GNSS Networks
powered by Leica Geosystems

The Iowa RTN
Concepts and Solutions

Chuck B. Jones, PLS
Support Engineer
GNSS Network Reference Stations

- when it has to be **right**

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Outline

- **Motivation for Network RTK**
- **Development of an RTCM Network RTK Message Format**
  - RTCM 3.0 Network Message
  - Master-Auxiliary Concept
- **Leica Implementation of the Master-Auxiliary Concept**
  - MAX
  - iMAX
- **Leica GNSS QC Analysis of Baseline vs. Network Solutions**
- **The Iowa Real Time Network**
  - Real Time Products
  - Static Products

Motivation for Network RTK

Reference Station Evolution

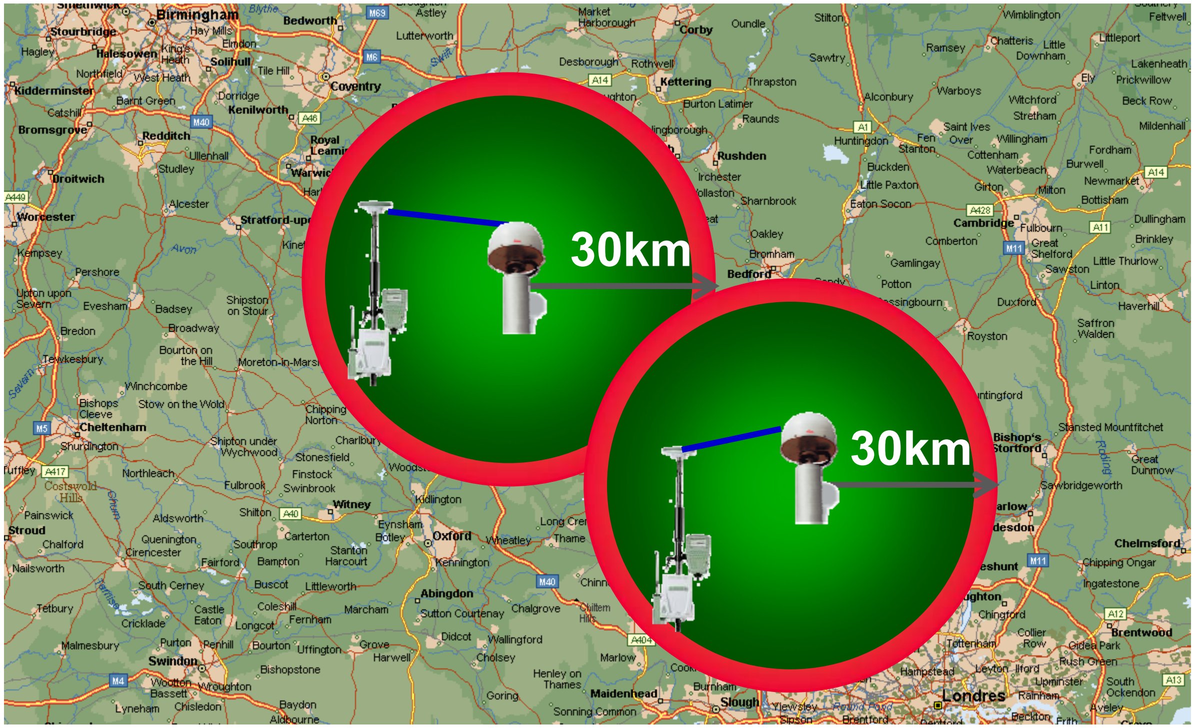
Base Station
- Temporary
- Owner use only
- High Costs

Permanent RS
- Fixed
- Private Use
- Proprietary

GNSS CORS
- Std. Coord Frame
- Active Control
- Standard RINEX

Network RTK
- Wide Area RTK
- Economical
- Standard RTK

Conventional Single Base RTK

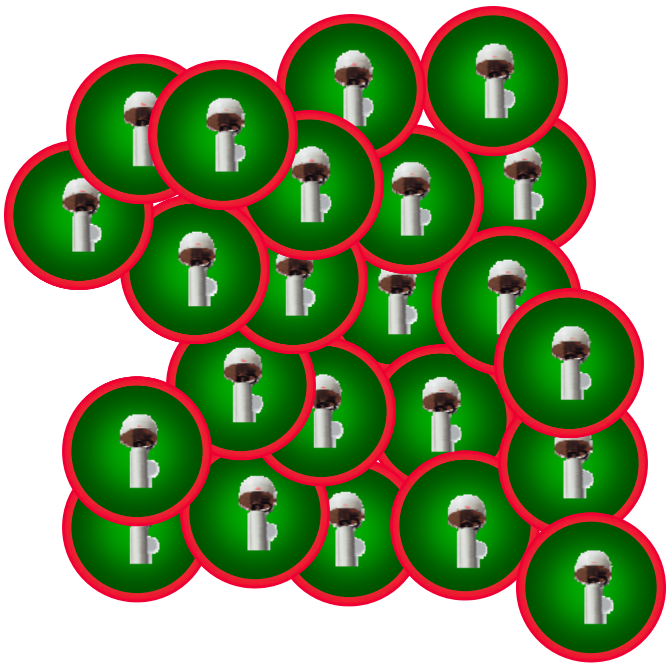


Accuracy, Reliability, Availability

Good ▬▬▬ Poor

- **GPS RTK base station**
  - Typically temporary installation on a tripod
  - Reference for GPS operations in a small area (up to 30km) over a limited time

Limitations of Single Base RTK



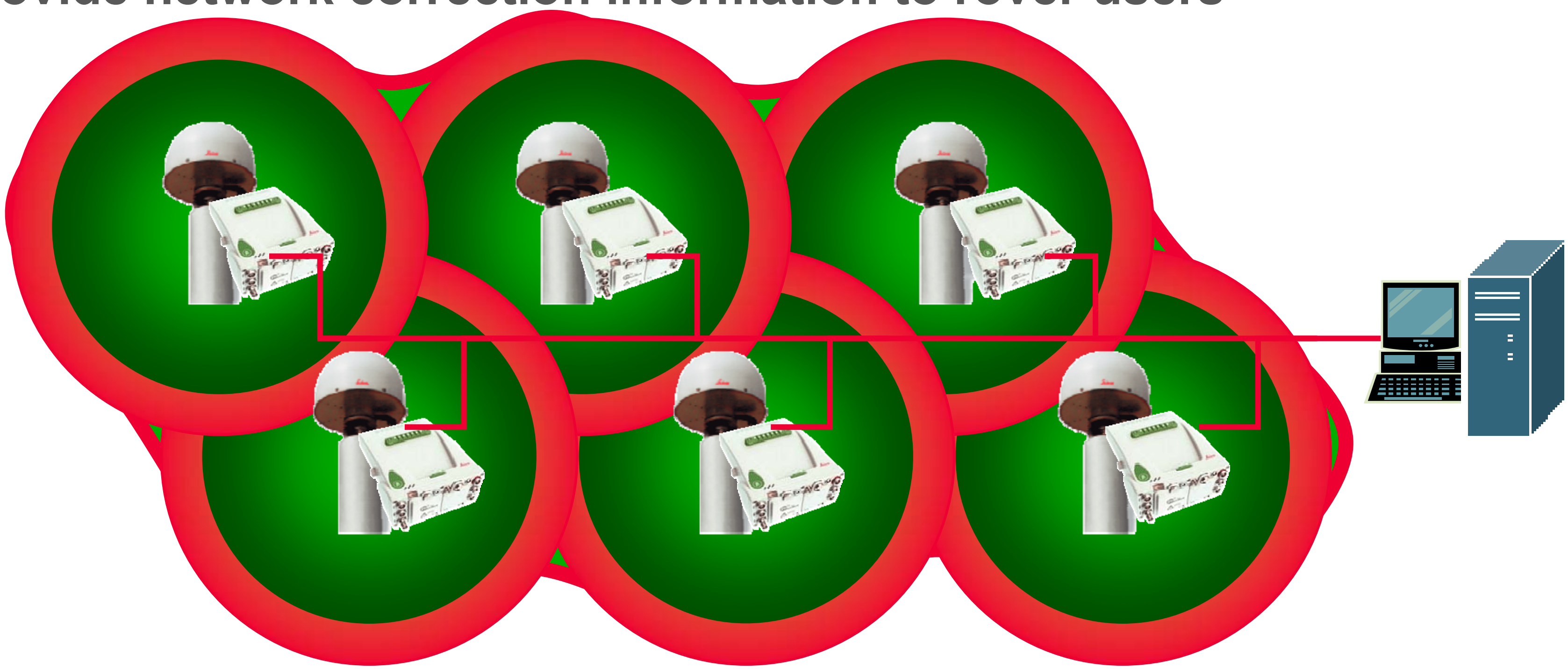
Accuracy, Reliability, Availability

Good Poor

- High density of stations required for good coverage
- No continuity in quality of service (accuracy, reliability, availability)
- Higher costs
- Reduced productivity

Motivation for Network RTK

- **Model and estimate distance-dependent errors**
  - Main error sources: ionosphere, troposphere and satellite orbits
- **Provide network correction information to rover users**



Accuracy, Reliability, Availability

Good Poor

Development of an RTCM Network RTK Message Format

- when it has to be **right**

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The Radio Technical Commission for Maritime Services (RTCM)

Founded in 1947 as a US State Dept Advisory Committee, now an independent organization

