

Rapid Deployment of a Statewide GPS RTK Network

A system to provide precise GPS location corrections for global navigation satellite system (GNSS) equipment.




Purpose of the System

- The objective is to provide real time kinematic (RTK) data to State agencies, public safety entities, utilities, private industry, and public users via the Internet.
- MoDOT intended from the beginning to make access of this system available to users in the area after MoDOT ensures that its needs and the needs of its other governmental partners are met.

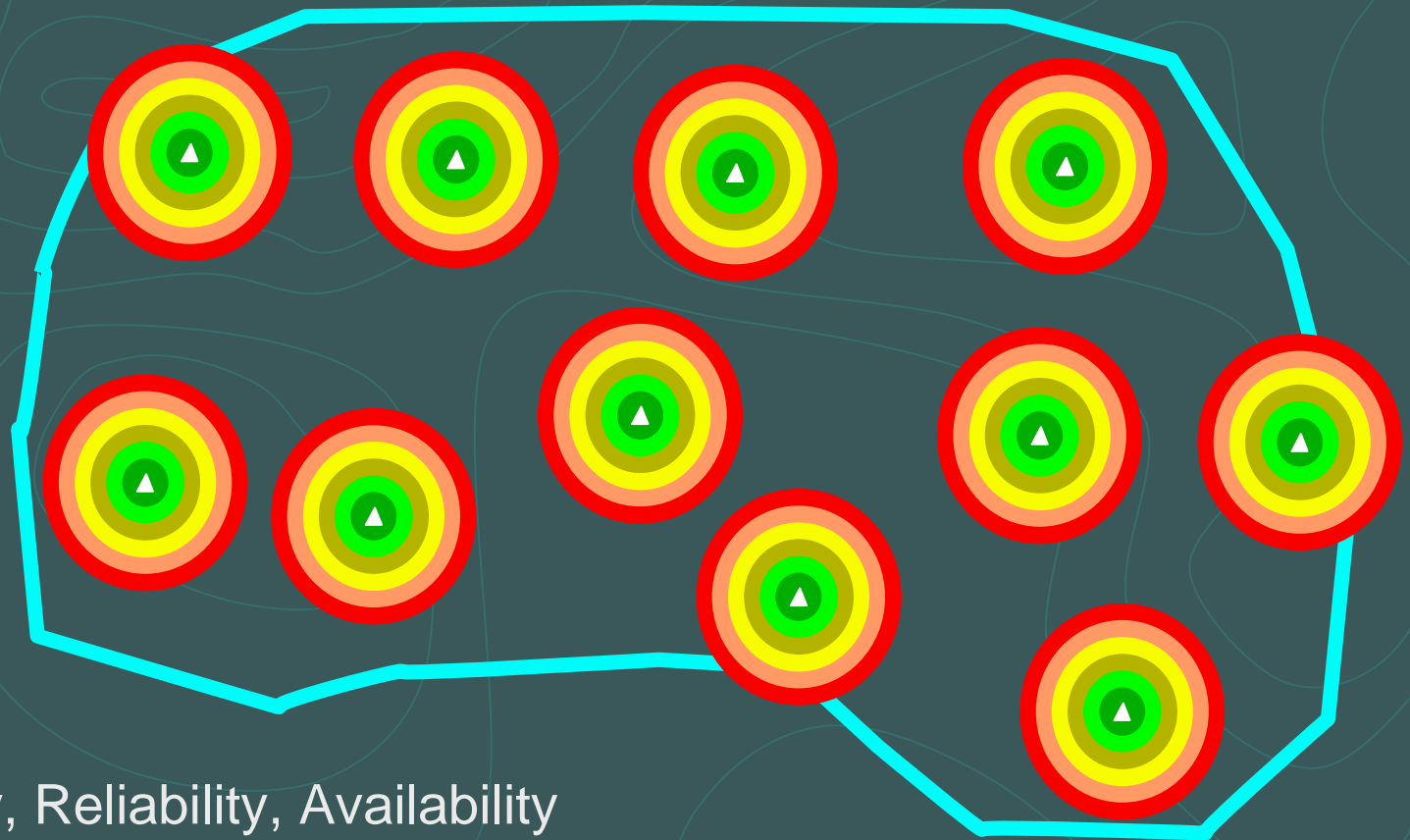


Uses of an GPS RTK Network

- 
- Surveying
 - GIS data collection
 - Construction Layout
 - Machine Controls
 - Automatic Vehicle Location
 - Asset Management
 - Other possible uses include automated road salting, unmanned mowers, and snow plow guidance.



