.noaa.gov* (port 2101).

User data (* mandatory): NGS privacy policy

Full Name* :
Organization* :
City* :
State/Country* : -- US states --
ZIP Code :(5 numbers. required only if country is US)
Phone :
E-mail* :

The login information you will receive by email in response to your request is only valid for your personal use.

DISCLAIMER

The NTRIP service being offered by NGS is in test and evaluation mode (prototype). NGS makes no claim, direct or implied, that the data streams will be uninterrupted, consistent or entire.

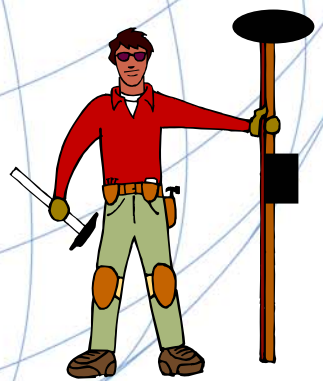
☐ I have read and accepted the disclaimer.

Send Registration Form | Clear This Form

National Geodetic Survey (NGS)
Maryland, U.S.A
ngs.realtime.gnss@noaa.gov
Date Last Updated: April 18, 2008
NOAA Privacy Policy NGS NTRIP Service Disclaimer

II. THE TWO DIRECTIONS OF REAL-TIME NETWORK POSITIONING

I. TOP DOWN: <u>Overall Administrator's viewpoint-</u> Alignment to the NSRS, coordinates, adjustments, Network spacing, Site requirements, Communication issues, Personnel, Cost/Benefit analysis, $$$$, Partners



II. USER UP: <u>Best methods-</u> Field techniques, GNSS knowledge, Knowing datum requirements, Knowing accuracy requirements, Calibrations, Applications, Data management

WHY SINGLE-BASE?

- **ACCOMMODATE LEGACY USERS**
- **CLOSEST BASE NETWORKS**
- **AREAS WITH NO CELL COVERAGE**
- **PROJECT SITE APPLICATIONS, SUCH AS MACHINE CONTROL**

WHY EMPIRICAL?

- **PLETHORA OF VARIABLES**
- **TIMELINESS**
- **PORT TO RTN USERS**
- **DYNAMIC NATURE OF RT POSITIONING**

http://www.ngs.noaa.gov/

RT ISSUES – SUCH AS:

- ✓ **PDOP**
- ✓ **RMS**
- ✓ **# SVNS**
- ✓ **BASELINE LENGTH**
- ✓ **REDUNDANCY**
- ✓ **# BASES**
- ✓ **OBS TIMES**
- ✓ **EQUIPMENT**
- ✓ **LATENCY**
- ✓ **FIXED/FLOAT**
- ✓ **ELEVATION MASK**
- ✓ **LOCALIZATIONS**
- ✓ **ACCURACY/PRECISION**
- ✓ **SPACE WEATHER**
- ✓ **GEOID QUALITY**
- ✓ **QA / QC**
- ✓ **GPS / GLONASS**

NGS HOME PAGE

http://www.ngs.noaa.gov/

REAL TIME NETWORKS (RTN)

?

- PERHAPS OVER 75 RTN EXIST IN THE USA WITH MANY IN THE PLANNING STAGES
- HOW ARE THEY ESTABLISHED?
- HOW ARE THEIR COORDINATES COMPUTED? ARE THEY CONSISTENT?
- HOW IS THE NETWORK ADJUSTED?
- ***HOW DOES THE RTN ALIGN TO THE NSRS?***
- CAN USERS USE ANY MANUFACTURERS' EQUIPMENT IN THE RTN?
- DO OVERLAPPING NETWORKS GIVE THE SAME COORDINATES?
- WHAT ARE THE FIELD ACCURACIES?

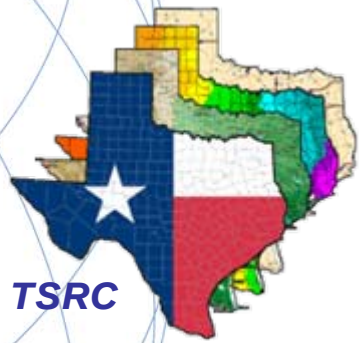
REAL-TIME CONSIDERATIONS

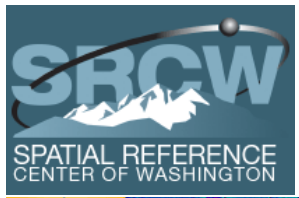
- PASSIVE / ACTIVE
- DATUMS & ADJUSTMENT EPOCHS
- GEOID + ELLIPSOID / CALIBRATE
- SINGLE BASE / RTN
- GNSS / GPS
- GRID / GROUND