Supports the development of GNSS message format standards

Membership includes

- **22 government agencies from 7 nations**
- **56 manufacturers from 14 nations**
- **41 other stakeholders**

Standing Committee 104 focuses on the Differential GNSS Standards

RTCM SC-104: Differential GNSS Standards

Originally set up in 1983 to develop standards for DGPS to achieve 5 meter accuracy navigation & positioning

● Version 1 was replaced by Version 2, when implementation problems turned up (1990)

● Version 2.1 added Real-Time Kinematic (RTK) messages to provide decimeter accuracy of short ranges (1994)

● Version 2.2 expanded differential operation to GLONASS, provided ancillary RTK messages (1998)

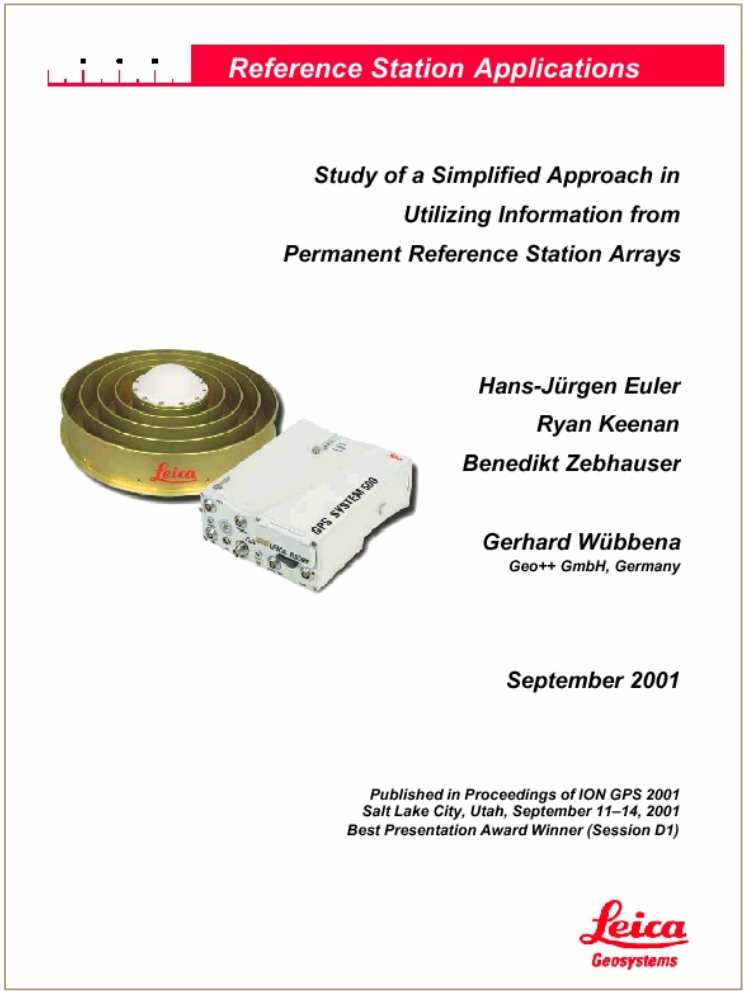
● Version 2.3 added several new messages to improve RTK, radio beacon broadcasts, use of Loran-C (2001)

● Inefficiency of Version 2 messages led to the development an improved format– more efficient, higher integrity, and simplicity of development– Version 3.0 (2004)

● Version 3 primarily aimed at improving RTK, supporting networked RTK

The RTCM 3.0 Master-Auxiliary Concept (MAC)

- **Purpose of the Master-Auxiliary Concept**
  - To overcome the issues of the existing approaches
  - To provide interoperability between network and rover systems
  - To transmit all relevant network correction data from a reference network to the rover user in a highly compact and standardized form by representing ambiguity levelled observation data as correction differences of dispersive and non-dispersive data.


Reference Station Applications

Study of a Simplified Approach in Utilizing Information from Permanent Reference Station Arrays

Hans-Jürgen Euler
Ryan Keenan
Benedikt Zebhauser

Gerhard Wübbena
Geo++ GmbH, Germany

September 2001

Published in Proceedings of ION GPS 2001
Salt Lake City, Utah, September 11–14, 2001
Best Presentation Award Winner (Session D1)

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RTCM 3.x Message Groups, Message Types (MT)

● Observations	
– GPS L1	MT: 1001, 1002
– GPS L1/L2	MT: 1003, 1004
– GLONASS L1	MT: 1009, 1010
– GLONASS L1/L2	MT: 1011, 1012
● Station Coordinates	MT: 1005,1006
● Antenna Description	MT: 1007,1008
● Auxiliary Operation Information	MT: 1013
● Supplemental	
– GPS Ephemeris	MT: 1019
– GLONASS Ephemeris	MT: 1020
– Network RTK (MAC)	MT: 1014-1017
– Transformation Parameters	MT: 1021-1027
– Proprietary Messages	MT: 4088-4095

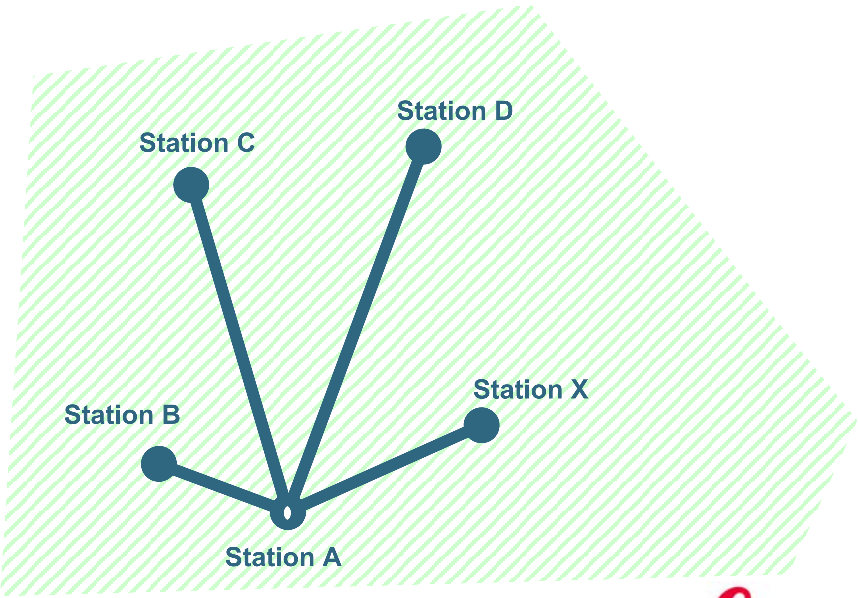
RTCM Master-Auxiliary Concept

$$\Delta\Phi_{km,1}^{j}(t) = \Delta s_{km}^{j} + \Delta\delta r_{km}^{j}(t) + c \cdot \Delta dt_{km,1} + \Delta T_{km}^{j}(t) - \frac{\Delta I_{km}^{j}(t)}{f_1^2} + \frac{c}{f_1} \cdot \Delta N_{km,1}^{j} + \Delta\varepsilon_1 \qquad (1)$$

where

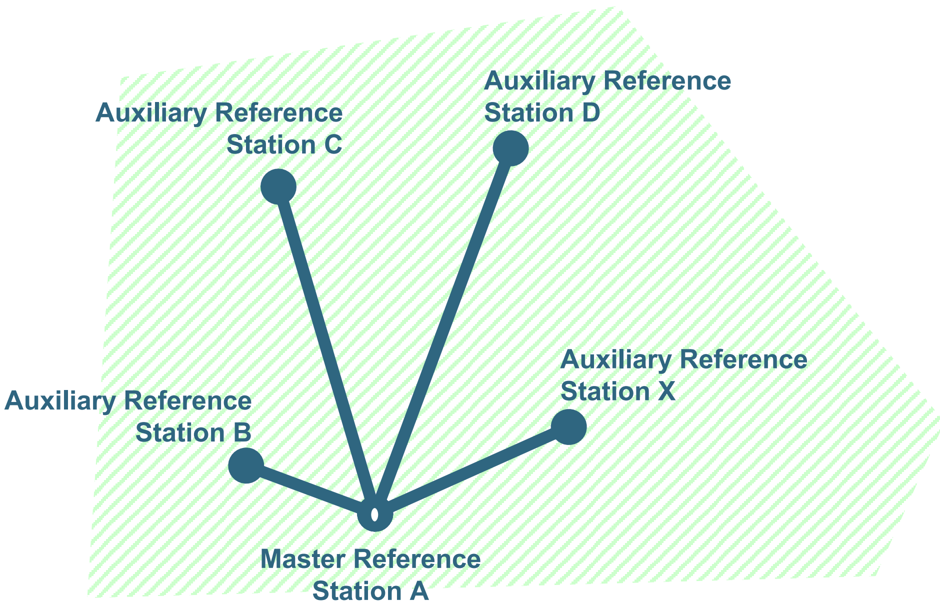
Δs_{km}^{j}	geometric range term including antenna phase centre variations which have been applied by the network processing software.
$\Delta\delta r_{km}^{j}$	broadcast orbit error.
Δdt_{km}	receiver clock error.
ΔT_{km}^{j}	tropospheric refraction error.
ΔI_{km}^{j}	frequency dependent ionospheric delay.
ΔN_{km}^{j}	frequency dependent integer ambiguity.
$\Delta\varepsilon$	frequency dependent random measurement error.
t	epoch.
c	speed of light.
f_1	frequency of L1.