Network of Single RTK Stations

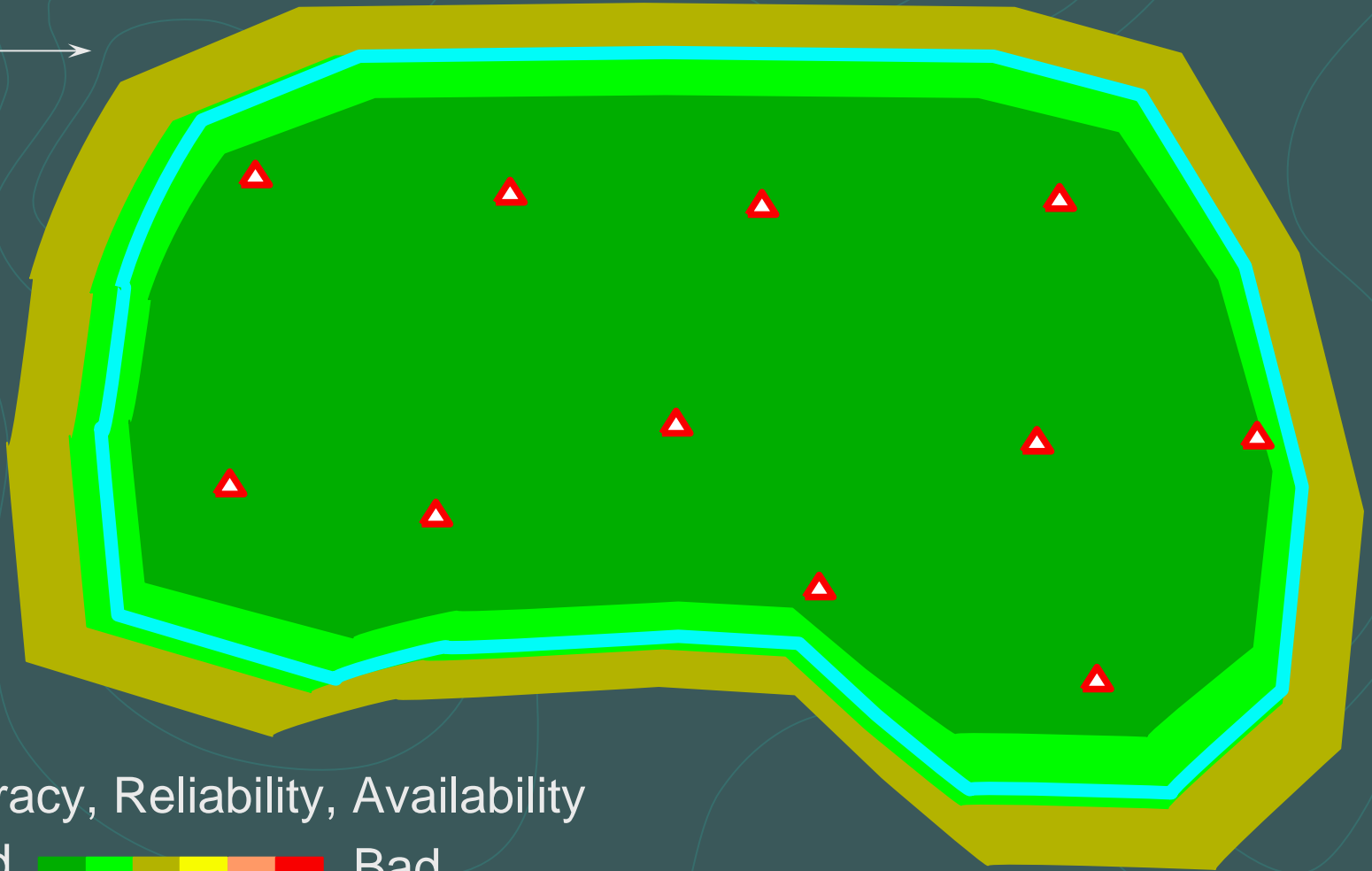


Accuracy, Reliability, Availability

Good  Bad



RTK Reference Stations Network



Accuracy, Reliability, Availability
Good  Bad



Benefits of a Reference Station Network

- Eliminate the need for local base stations
- Only GPS rover receivers are needed
- Less initial GPS expense because it doubles the number of GPS systems MoDOT has now
- No surveyor required to “watch” the base station
- Consistent known datum and coordinate system



Components of a CORS site

Monumentation

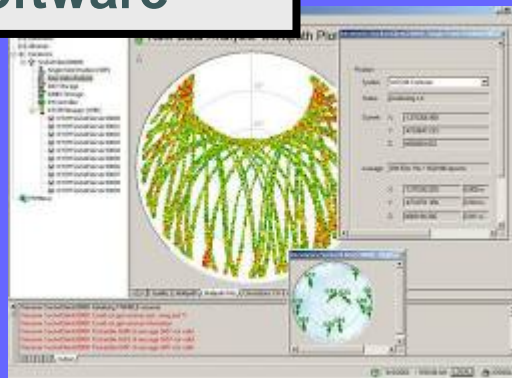


Hardware

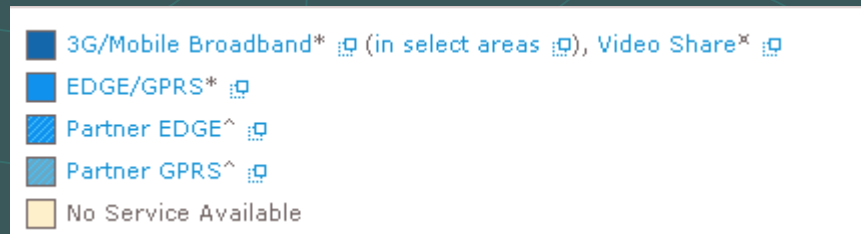
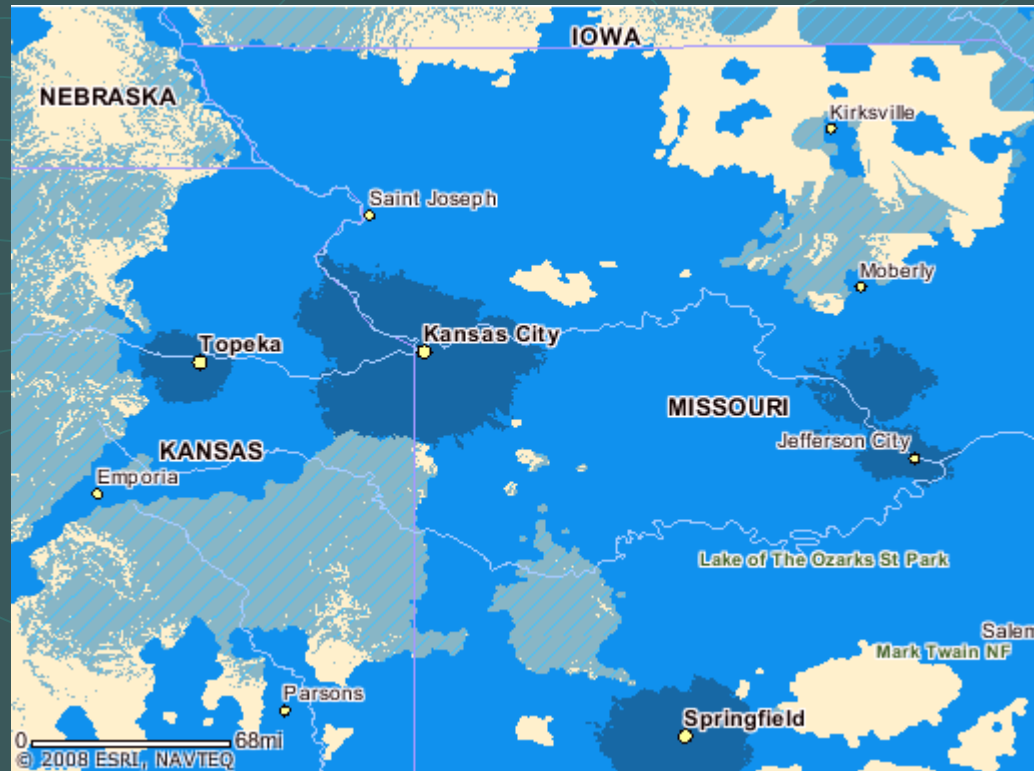
Communications



Software



The Key is Cellular Data Services



Goals

- Provide proof that a system could be established in Missouri at an acceptable cost
- Provide a turn key system for the St Louis metropolitan area as a pilot
- Expand the system statewide if the initial phase is successful




How did MoDOT Accomplish This?

