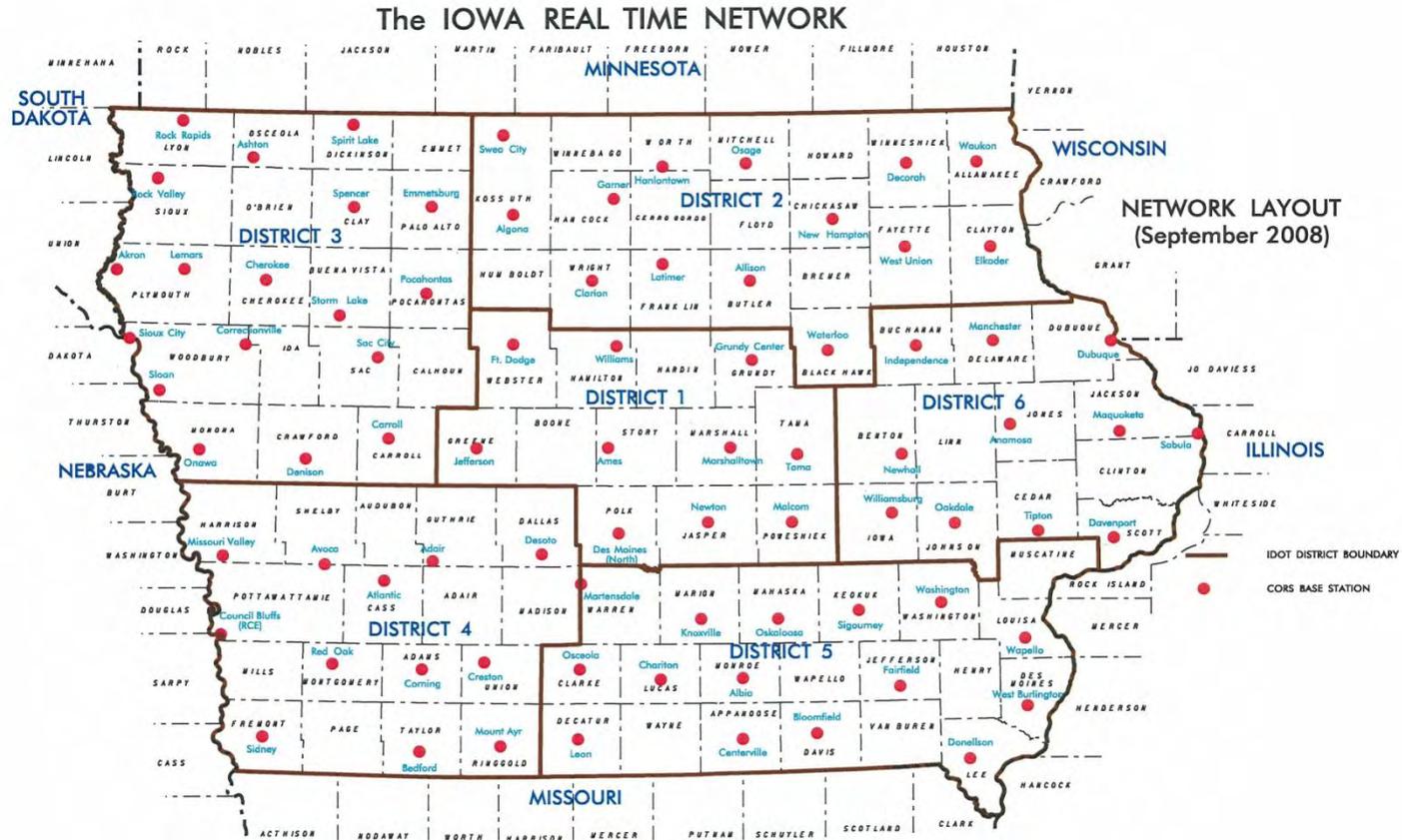


Iowa Real Time Network (IaRTN)

IaRTN Update



Steve Milligan

Statewide RTN Coordinator

Iowa Department of Transportation

March 11, 2009

Iowa Real Time Network (IaRTN)

- **How the Network was positioned**
 - **Network Testing**
 - **Network enhancements**
 - **RTK Products**
 - **Issues**
- **What lies ahead & Enhancements**
 - **Network User Statistics**

Iowa Real Time Network (IaRTN)