Description of the MAC correction differences begins with the definition of a single difference L1 phase equation between station *k* and *m* and satellite *j*. (L2 equations follow similarly.)



RTCM Master-Auxiliary Concept

$$\delta\Delta\Phi^{j}_{km,1} = \Delta s^{j}_{km}(t) - \Delta\Phi^{j}_{km,1}(t) + c \cdot \Delta dt_{km,1} + \frac{c}{f_1} \cdot \Delta N^{j}_{km,1} \qquad (2)$$



Correction differences are formed by subtracting the *ambiguity-leveled phase corrections* of a designated master reference station from the equivalent corrections of the remaining auxiliary reference stations in the network.

This is the main task of the network processing software is to reduce the ambiguities for the phase ranges from all reference stations in the network to a common level.

RTCM Master-Auxiliary Concept

$$\delta\Delta\Phi_{km,1}^{j,\ disp} = \frac{f_2^2}{f_2^2 - f_1^2}\delta\Delta\Phi_{km,1}^{j} - \frac{f_2^2}{f_2^2 - f_1^2}\delta\Delta\Phi_{km,2}^{j} \tag{3}$$

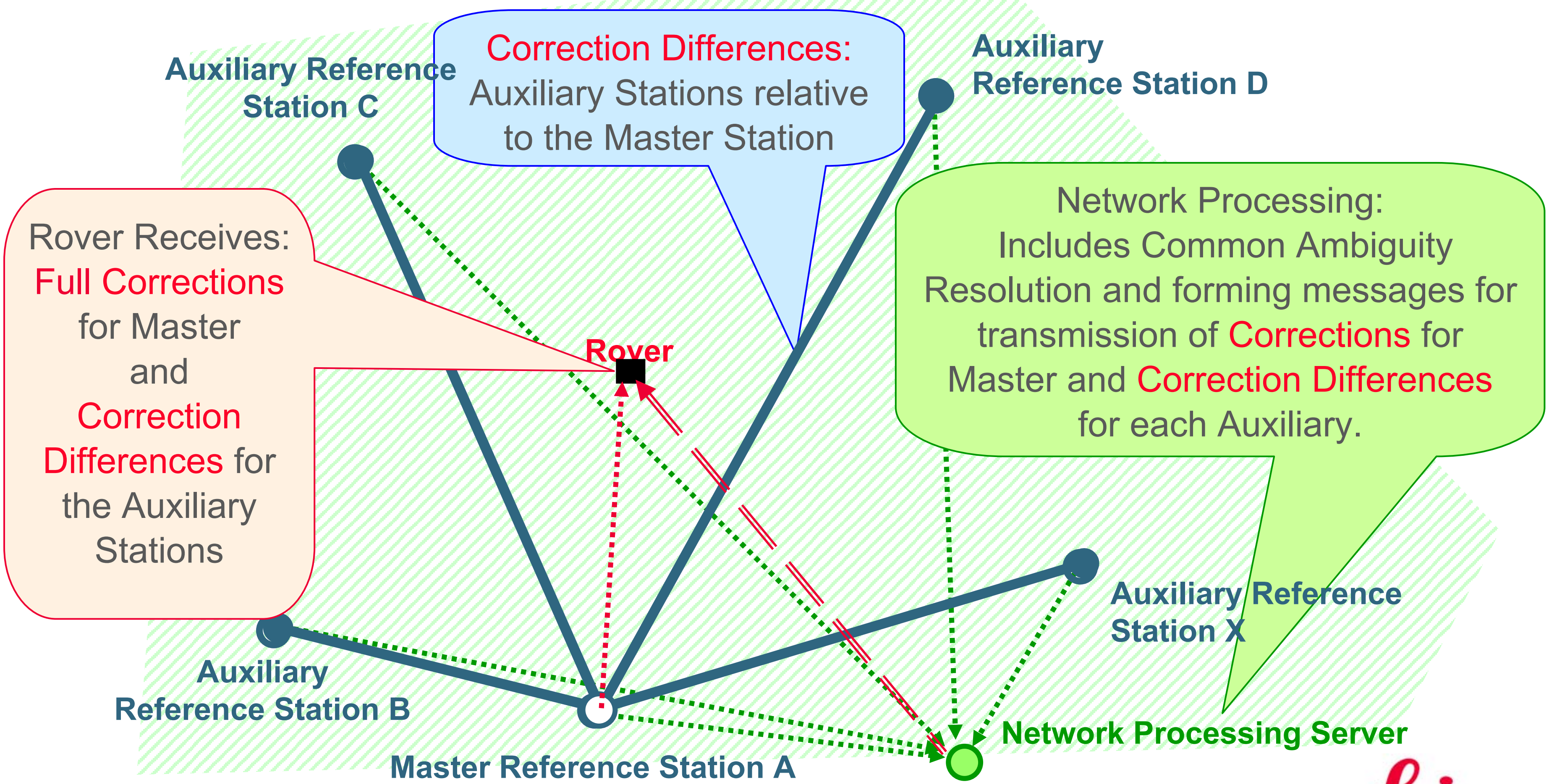
$$\delta\Delta\Phi_{km,1}^{j,\ non-disp} = \frac{f_1^2}{f_1^2 - f_2^2}\delta\Delta\Phi_{km,1}^{j} - \frac{f_2^2}{f_1^2 - f_2^2}\delta\Delta\Phi_{km,2}^{j} \tag{4}$$

To further reduce the amount of data transmitted to the rover, the correction differences are separated into a dispersive component (ionospheric refraction) and a non-dispersive component (tropospheric refraction and orbit errors).

In general, non-dispersive errors change more slowly over time compared to the dispersive errors, especially in times of high ionospheric activity.

RTCM MAC Concept for Network Transmission

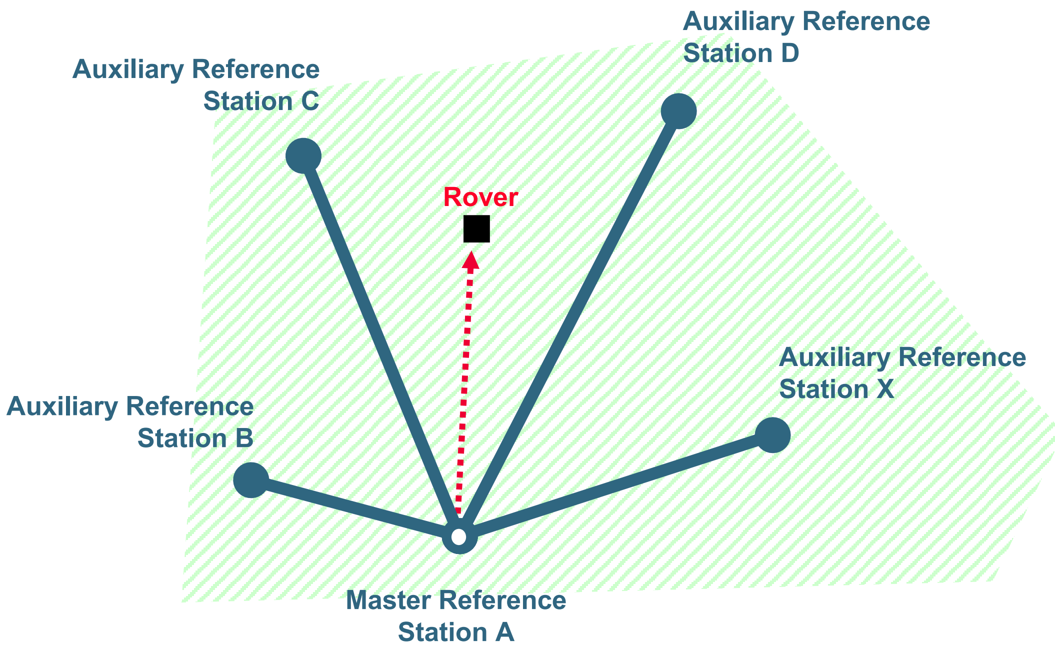
One Master Reference Station, plus
Some Auxiliary Reference Stations ➔ One Network Cell



RTCM Master-Auxiliary Concept

The rover receives the raw carrier phase data for the master reference station and the ambiguity-leveled correction differences for each auxiliary reference station.

Optimal correction differences can then be interpolated for the position of the rover, due to the common integer ambiguity level of the reference stations, and used to improve the double difference phase residuals of the master-rover baseline.