- Worked with a consultant (HNTB) to prepare a set of comprehensive bid specifications
- Engaged in a competitive bidding process for a turn key system in St Louis
- Awarded the contract to the lowest and best bidder
- Had provisions in the contract that if successful, we could expand the system



Bid Specifications

- Specs were 51 pages
- Provided for vendors to bid the number of stations required to cover a specific area
- Allowed vendors to design their own solution

 **STATE OF MISSOURI
OFFICE OF ADMINISTRATION
DIVISION OF PURCHASING AND MATERIALS MANAGEMENT (DPMM)
REQUEST FOR PROPOSAL (RFP)**

AMENDMENT NO.: 003
RFP NO.: B2208007
TITLE: REAL TIME KINEMATIC NETWORK
ISSUE DATE: 11/16/07
RETURN PROPOSAL NO LATER THAN: 12/05/07 AT 2:00 PM CENTRAL TIME

REQ NO.: NR 605 2E23000070
BUYER: JOHN STOBART
PHONE NO.: (573) 751-3796
E-MAIL: john.stobart@ea.mo.gov@ea.mo.gov

MAILING INSTRUCTIONS: Print or type RFP Number and Return Due Date on the lower left hand corner of the envelope or package. Delivered sealed proposals must be in DPMM office (301 W High Street, Room 030) by the return date and time.

RETURN PROPOSAL AND AMENDMENT(S) TO:

(U.S. Mail)		(Courier Service)
DPMM	or	DPMM
PO BOX 809		301 WEST HIGH STREET, ROOM 030
JEFFERSON CITY MO 65102-0809		JEFFERSON CITY MO 65101-1517

CONTRACT PERIOD: DATE OF AWARD THROUGH ONE YEAR

DELIVER SUPPLIES/SERVICES FOR (Free On Board) DESTINATION TO THE FOLLOWING ADDRESS:

MISSOURI DEPARTMENT OF TRANSPORTATION
P.O. Box 270
JEFFERSON CITY, MO 65102

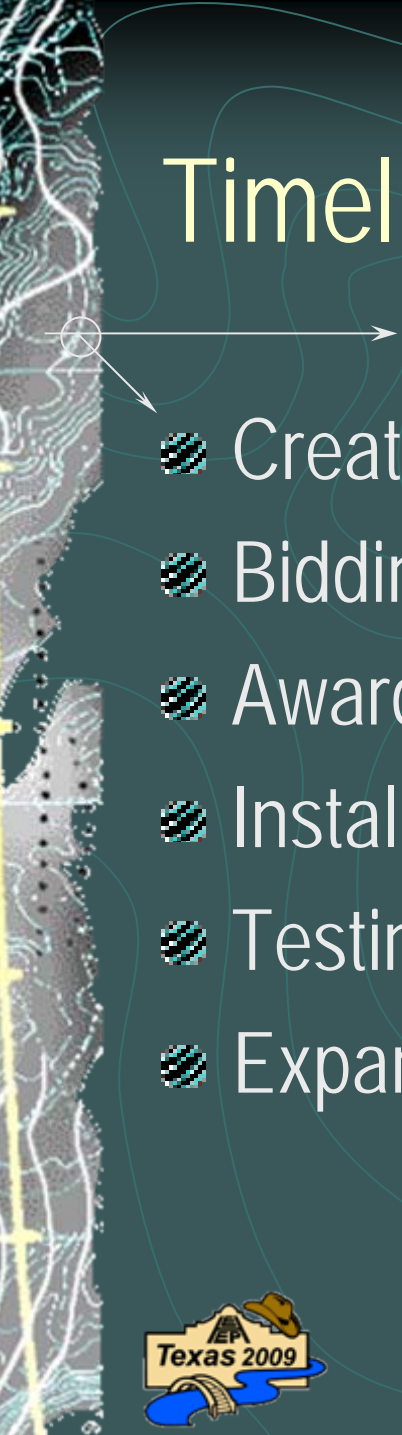
The offeror hereby declares understanding, agreement and certification of compliance to provide the items and/or services, at the prices quoted, in accordance with all terms and conditions, requirements, and specifications of the original RFP as modified by this and any previously issued RFP amendments. The offeror should, in a matter of clarity and assurance, also sign and return all previously issued RFP amendment(s) and the original RFP document. The offeror agrees that the language of the original RFP as modified by this and any previously issued RFP amendments shall govern in the event of a conflict with his/her proposal. The offeror further agrees that upon receipt of an authorized purchase order from the Division of Purchasing and Materials Management or when a Notice of Award is signed and issued by an authorized official of the State of Missouri, a binding contract shall exist between the offeror and the State of Missouri.

SIGNATURE REQUIRED

DOING BUSINESS AS (OR) NAME 	LEGAL NAME OF ENTITY/INDIVIDUAL FILLED WITH DE FOR THE TAX ID NO.
MAILING ADDRESS 	IRS FORM 1099 MAILING ADDRESS
CITY, STATE, ZIP CODE 	CITY, STATE, ZIP CODE



Timeline

- 
- Created bid specifications – 6 months
 - Bidding Process – 3 months
 - Awarding the bid – 2 weeks
 - Installation of the St Louis Network – 3 months
 - Testing of the St Louis Network – 1 month
 - Expansion of the network statewide – 18 months



Site Location Criteria

MoDOT needed to own the real estate at the site

- Power
 - Main line connections, Lightning Protection, back-up
- Security
 - Antenna and receiver
- Internet connection
 - Ideal although others could be used



Bid Awarded in April 2008 to

Seiler Instrument and Manufacturing
Company, Inc.

St. Louis, Missouri







253

BP
B & P construction, inc.

BP
B & P construction, inc.