Positioned/Adjusted the Network

Collected +/- 2 weeks of 24 hour OPUS data at each base station

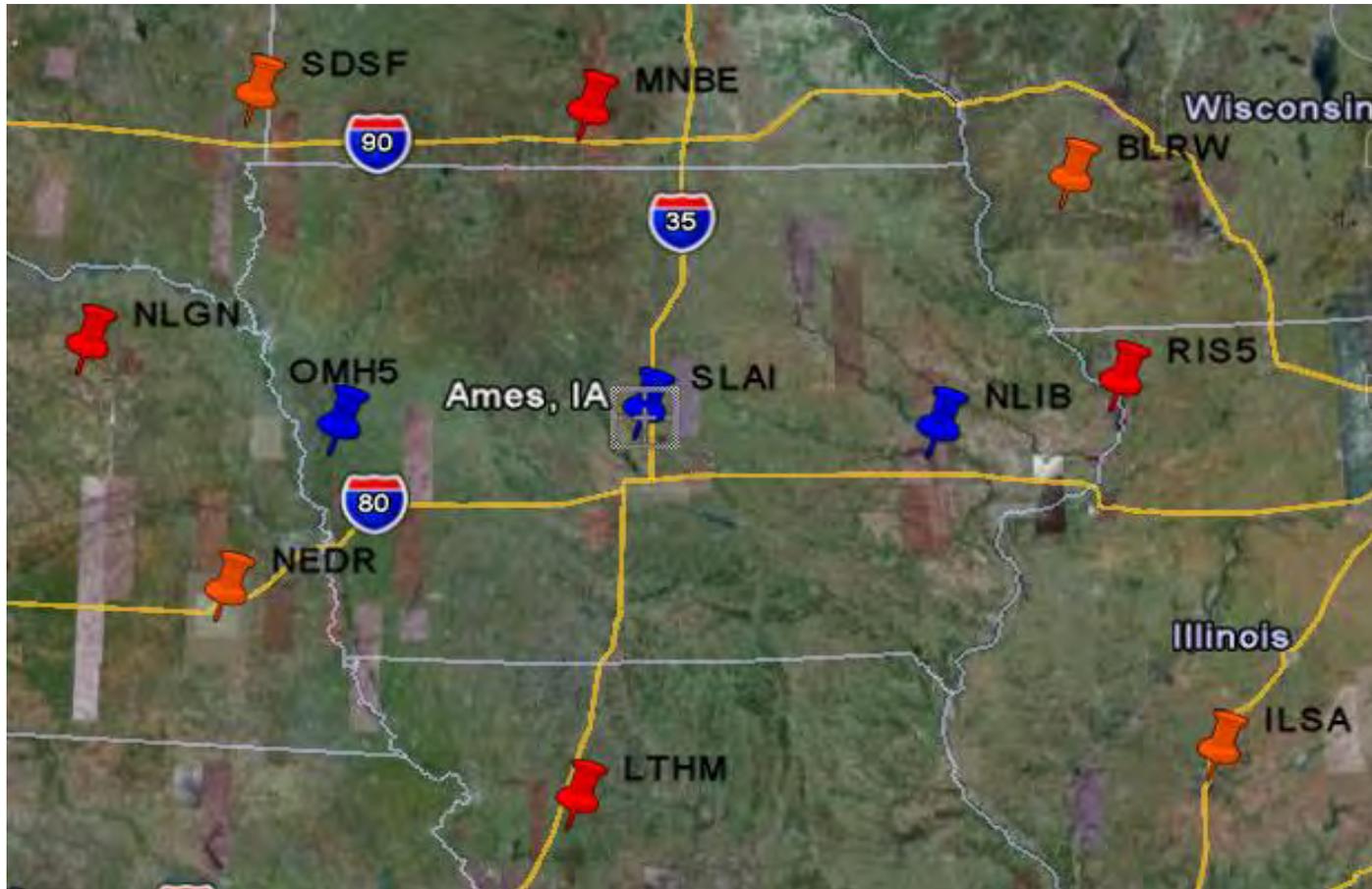
Held 4 COR stations surrounding Iowa fixed in 3D

Held 4 additional COR stations roughly in middle of state side in 2D

Independently verified using 3 COR stations in Iowa

Iowa Real Time Network (IaRTN)

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Independently verified using 3 COR stations in Iowa

Fully constrained adjusted coordinates are reported accurate to +/- 0.5 cm (horizontal) & +/- 1.5 cm (vertical) at 95% Confidence Level