Benefits of the RTCM MAC concept …

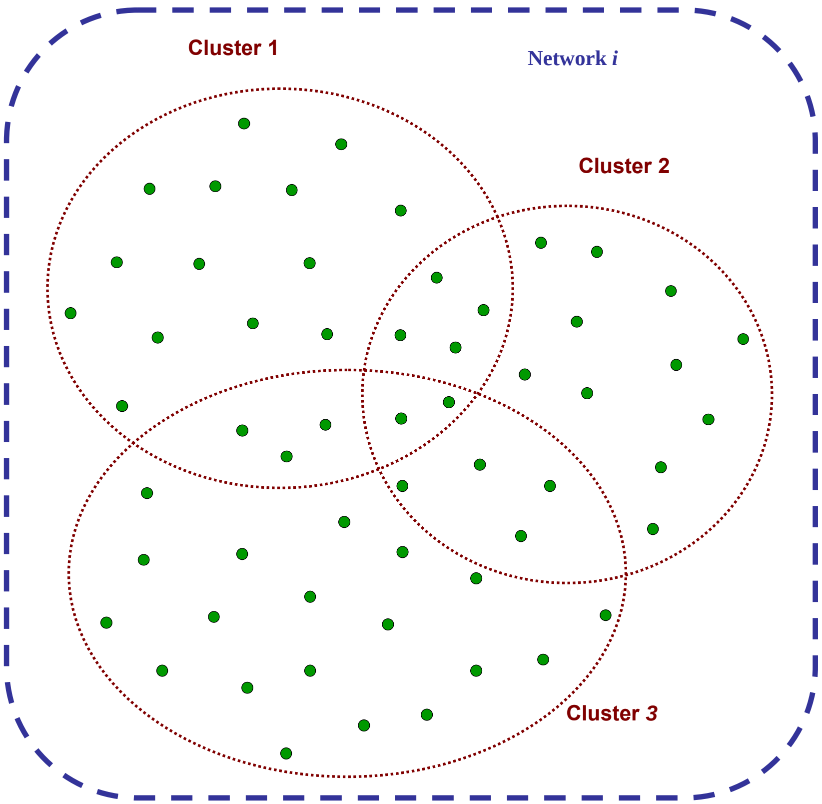
As it is a standard, ALL processes are fully described & documented.

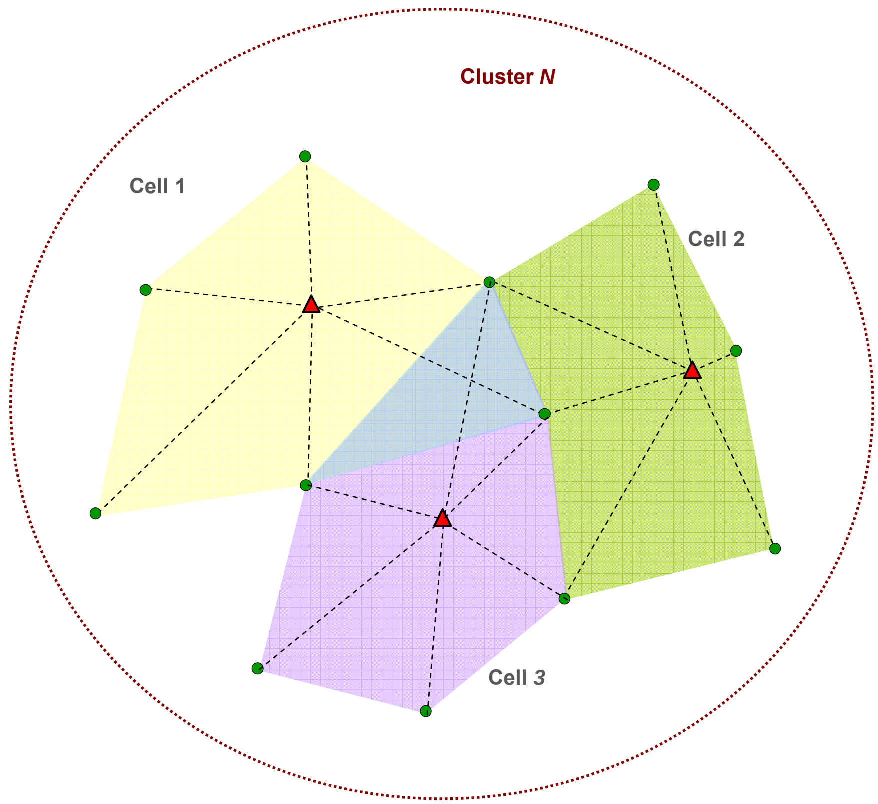
- **No need for any additional proprietary message**
- **Full interoperability is guaranteed between rovers and control center and between different control centers**
- **Networking Software is “transparent” regarding Reference Station data**
- **Network Operators can concentrate on valuable additional services**

➔ Rovers will finally perform optimally

Leica Implementation of the Master – Auxiliary Concept

Leica SpiderNet Concept
Networks, Clusters & Cells





● Reference/Auxiliary station ▲ Master station

Network Processing
Understanding how SpiderNET works

Network Processing is done in 4 main steps:

- Pre-processing of raw observations
- Estimation of Float Ambiguities (LAMBDA method)
- Fixing of Float Ambiguities (Constraints)
- Provision of network corrections

For estimation of the relevant parameters, including network ambiguities, satellite and receiver clocks, satellite orbits and deterministic atmospheric models, SpiderNet uses zero-difference code and carrier phase measurements in an mathematically optimal observation based Kalman filter.

This approach avoids the use of linear combinations of GPS observables, such as the well known wide-lane and ionosphere-free combinations, which magnify measurement noise and multipath.

Network Processing
Understanding how SpiderNET works

- **Pre-processing of raw observations**
  - Cycle slip detection
  - Application of Troposphere model
  - Application of Ionospheric model
  - Code and phase range checks
    - Gross errors in station coordinates
    - Bad data
  - Orbit calculation (Broadcast and Precise)

Network Processing
Understanding how SpiderNET works

- **Estimation of Float Ambiguities**
  - Cycle slip repair
  - Ionosphere activity parameter effects the temporal parameters used in stochastic ionosphere modelling
  - Clock parameters estimation

☝ New Orbits are taken into account at start of new estimation cycle

☝ New Satellites are taken into account at start of new estimation cycle

Network Processing
Understanding how SpiderNET works

- **Fixing of Float Ambiguities**
  - GPS SpiderNET uses zero difference processing, so it is necessary to constrain the ambiguities
    - For one station (all satellites are fixed)
    - For one satellite (all stations are fixed)
  - Constraining is done automatically
  - Constraints define the ambiguity level
  - Repeated fixing of ambiguities and verification of ambiguities takes place

Network Processing
Understanding how SpiderNET works

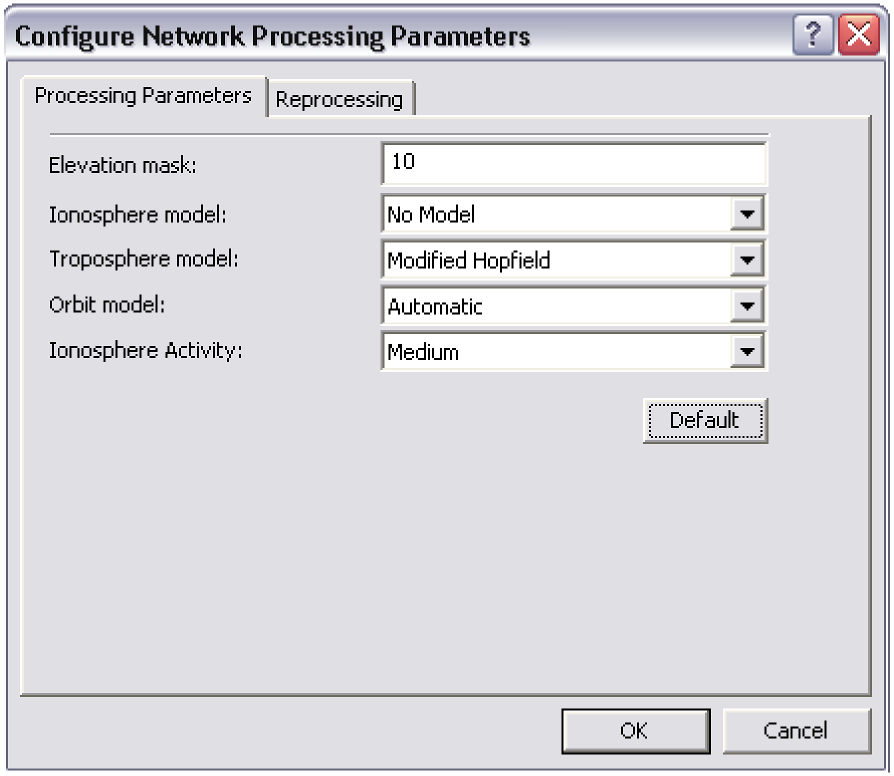
- **Provision of network corrections**
  - Reduction of raw data
    - Broadcast ephemeris
    - Common receiver clock
    - Fixed ambiguities
    - Geometric range
  - Network corrections are on a common ambiguity level within one cluster

Network Processing

Understanding how SpiderNET works

Configurable Network Processing Parameters

- Elevation mask
- Ionosphere model
- Troposphere model
- Orbit model
- Ionosphere activity



- when it has to be **right**

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Network Processing

Configurable Parameters - Elevation mask

- Observations of low elevation satellites can sometimes prove to be problematic because of:
  - An increase in measurement noise
  - An increase in measurement error
  - A higher likelihood of loss of data
- In such cases the recommended procedure is to increase the satellite elevation cut-off angle to limit the influence of bad data.
- If there are problems with the resolution of ambiguities an increase in the cut-off angle might also improve processing. This is because low elevation satellites are more influenced by multipath, un-modelled atmospheric effects and measurement noise.

Network Processing

Configurable Parameters - Ionosphere model

- The Ionospheric model parameter defines which model is used to reduce the impact of the ionosphere. The following models for the ionosphere are available:
  - **No model**
  - **Klobuchar model**
- The ionospheric activity follows an eleven years cycle with its last peak in 2000. The Klobuchar model reflects the 11-year cycle of solar activity and can be advantageous during the time of high solar activity.
- The Klobuchar model should correct for global ionospheric disturbances. In general, it models about 50% of the ionosphere.
- The Klobuchar model is a rather coarse model and hence, there is not much benefit to using it at times of low ionospheric activity.
- The parameters for the Klobuchar model are provided by the navigation message that is sent by each satellite.