McNeilus





Missouri Department
of Transportation

WARRENTON
1-888-454-MODOT
www.mdot.org



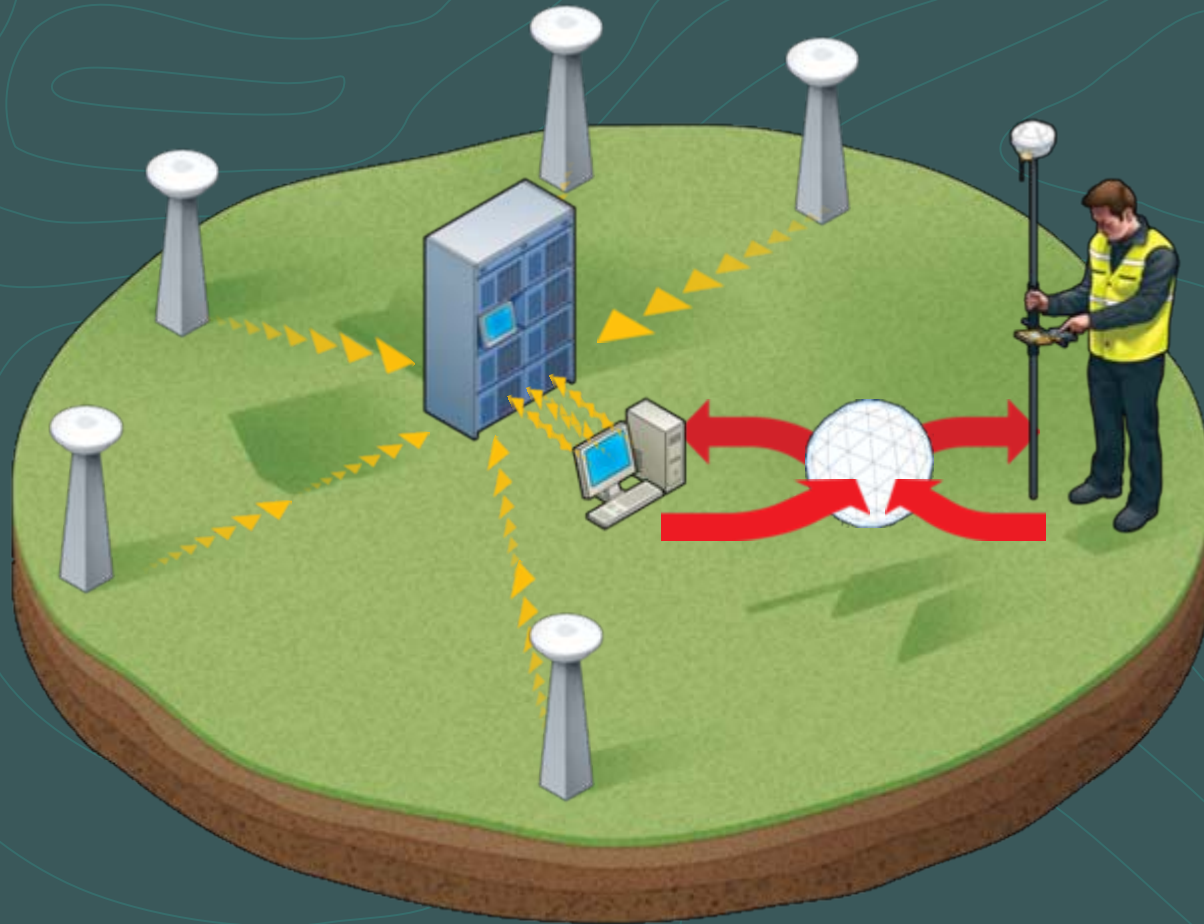








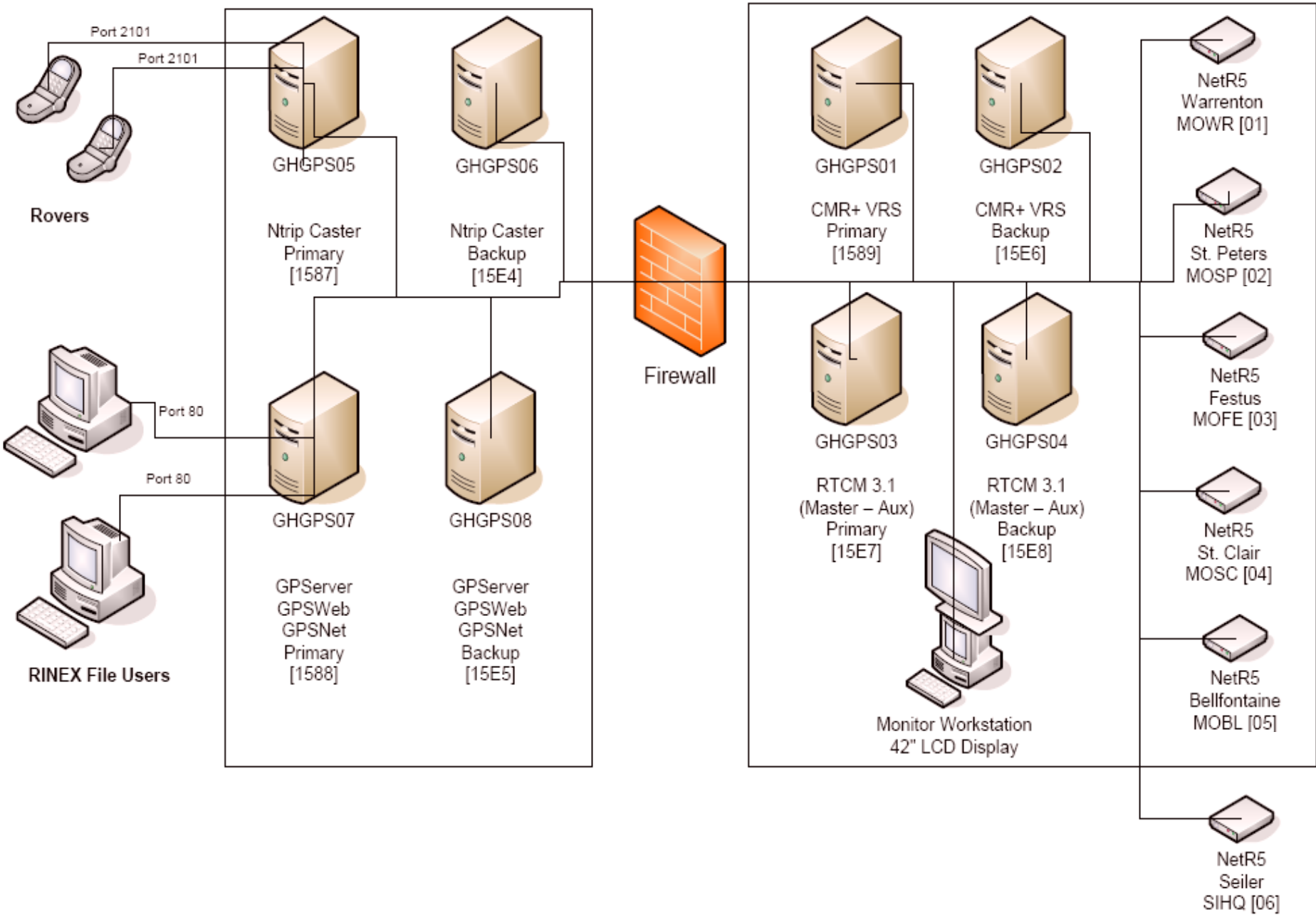
How can you make use of it?