Adjusted coordinates are tied to NAD83(CORS) datum for Epoch 2002.00

Iowa Real Time Network (IaRTN)

The NAD 83(CORS) and NAD 83(2007) realizations of the North American Datum of 1983 – IaRTN vs NGS Monuments

- NGS has adopted a realization of NAD 83 called NAD 83(2007) for the distribution of coordinates at ~70,000 passive geodetic control monuments.
- ***The NAD 83(2007) realization approximates (but is not, and can never be, equivalent to) the NAD 83(CORS) realization.***
- NAD 83(2007) was created by adjusting GPS data previously collected on the passive monuments (1980's – 2005), while holding fixed the NAD 83(CORS 96) positional coordinates for the ~700 CORS stations.
- NAD 83(2007) positional coordinates should be consistent with corresponding NAD 83(CORS) positional coordinates (within the accuracy of the GPS data used and the systematic errors in the adjustment).
- No corrections made to the observations for vertical crustal motion of the passive monuments, while the NAD 83 (CORS) coordinates of the CORS sites do reflect motion in all three directions.
- Therefore there can never be total equivalency between NAD 83(2007) and NAD 83(CORS).

Iowa Real Time Network (IaRTN)

IaRTN Vertical Datum

- **IaRTN sends Ellipsoid heights**
- Users GPS software makes the transformation to an Orthometric height
- Established by NGS CORS, which have GPS observed Ellipsoid heights
- **Don't expect to be able to check the vertical component of ground monuments (NGS or Local System)**
- **Calibrate/localize to the ground monuments**

Height Modernization !

Iowa Real Time Network (IaRTN)

Network Performance Testing

- **2 Counties in each IDOT District**

- District 1 – Greene & Hardin**

- District 2 – Winneshiek & Chickasaw**

- District 3 – Sac & Dickinson**

- District 4 – Dallas & Pottawattamie**

- District 5 – Wapello & Lee**

- District 6 – Linn & Clinton**

- **20 – 3 epoch shots – 4 times a day – on 4 to 6 monuments**

Iowa Real Time Network (IaRTN)

Pottawattamie County Testing Results

Mon.	Average Variance			Maximum Variance		
	N	E	ELL	N	E	ELL
MJ0600	0.005'	0.007'	0.009'	0.017'	0.015'	0.022'
MJ1402	0.009'	0.016'	0.024'	0.029'	0.048'	0.053'
MJ1258	0.004'	0.005'	0.029'	0.013'	0.014'	0.096'
MJ1242	0.010'	0.006'	0.024'	0.024'	0.006'	0.052'

NOTES:

- Fieldwork completed on 03/08/10 by Steve Milligan using Leica GG1250RX GPS rover.
- Sessions ran from 8:00 AM until 4:30 PM with 2 to 2-1/2 hours between sessions.

Difference from Pub.			
Mon.	N	E	ELL
(1) MJ0600	-0.02'	0.16'	
(2) MJ1402	0.02'	0.02'	-0.10'
(1) MJ1258	0.16'	0.30'	
(1) MJ1242	0.18'	0.13'	

(1) The published datum is NAD83(1996).

(2) The published datum is NAD83(2007) & NAVD88.

Iowa Real Time Network (IaRTN)

Network Performance Testing (Repeatability)

- Dallas County (middle August & early October)

<u>Monument</u>	Difference Between Times		
	<u>N</u>	<u>E</u>	<u>EL</u>
Dallas Co. 114	0.021'	0.023'	0.033'
Dallas Co. 115	0.006'	0.008'	0.023'
Dallas Co. 120	0.000'	0.016'	0.020'
Dallas Co. 121	0.009'	0.049'	0.015'
West Des Moines 59	0.021'	0.011'	0.003'

Iowa Real Time Network (IaRTN)

IaRTN RTK Products

- **Single Baseline Solution Products**

- **RTCM 2.3 (GPS Only)=> Nearest or Specific sites**
- **RTCM 3.x (GNSS)=> Nearest or Specific sites**
- **CMR (GPS Only)=> Nearest or Specific sites**
- **CMR+ (GPS Only)=> Nearest or Specific sites**

Nearest – IaRTN software picks nearest station to the GPS receiver

Specific – User picks a specific station

Iowa Real Time Network (IaRTN)

IaRTN RTK Products

- **Network Solution Products**

- RTCM 2.3 (GPS Only)=> iMAX
- RTCM 3.x (GNSS)=> MAC & iMAX
- CMR+ (GPS Only)=> iMAX

iMAX – Raw RTK data from the base stations is processed by the IaRTN's network processing software using the central servers, and the RTK corrections are sent to the user.