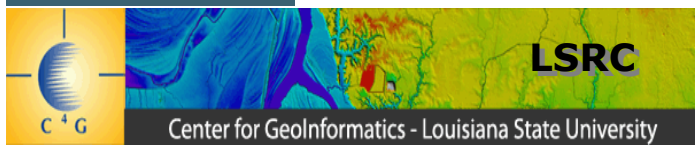
Guidelines for Operating a Real-Time GNSS Network CHAPTER ONE -Achieving Consistency Among Positional Coordinates and Velocities

- ITRF 2000 or NAD 83
  3 recommendations:
- #1 Include a subnetwork of the RTN into the National CORS network.
- #2 For each reference station contained in the RTN, adopt values for its 3-dimensional positional coordinates (at a selected epoch date) and a velocity that are consistent with corresponding values adopted by NGS for reference stations in the National CORS network.
- #3 For each reference station in the RTN, use the Online Positioning User Service (OPUS) at http://www.ngs.noaa.gov/OPUS/ to test for the continued consistency of its adopted positional coordinates and velocity on a daily basis, and revise the station's adopted coordinates and/or velocity if the tests reveal a need to do so.

III. OUTREACH, COOPERATIVE EFFORTS AND LEADERSHIP



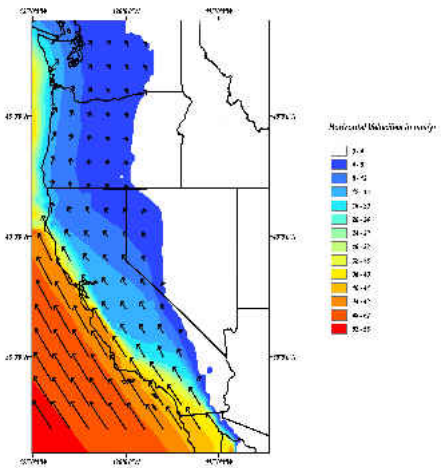




+ PUBLIC & PRIVATE *RTN ADMINISTRATORS* SPANNING MORE THAN 35 STATES

IV. HTDP 3.0- REFERENCE STATION VELOCITIES

HTDP - Horizontal Time Dependent Positioning



Horizontal velocities across the western United States. Colors specify speed in mm/yr and arrows specify corresponding directions of motion relative to the North American Datum of 1983.

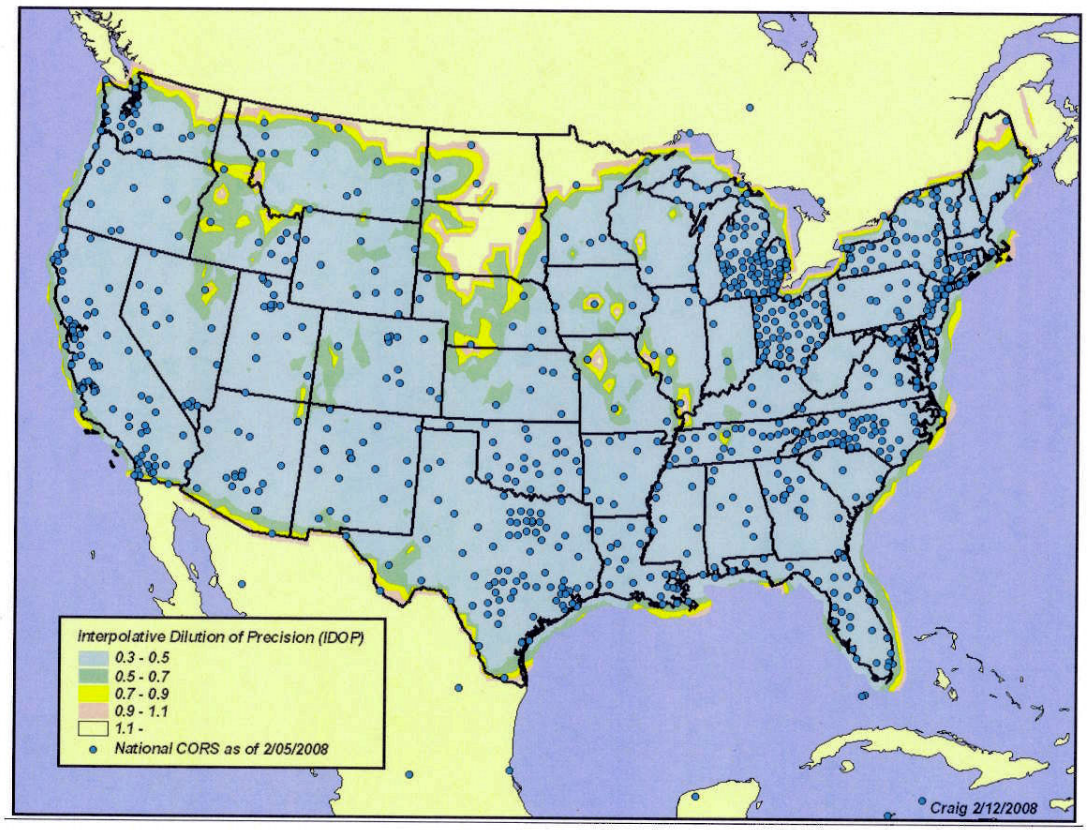
The HTDP software enables users to predict horizontal displacements and/or horizontal velocities related to crustal motion in the United States and its territories. The software also enables users to update positional coordinates and/or geodetic observations to a user-specified date. HTDP supports these activities for coordinates in the North American Datum of 1983 (NAD_83) as well as in all official realizations of the International Terrestrial Reference System (ITRS),and all official realizations of the World Geodetic System of 1984 (WGS_84). Hence this software may be used to transform geodetic coordinates between any pair of these reference frames in a manner that rigorously addresses differences among the definitions of their respective velocity fields.