Internet

DMZ

Trusted Network

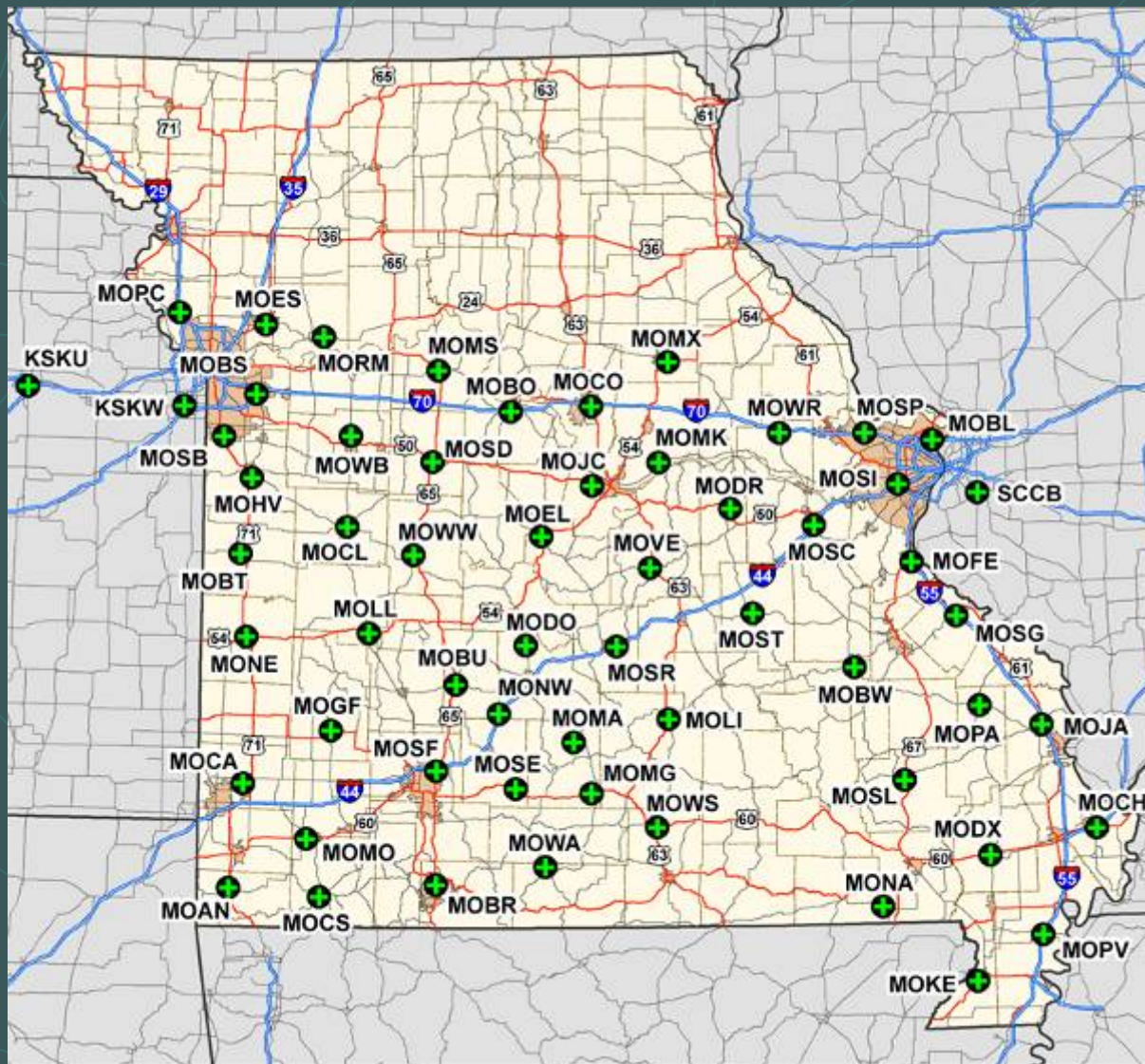


Improving GIS Accuracy using an RTK Network

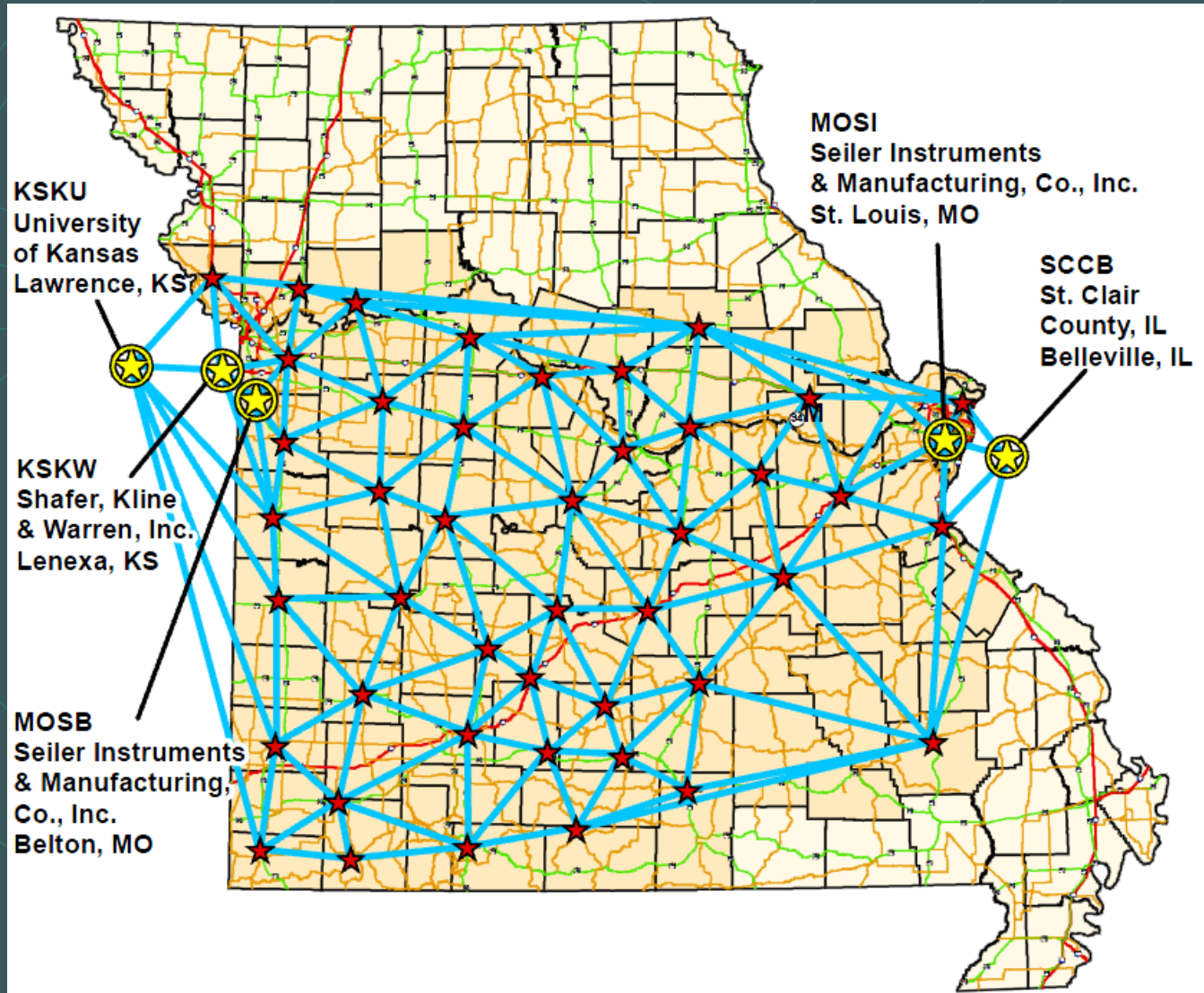
- Many handheld GPS units support the use of an RTK network
- Units connect to a bluetooth enabled cell phone
- Data connection is established for downloading real time corrections



MoDOT Network – September 2009

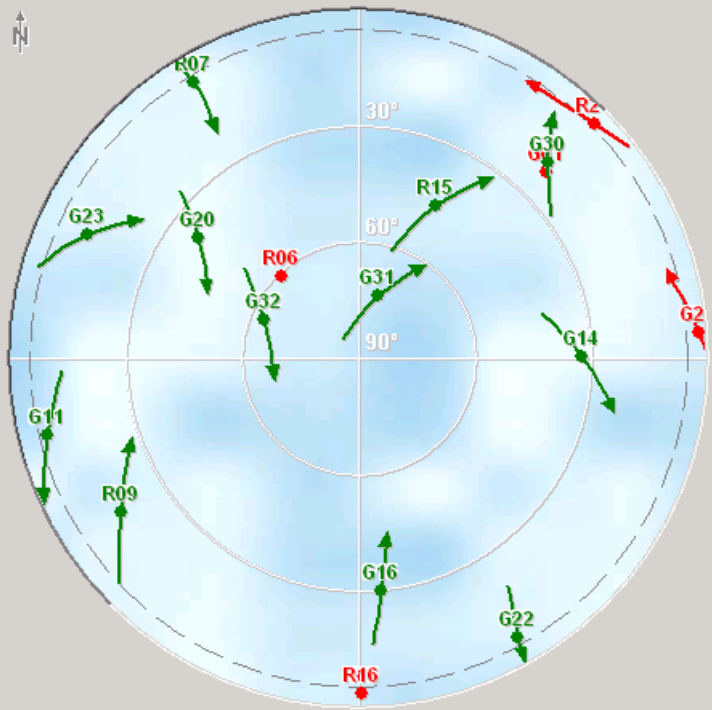


MoDOT Network Partners



- GPSNet
 - Almanac
 - Ephemeris
 - Receivers
 - MOWR
 - Raw Data Anal
 - MOBL
 - Raw Data Anal
 - MOFE
 - Raw Data Anal
 - MOSC
 - Raw Data Anal
 - MOSP
 - Raw Data Anal
 - SCCB
 - Raw Data Anal
 - MOJC
 - Raw Data Anal
 - RTCM SC_
 - RTCM SC_
 - RTCM SC_
 - RTCM SC_
 - MOCO
 - Raw Data Anal
 - RTCM SC_
 - RTCM SC_
 - RTCM SC_
 - RTCM SC_
 - MOBS