MAC – Raw RTK is data minimally processed by the central servers, and then sent to the users GPS receiver for final processing.

Iowa Real Time Network (IaRTN)

RTK Products Comparison Pottawattamie County (NGS MJ0600)

RTK Product	Average Variance			Maximum Variance		
	N	E	ELL	N	E	ELL
RTCM 3_MAX	0.005'	0.007'	0.009'	0.017'	0.015'	0.022'
RTCM3_IMAX	0.015'	0.005'	0.033'	0.044'	0.017'	0.085'
RTCM3_NEAR	0.006'	0.008'	0.013'	0.019'	0.028'	0.037'
RTCM2_IMAX	0.012'	0.001'	0.019'	0.033'	0.003'	0.055'
RTCM2_NEAR	0.006'	0.016'	0.039'	0.020'	0.036'	0.134'

Difference From RTCM3_MAX			
RTK Product	N	E	ELL
RTCM3_IMAX	0.016'	0.000'	0.027'
RTCM3_NEAR	-0.004'	0.015'	0.001'
RTCM2_IMAX	-0.004'	0.009'	0.002'
RTCM2_NEAR	0.003'	0.008'	-0.029'

Iowa Real Time Network (IaRTN)

Network Issues

- **Outages/problems due to IDOT scheduled maintenance**
 - Server maintenance is scheduled for off-hours
 - IDOT IT network personnel have ability to test GPS network
- **Outages/problems due to outside Communication issues**
 - Minimal disruption
 - **ICN & INS communications equipment compatibility issue**
November 23 (11:00 am to 5:00 pm) & November 24 (2:00 pm to 2:50 pm)
Affected more than just IDOT
- **Outages/problems due to unexpected Network equipment issues**
 - Server issues – increased the speed and memory capacity of the servers
- **Outages/problems due to outside influences**
 - Unexplained problems experienced Mid-May thru June
 - Blizzard & ice storms

Iowa Real Time Network (IaRTN)

Base Station Issues

- **Good news – Generally don't affect the network as a whole**
- **Will affect you if:**
 - **Specifically tied to it as a single base**
 - **Using Nearest RTK product & it is the nearest site**
 - **Is your master station in a network solution**
- **Communications to and from the sites**
 - **Biggest Issue!**
 - **Outside communication providers**
 - **Two main culprits**
 - IASW (Swea City)**
 - IANH (New Hampton)**
- **3 lightning strikes**

Iowa Real Time Network (IaRTN)

Down Time Statistics - Base Stations (February 2010)

	Feb.	Nov.	Aug.
	(hrs)	(hrs)	(hrs)
Hours of Total Base Station Operation	53760	57600	59520
Down (GPS Equipment)	0	279	113
Down (Communications)	852	146	192
Total Down Time	852	415	305
	1.6%	0.7%	0.5%