Network Processing

Configurable Parameters - Troposphere model

Various models exist (all based on information of pressure, temperature and relative humidity of the ground station) which reduce the tropospheric path delay.

- The following models for the troposphere are available:
  - No model
  - Modified Hopfield
  - Saastamoinen
  - Niell
- Standard troposphere models usually agree for high elevation satellites (difference of few millimeters).
- The differences between the models are only significant for low elevations below 5 degrees.

Network Processing
Configurable Parameters - Orbit model

- **Two orbit model options are available:**
  - Broadcast only
  - Automatic
    - Broadcast ephemeris used for sending network RTK corrections
    - Precise ephemeris used for network ambiguity resolution
- **Precise ephemeris (IGS Ultra Rapid Orbits)**
  - are near real-time orbits delivered 4 times a day
  - have an accuracy of approx. ~10cm
- **Broadcast ephemeris**
  - have an accuracy of approx. ~2m

Steps to Network Positioning

Reference stations

- Fix the carrier phase ambiguities between the reference stations.
- Calculate the errors for each reference station.
- Interpolate the estimated reference errors to the location of the rover.
- Apply corrections to the data from the master reference station.

Rover

- Rover processing to calculate a position.

Steps to Network Positioning (Spider MAX)

Reference stations

Fix the carrier phase ambiguities between the reference stations.

Calculate the errors for each reference station.

SpiderNET

MAX

Interpolate the estimated reference errors to the location of the rover.

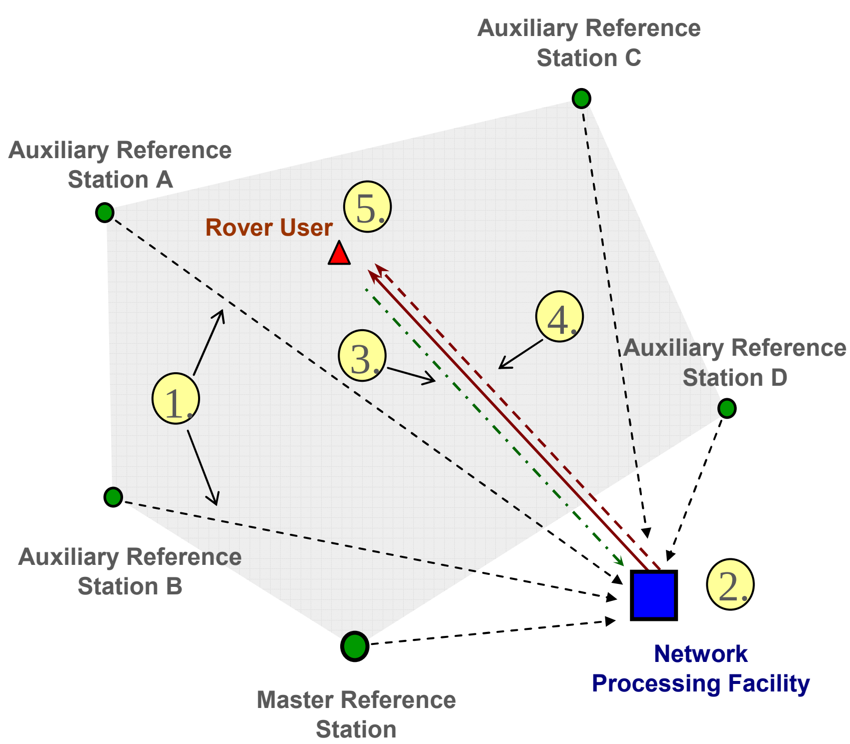
Apply corrections to the data from the master reference station.

Rover processing to calculate a position.

Rover

Rover receiver

MAX Corrections



1. Transmission of raw observation data from the reference stations to the network processing facility.
2. Network estimation process including **ambiguity resolution** to reduce the stations to the common ambiguity level.
3. (Optional) NMEA GGA position received from the rover at the network processing facility. The most appropriate reference stations are chosen for the rover based on its location.
4. Formation and transmission of RTCM 3.0 network message using **corrections** for the Master station and **correction differences** for the auxiliary stations.
5. Computation of high accuracy rover position using the full information from the reference network.

Steps to Network Positioning (Spider iMAX)

Reference stations

Fix the carrier phase ambiguities between the reference stations.

Calculate the estimated errors for each reference station.

Interpolate the estimated reference errors to the location of the rover.

Apply corrections to the data from the master reference station.

SpiderNET

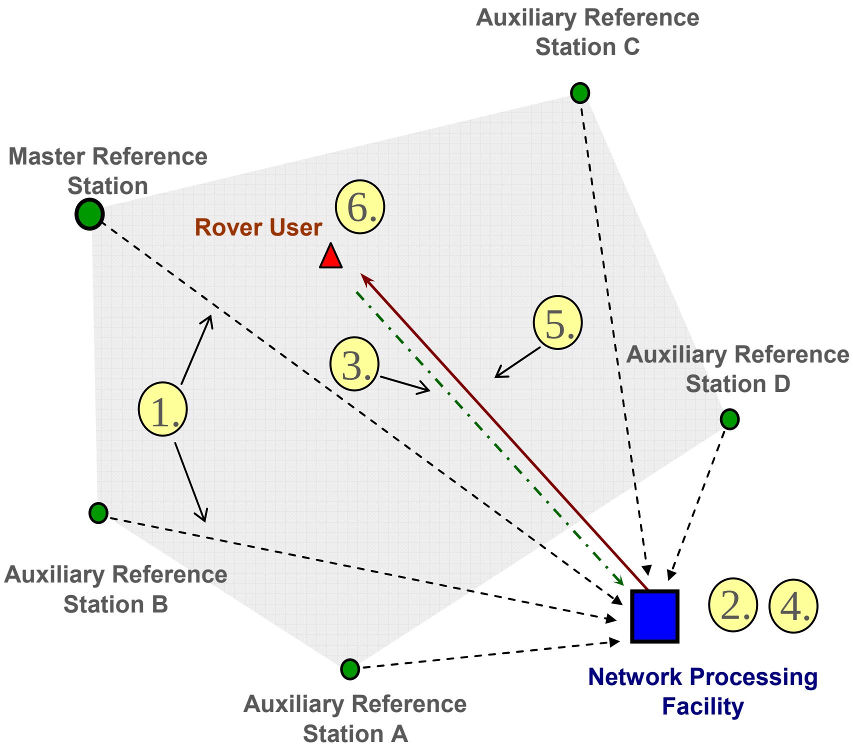
iMAX

Rover

Rover processing to calculate a position.

Rover receiver

i-MAX Corrections



1. Transmission of raw observation data from the reference stations to the network processing facility.
2. Network estimation process including **ambiguity resolution** to reduce the stations to the common ambiguity level.
3. NMEA GGA position received from the rover at the network processing facility. The most appropriate reference stations are chosen for the rover based on its location. The master station is chosen as the reference station closest to the rover.
4. Leica GPS Spider calculates the **network corrections** for the rover and applies them to the observations from the master station.
5. Formation and transmission of RTCM 2.3 or Leica format corrections from the master station.
6. Computation of high accuracy rover position using the reference network.

Network Processing and Performance
Understanding how SpiderNET works

Network RTK corrections – RTK Proxy Server

- **iMAX Network RTK corrections**
  - Rover NMEA required
  - Two-way communication (duplex) is always required
  - Master-Auxiliary correction differences used to correct raw observations of Master station
  - Send corrections to rover

- **MAX Network RTK corrections**
  - Send Master-Auxiliary correction differences to rover
  - Send raw observations of Master station to rover
  - Rover applies Master-Auxiliary correction differences in baseline processing
  - One-way communication (simplex) is supported when providing MAX Network RTK corrections based on Single Cells (Master and Auxiliary Stations are predefined)