 - Raw Data Anal
 - MOHV
 - Raw Data Anal

MOSP: SkyPlot



Details

Visible Satellites:	20
Available Satellites:	12
Elevation Mask:	5°

```

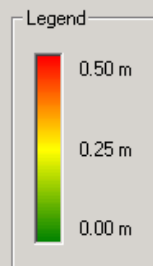
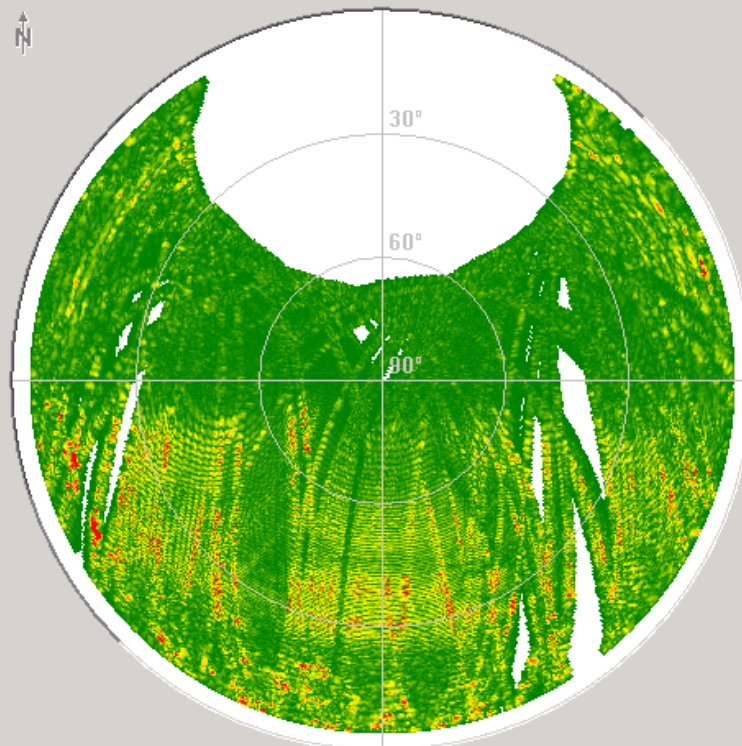
7/15/2009 11:16:23 AM RTCM SocketServer8000: Using station 42 MOLI as PBS.
7/15/2009 11:16:23 AM RTCM SocketServer8000: Attached to station 42 MOLI
7/15/2009 11:16:27 AM RTCM SocketServer8000: 1540 317802.0 Working in VRS-Mode
7/15/2009 11:16:27 AM RTCM SocketServer8000: Using new GPS reference station coordinates: ECEF[m] -187844.84000 -5060879.15000 3864922.06300
7/15/2009 11:16:27 AM RTCM SocketServer8000: Station ID 94 out of valid range [0..31], using 30 instead!
7/15/2009 11:16:34 AM RTCM SocketServer8000: Scrolling station info record has been changed.
    
```