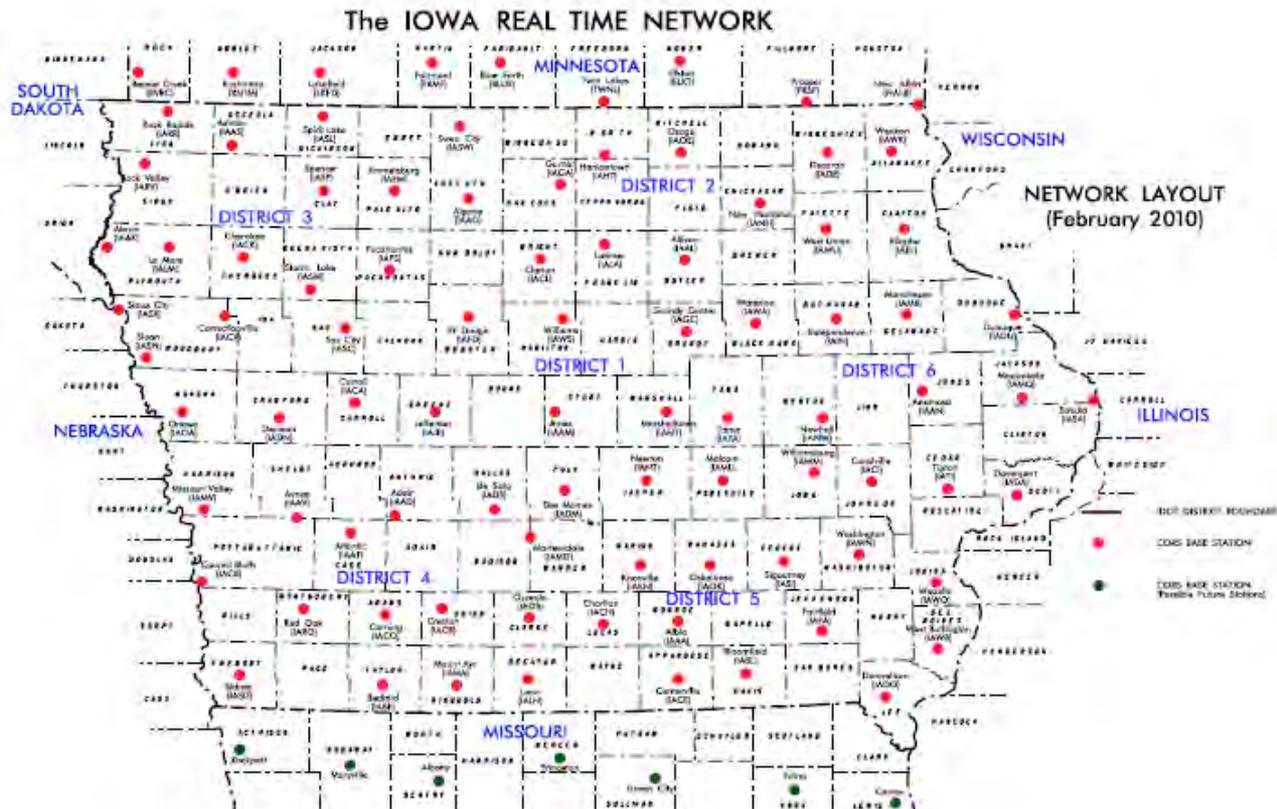
Communication Issue Breakdown	Down (hrs)
IASW (Swea City)	532
IANH (New Hampton)	296
Subtotal	828

Down (W/ IASW & IANH Problems Solved) Less than 0.1%

Iowa Real Time Network (IaRTN)

- Add other Networks to enhance the IaRTN

- Added 9 MnDOT base stations
- Looking at adding 7 MoDOT base stations
- Willing to look at adding base stations in neighboring states



Iowa Real Time Network (IaRTN)

IaRTN User Problem Report Form

Will add form to IaRTN webpage

Report all problems

- Helps us become aware of any possible network problems
- Able to forward pertinent information to Leica Geosystems

Rover Incident Report

- Username
- Contact information
- Type of Rover and Firmware Version
- Communication device and service provider being used
- Location (City and/or County and Latitude/Longitude)
- Master Station (if known)
- Real Time Product being used
- Mask Angle being used
- Date of Incident
- Duration of Incident
- Incident Experienced (include as many details as possible)

Iowa Real Time Network (IaRTN)

What Lies Ahead?

- **Continue Network Testing Program**
 - Repeat county testing systematically
 - Expand testing into potential problem areas

- **Make the IaRTN More Reliable**
 - Work with IDOT IT department on a more reliable communications network
 - Work with Leica on problems and enhancements
 - Make an interactive network map available to the users
 - Upgrade base station GPS receiver firmware
 - Upgrade Spider Network Operating software
 - Work with the different GPS vendors on specific problems

Iowa Real Time Network (IaRTN)

Registration Statistics (Thru February 2010)

Total Users	483	
Survey/G.I.S.	284	59%
Agriculture	152	32%
Construction	26	5%
Other	21	4%

Connection Statistics (February 2010)

	<u>Total</u>	<u>Survey</u>
Number of RTK users connected	135	110
RTK connections to the network	2690	2140
RTK connection time	3015 hrs	1950 hrs
Average RTK connection time	60 min	55 min

Iowa Real Time Network (IaRTN)

Questions?

Steve Milligan

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IDOT's IaRTN Website

<http://www.iowadot.gov/rtn/>

IaRTN SmartNet Website

(Administered by Leica Geosystems)

<http://spiderweb.iartn.com/spiderweb/frmlIndex.aspx>