Leica GNSS QC Analysis of Baseline vs. Network Solutions

- when it has to be **right**

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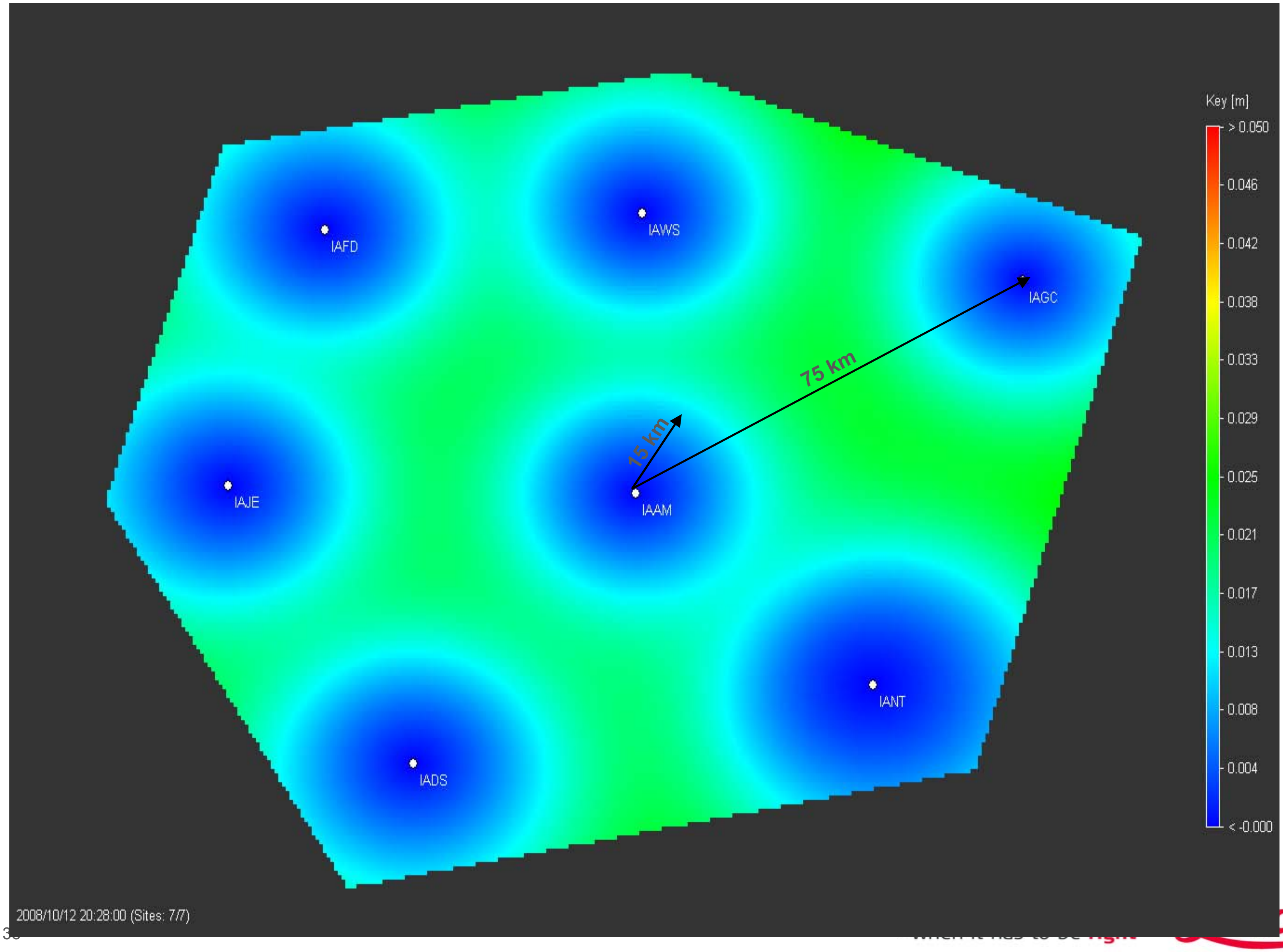
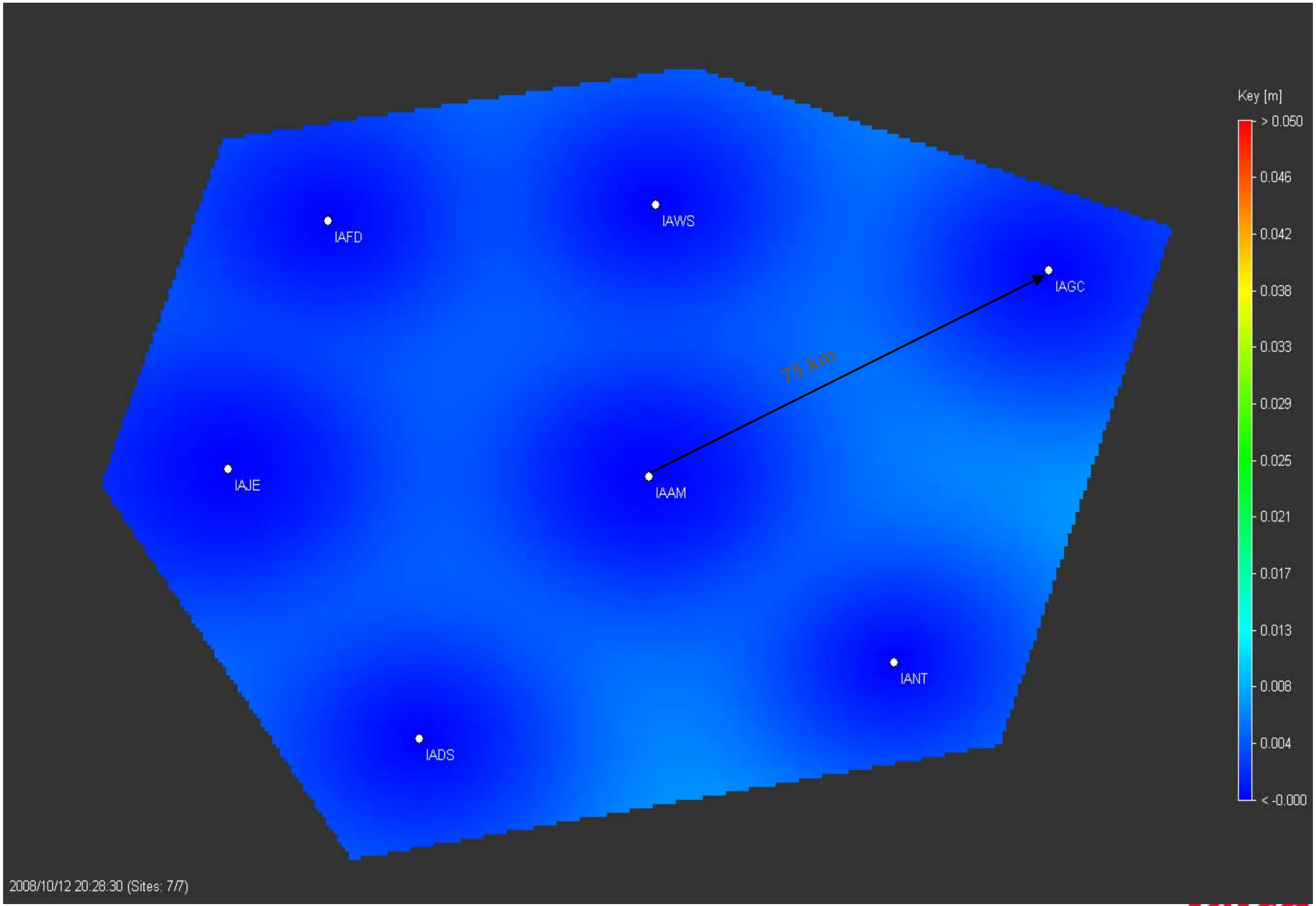
Graphical display of residual ionosphere error for single baseline RTK calculated in real time using data from Leica GNSS Spider RTK processing.

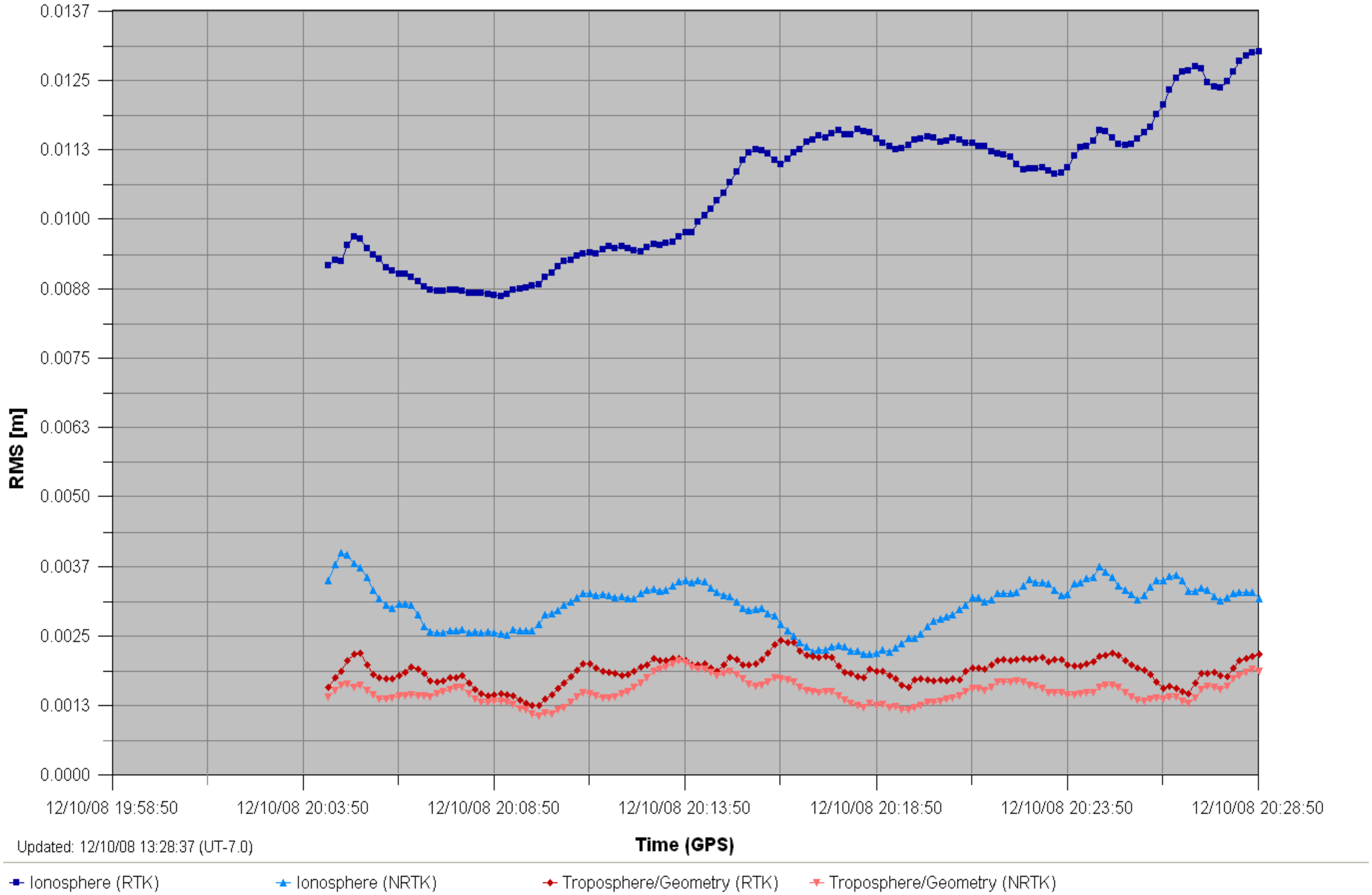


Geosystems

Graphical display of residual ionosphere error across the RTK network calculated in real time using data from Leica GNSS Spider network RTK processing.