Output



- GPSNet
 - Almanac
 - Ephemeris
 - Receivers
 - MOWR
 - Raw Data Anal
 - MOBL
 - Raw Data Anal
 - MOFE
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 - RTCM SC_
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 - RTCM SC_
 - RTCM SC_
 - MOCO
 - Raw Data Anal
 - RTCM SC_
 - RTCM SC_
 - RTCM SC_
 - RTCM SC_
 - MOBS
 - Raw Data Anal
 - MOHV
 - Raw Data Anal

Raw Data Analysis: Multipath Plot



Quality \ Multipath \ Multipath Plot \ Corrections

```

7/15/2009 11:16:23 AM RTCM SocketServer8000: Using station 42 MOLI as PBS.
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```

Output



MOSP
SAINT PETERS
Saint Peters, MO

Site operated by:
[Seiler Instrument Company](#)

- [Coordinates](#)
- [Data Sheet \(ARP only\)](#)
- [Data Sheets](#)
- [SiteLog](#)
- [Photographs](#)
- [Data Availability](#)
- [Standard Files](#)
- [Custom Files \(UFCORS\)](#)

- [Time Series \(60-day\)](#)
- [Time Series \(longterm\)](#)

- [Google Map mosp only](#)
- [Google Map all CORS](#)



National Geodetic Survey - CORS



MOSP Photographs

Saint Peters, MO

[Description of photos](#) | [Additional Photos](#) | [Send Photos to Us](#)

Pictures of equipment may not reflect equipment currently installed. Please see [sitelog](#)



View looking north



Download RINEX data to Post Process

MoDOT
Missouri Department of Transportation

**GNSS
Web Server**

Home

Please login with your name and password.

Login

Pass

New users may register here to obtain full service of this website or just use guest account below.

MoDOT Home

Welcome to the Webserver for GNSS-Reference stations

This service

- allows to download RINEX data
- creates virtual RINEX data on request
- provides information on the current tracking conditions in the network
- provides information on current atmospheric and ephemeris errors in the network.

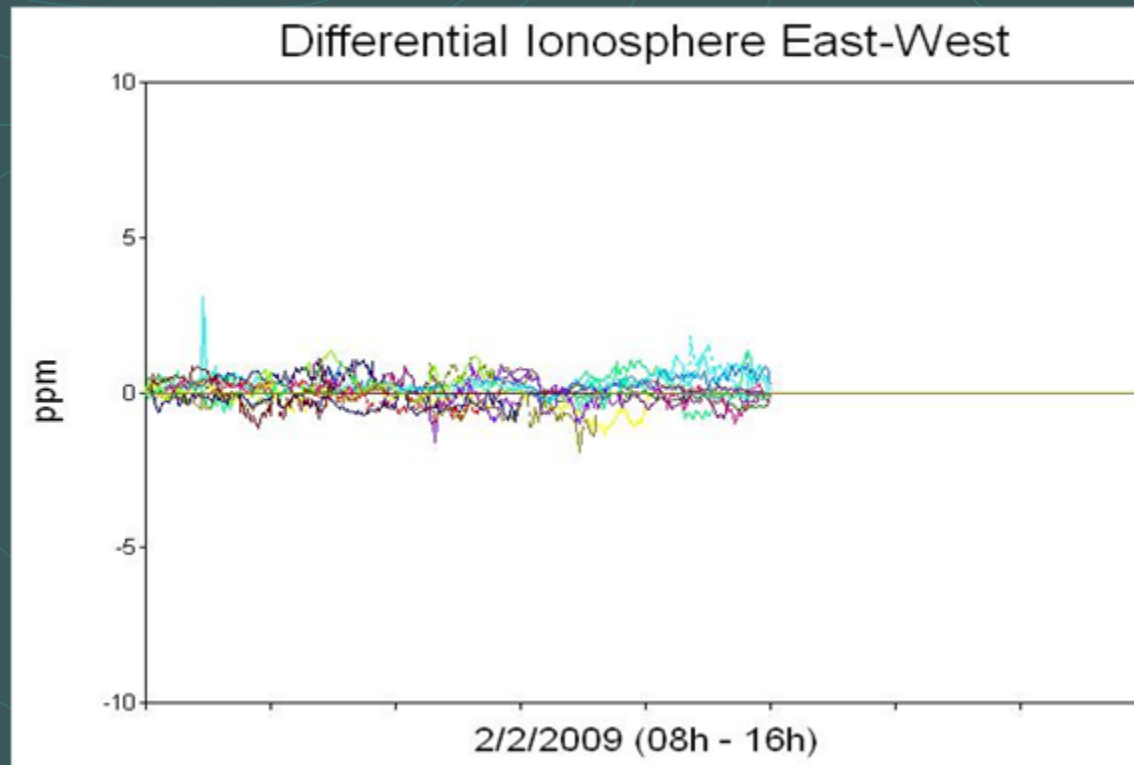
Copyright © 2000-2008 by Trimble Navigation Limited. All rights reserved.



<http://gpsweb.modot.mo.gov>

Differential Ionosphere Corrections

Network ionospheric and geometric corrections



Download Post Processing Corrections

MoDOT RINEX Shop – Date & Time Selection