The software employs models that address both the continuous and the episodic components of crustal motion. For characterizing continuous motion, the models assume that points on the Earth's surface move with constant horizontal velocities. This assumption is generally acceptable except for the accelerated motion experienced during the years immediately following a major earthquake and for the motion associated with volcanic/magmatic activity. For characterizing the episodic motion associated with earthquakes, the models use the equations of dislocation theory.

"IDOP" – CAN BE APPLIED TO RTN

OPUS-RS Coverage

Interpolative Dilution of Precision (IDOP) Values



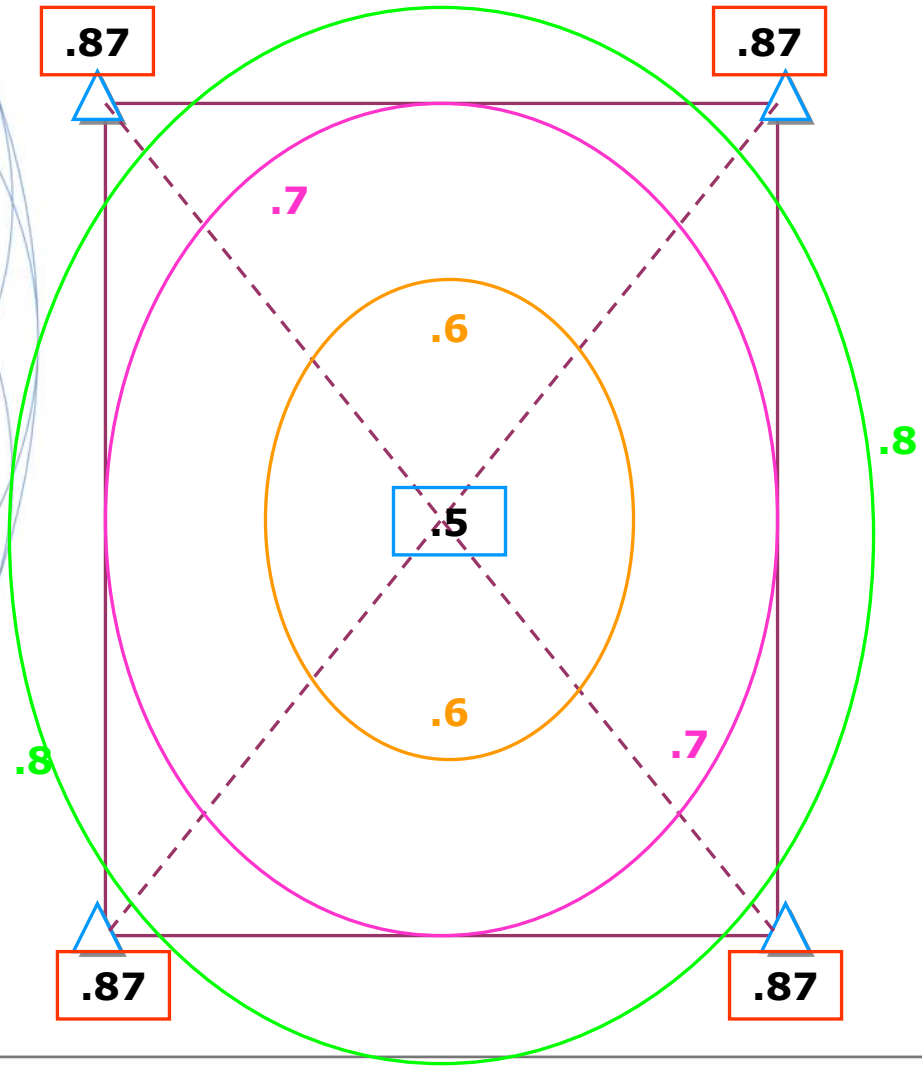
IDOP + SCALE WILL CORRELATE TO ACCURACY

IDOP VALUES – 4 CORS EXAMPLE

BEST IDOP = $\frac{1}{\sqrt{N}}$

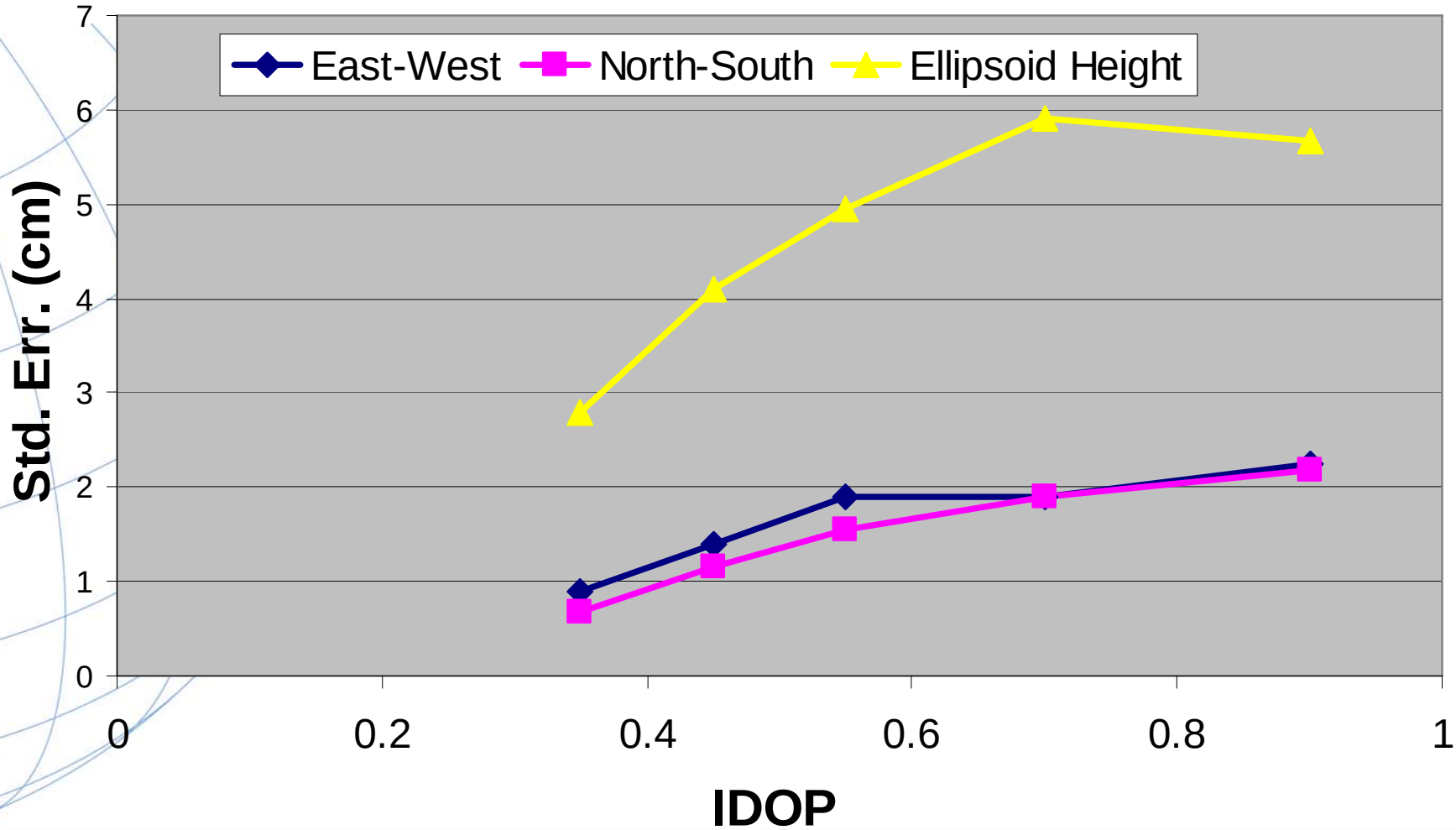
THEREFORE, WITH 9 CORS, THE IDOP AT THE CENTROID WOULD BE .33, WITH 4 CORS IT WOULD BE .5 AT THE CENTROID

ADDITION OF RMS OF DISTANCE TO CORS CONTRIBUTING TO THE SOLUTION GIVES FINAL UNITLESS NUMBER



"IDOP" WILL BE THE SUBJECT OF A FORTHCOMING PAPER BY DRS. RICHARD SNAY, TOM SOLER AND CHARLES SCHWARZ

OPUS-RS Accuracy for 15-minute data sets



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