Time series of global RMS values for residual Ionosphere and troposphere errors



The Iowa Real Time Network


N
W
E
S
Rock Rapids
Ashton
Rock Valley
Spirit Lake
Spencer
Emmetsburg
Swea City
Algona
Hanlontown
Garner
Osage
Decorah
Waukon
New Hampton
West Union
Elkader
Akron
Lemars
Cherokee
Storm Lake
Pocahontas
District 3
District 2
Clarion
Latimer
Allison
Sioux City
Correctionville
Sac City
Fort Dodge
Williams
Iowa Falls
Grundy Center
Waterloo
Independence
Manchester
Dyersville
Dubuque
Sloan
Onawa
Denison
Carroll
Jefferson
District 1
Ames
Marshalltown
Tama
Newhall
Anamosa
Maquoketa
Sabula
District 6
Missouri Valley
Avoca
Atlantic
Adair
Desoto
Des Moines-North
Newton
Malcolm
Williamsburg
Oakdale
Tipton
Davenport
Martensdale
Council Bluffs-South
District 4
Knoxville
Oskaloosa
Sigourney
Washington
Wapello
Red Oak
Corning
Creston
Osceloa
District 5
Chariton
Albia
Fairfield
West Burlington
Sidney
Bedford
Mount Ayr
Leon
Centerville
Bloomfield
Donnellson
Legend
Reference Station Sites
Type of Mount
Earl Conic
Flush
Multiple Site Location
Non-Iowa DOT Site
Off Set
Iowa DOT Districts
Interstate Hwy
Iowa Counties
HOUSEHOLDS
2005 - 6036
6037 - 13632
13633 - 31262
31263 - 65501
65502 - 129237


Iowa Real Time Network - Iowa Department of Transportation - Microsoft Internet Explorer provided by Leica Geosystems
http://www.iowadot.gov/rtn/
Iowa Department of TRANSPORTATION
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IaRTN
Iowa Real Time Network
IaRTN Home
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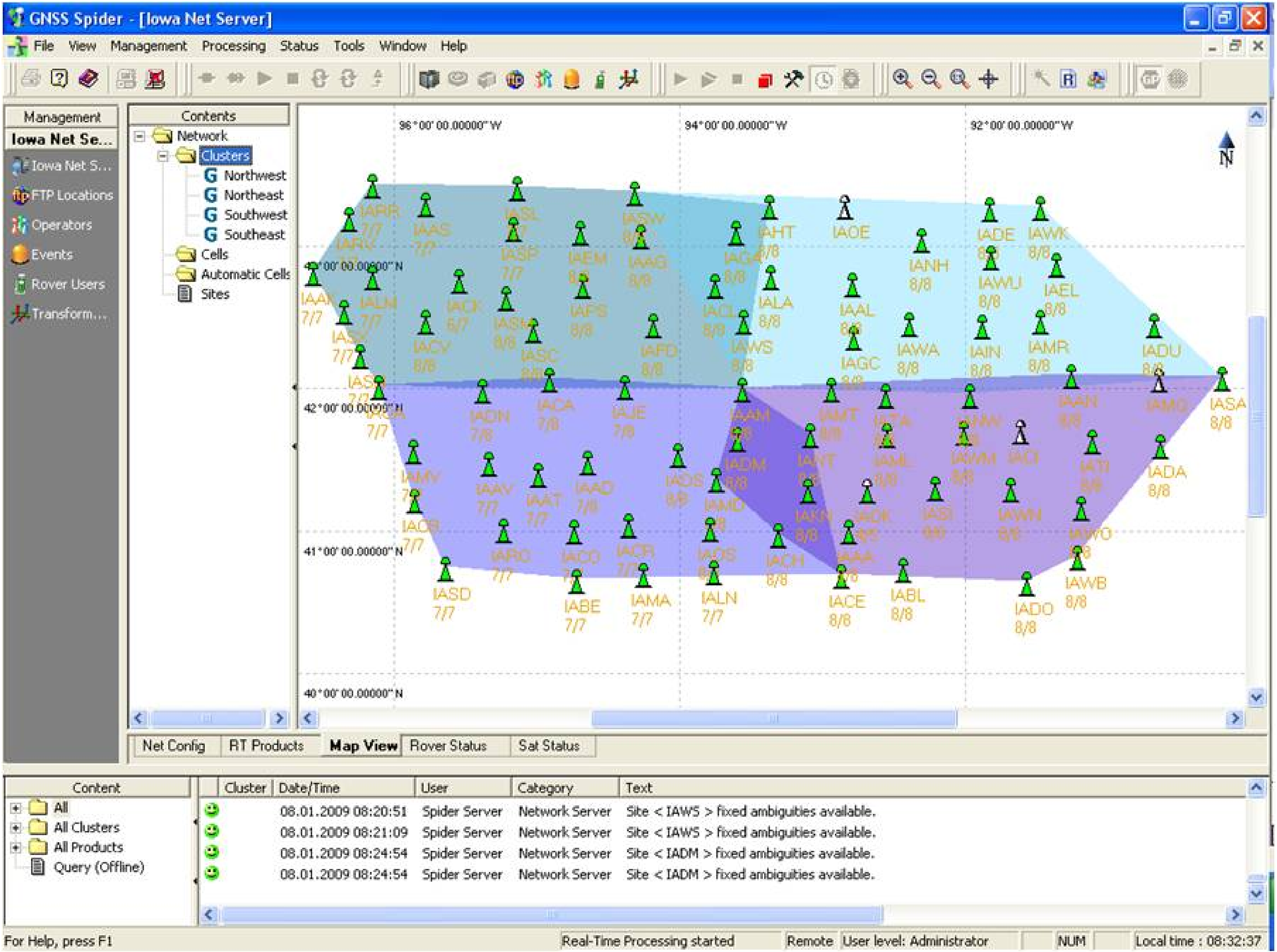
About the IaRTN
FAQ
Time Line
Office of Design
Contact Us
Iowa Real Time Network (IaRTN)
Welcome to the Iowa Real Time Network (IaRTN) Web site. The Iowa Department of Transportation is in the process of implementing a statewide, high-precision global positioning system (GPS) referencing network. The goal is to provide a system that will improve the efficiency and
click map to view IaRTN locations
Network Status
Base stations have been installed and network adjustments completed. The IaRTN is expected to be available to the public on Feb. 2, 2009.
Training Registration
The Iowa DOT will be providing free training sessions for GPS venders/suppliers followed by training sessions for network users. Registration closes on Tuesday, Jan. 6, 2009.
About the IaRTN
The Iowa DOT plans to deploy a statewide RTK-GPS network using wide area network (WAN) communications infrastructure.
Iowa Department of Transportation
Policies and Statements | Applets and Plug-ins
Iowa Department of Transportation - 800 Lincoln Way - Ames, IA 50010