You have selected the following reference station(s):

MOES, MOWB

Please enter your desired observation period:

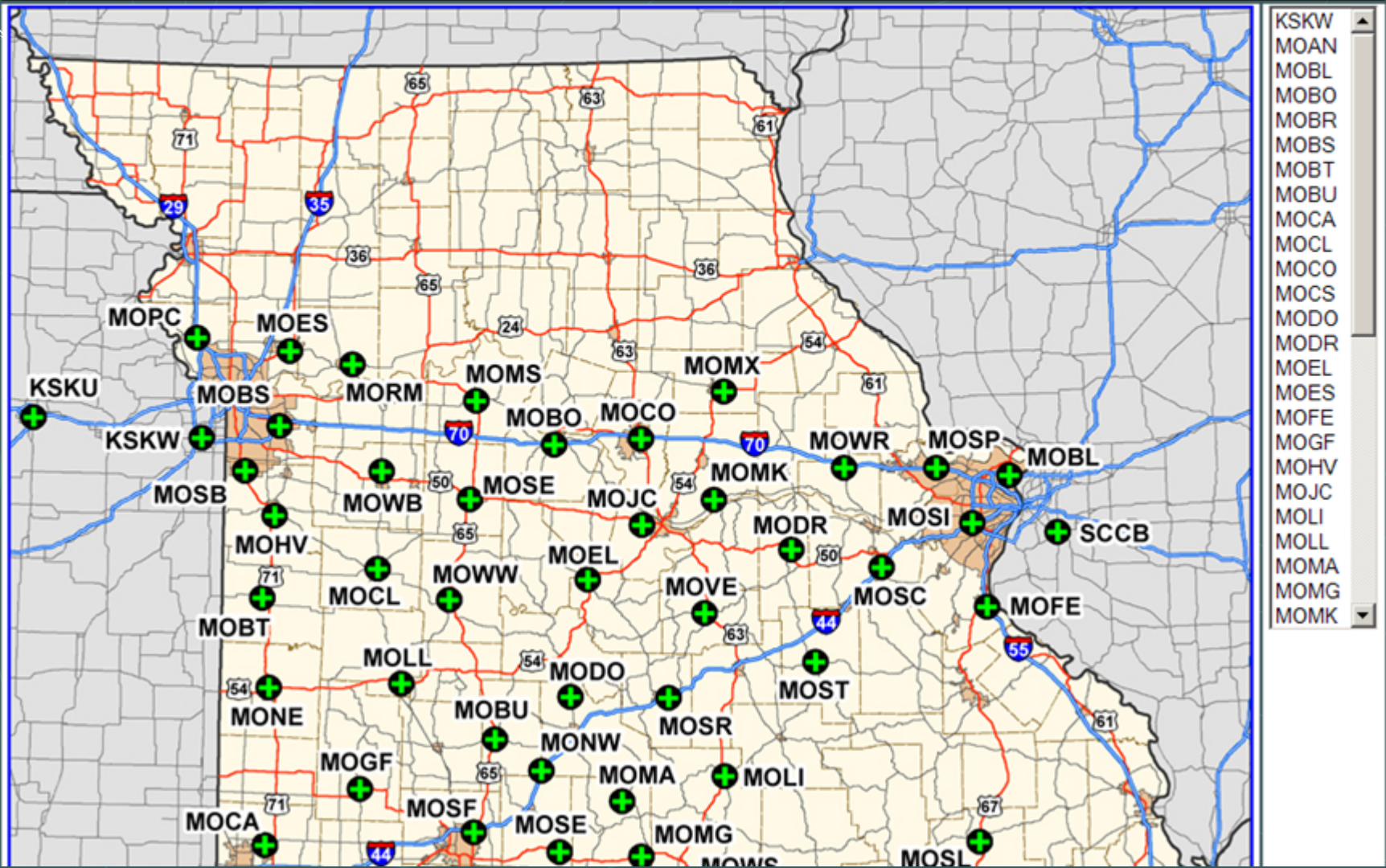
Observation Period	
Date:	[02] [February] [2009]
Start time:	[11] h [0] m [0] s
Duration:	[0] h [30] m
Interval:	[15] s
Time system:	GPS [GPS time = Local time + 05 hour(s) (summer time)] [GPS time = Local time + 06 hour(s) (winter time)]
	<input type="checkbox"/> Include Broadcast ephemeris
<< Back: Reference Stations Reset to initial values Next: Add to order >>	



MoDOT RINEX Shop – Reference Stations

Choose one or more reference stations by clicking in the list or in the map. If you want to select multiple stations from the list, press and hold down the CTRL key and click with the mouse.

Available Reference Stations



Satellite Tracking Information

Satellite Tracking Information

MOBS (Trimble NetR5)

Geographical coordinates


Latitude:	39° 0' 32.801461" N
Longitude:	94° 17' 26.155142" W
Ellipsoidal Height:	247.665 m

System	PRN	Elev [°]	Az [°]	SnrCA [dB]	SnrP2 [dB]	CA	P2	URA	Health
GPS	16	5.9	324.5	35	15	221	102	0	OK
GPS	5	5.0	203.9	40	19	756	756	2	OK
GLN	7	63.2	255.0	51	46	7450	7448	0	OK
GPS	24	67.0	335.6	51	42	11795	11795	0	OK
GLN	22	54.4	326.2	53	47	6340	6335	0	OK
GPS	18	14.1	233.8	43	22	1445	1445	0	OK
GPS	2	20.5	91.7	45	29	22661	22661	0	OK
GLN	21	66.3	149.9	53	48	13676	13671	0	OK
GPS	10	50.6	45.9	49	39	14687	14687	0	OK
GPS	15	39.4	151.0	49	39	5021	5021	0	OK
GPS	21	28.1	291.8	44	29	4631	4631	0	OK
GPS	30	16.4	224.7	43	26	14447	14447	0	OK
GPS	29	73.3	277.1	50	45	10715	10619	0	OK
GPS	26	43.8	126.5	50	40	5951	5951	0	OK
GLN	20	13.2	147.7	41	38	22338	22333	0	OK

13:12:31 February 02 2009 Central Standard Time



Implementation Phases

- 
- St Louis Area – In Production
 - Kansas City Area – In Production
 - Springfield and Branson Area – In Production
 - I70 Corridor – Connect St Louis and Kansas City - Summer 2009
 - I44 Corridor – Connect St Louis and Joplin - Summer 2009
 - Rte 71 Corridor – Arkansas to Kansas City – Summer 2009
 - I55 Corridor – St Louis to the boot heel – Fall 2009
 - Northern Missouri – Winter 2009-2010





Questions?

<http://gpsweb.modot.mo.gov>