GNSS Spider - [Iowa Net Server]
File View Management Processing Status Tools Window Help
Management
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Iowa Net S...
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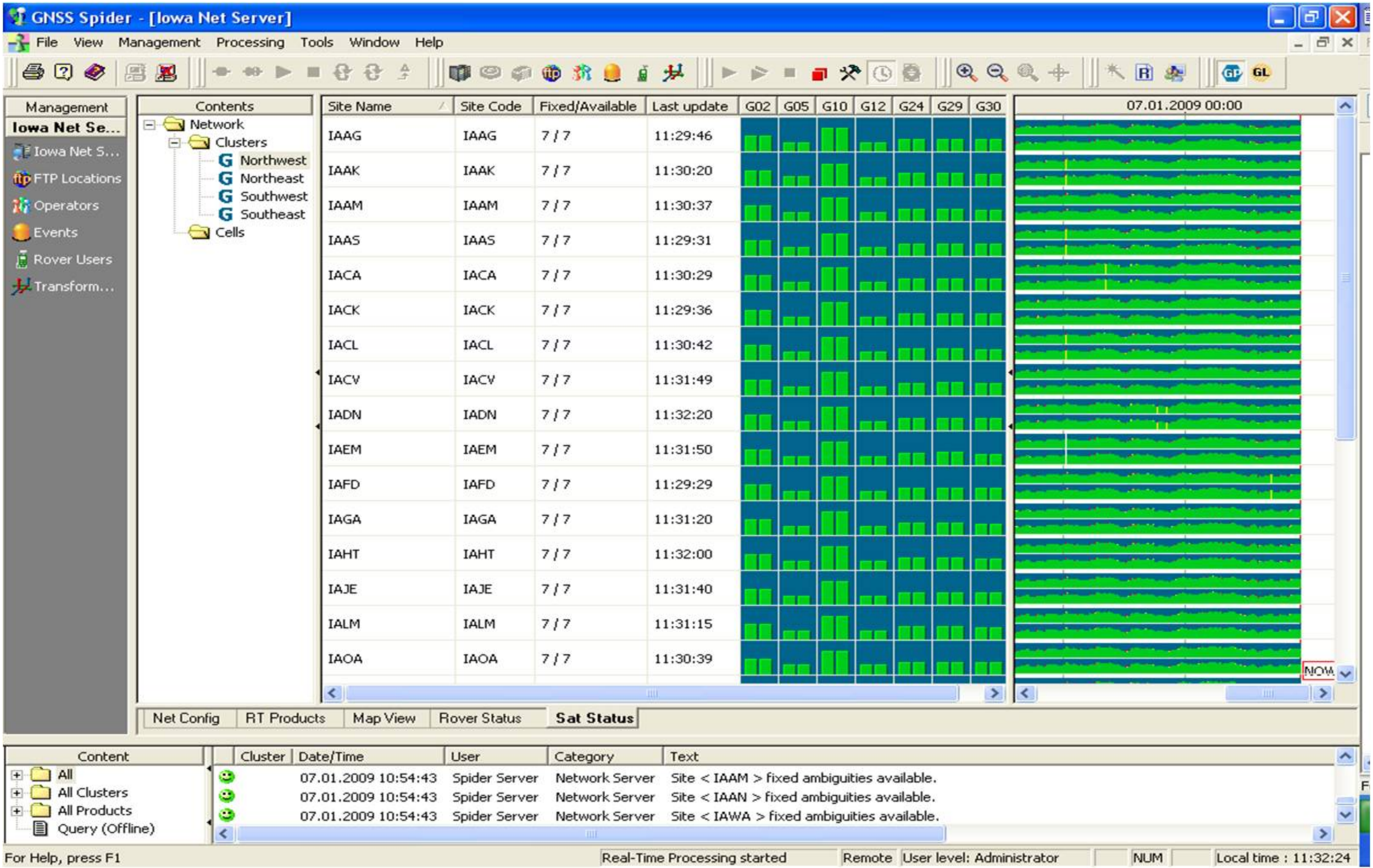
Contents
Network
Clusters
Northwest
Northeast
Southwest
Southeast
Cells
Automatic Cells
Sites
96°00' 00.00000" W
94°00' 00.00000" W
92°00' 00.00000" W
42°00' 00.00000" N
41°00' 00.00000" N
40°00' 00.00000" N
N
Net Config
RT Products
Map View
Rover Status
Sat Status
Content
All
All Clusters
All Products
Query (Offline)
Cluster Date/Time User Category Text
08.01.2009 08:20:51 Spider Server Network Server Site < IAWS > fixed ambiguities available.
08.01.2009 08:21:09 Spider Server Network Server Site < IAWS > fixed ambiguities available.
08.01.2009 08:24:54 Spider Server Network Server Site < IADM > fixed ambiguities available.
08.01.2009 08:24:54 Spider Server Network Server Site < IADM > fixed ambiguities available.
For Help, press F1
Real-Time Processing started
Remote
User level: Administrator
NUM
Local time : 08:32:37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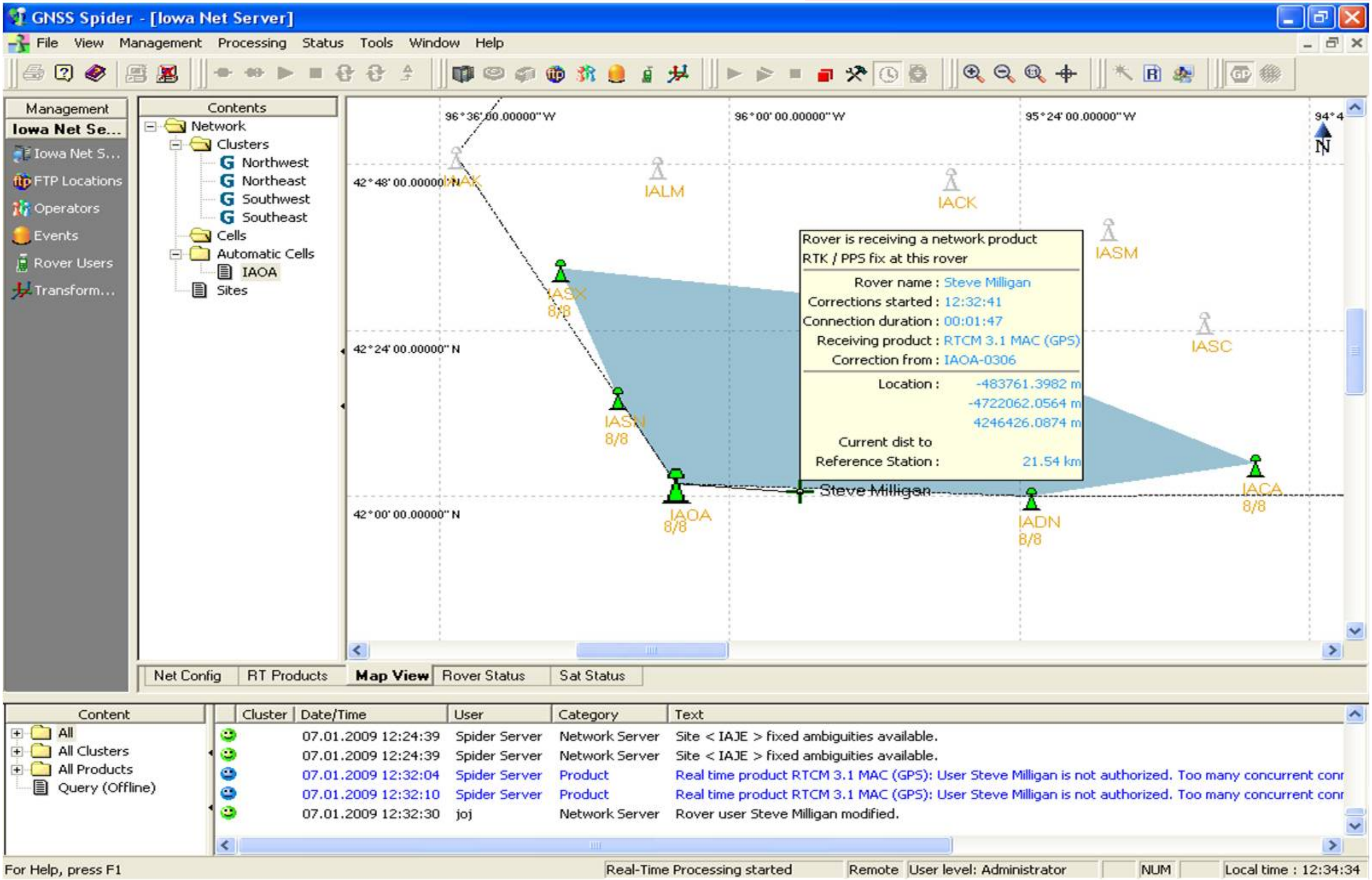
Network
Clusters
Northwest
Northeast
Southwest
Southeast
Cells
Site Name | Site Code | Fixed/Available | Last update | G02 | G05 | G10 | G12 | G24 | G29 | G30
IAAG | IAAG | 7 / 7 | 11:29:46
IAAK | IAAK | 7 / 7 | 11:30:20
IAAM | IAAM | 7 / 7 | 11:30:37
IAAS | IAAS | 7 / 7 | 11:29:31
IACA | IACA | 7 / 7 | 11:30:29
IACK | IACK | 7 / 7 | 11:29:36
IACL | IACL | 7 / 7 | 11:30:42
IACV | IACV | 7 / 7 | 11:31:49
IADN | IADN | 7 / 7 | 11:32:20
IAEM | IAEM | 7 / 7 | 11:31:50
IAFD | IAFD | 7 / 7 | 11:29:29
IAGA | IAGA | 7 / 7 | 11:31:20
IAHT | IAHT | 7 / 7 | 11:32:00
IAJE | IAJE | 7 / 7 | 11:31:40
IALM | IALM | 7 / 7 | 11:31:15
IAOA | IAOA | 7 / 7 | 11:30:39
07.01.2009 00:00
NOW
Net Config
RT Products
Map View
Rover Status
Sat Status
Content
All
All Clusters
All Products
Query (Offline)
Cluster | Date/Time | User | Category | Text
07.01.2009 10:54:43 | Spider Server | Network Server | Site < IAAM > fixed ambiguities available.
07.01.2009 10:54:43 | Spider Server | Network Server | Site < IAAN > fixed ambiguities available.
07.01.2009 10:54:43 | Spider Server | Network Server | Site < IAWA > fixed ambiguities available.
For Help, press F1
Real-Time Processing started
Remote
User level: Administrator
NUM
Local time : 11:32:24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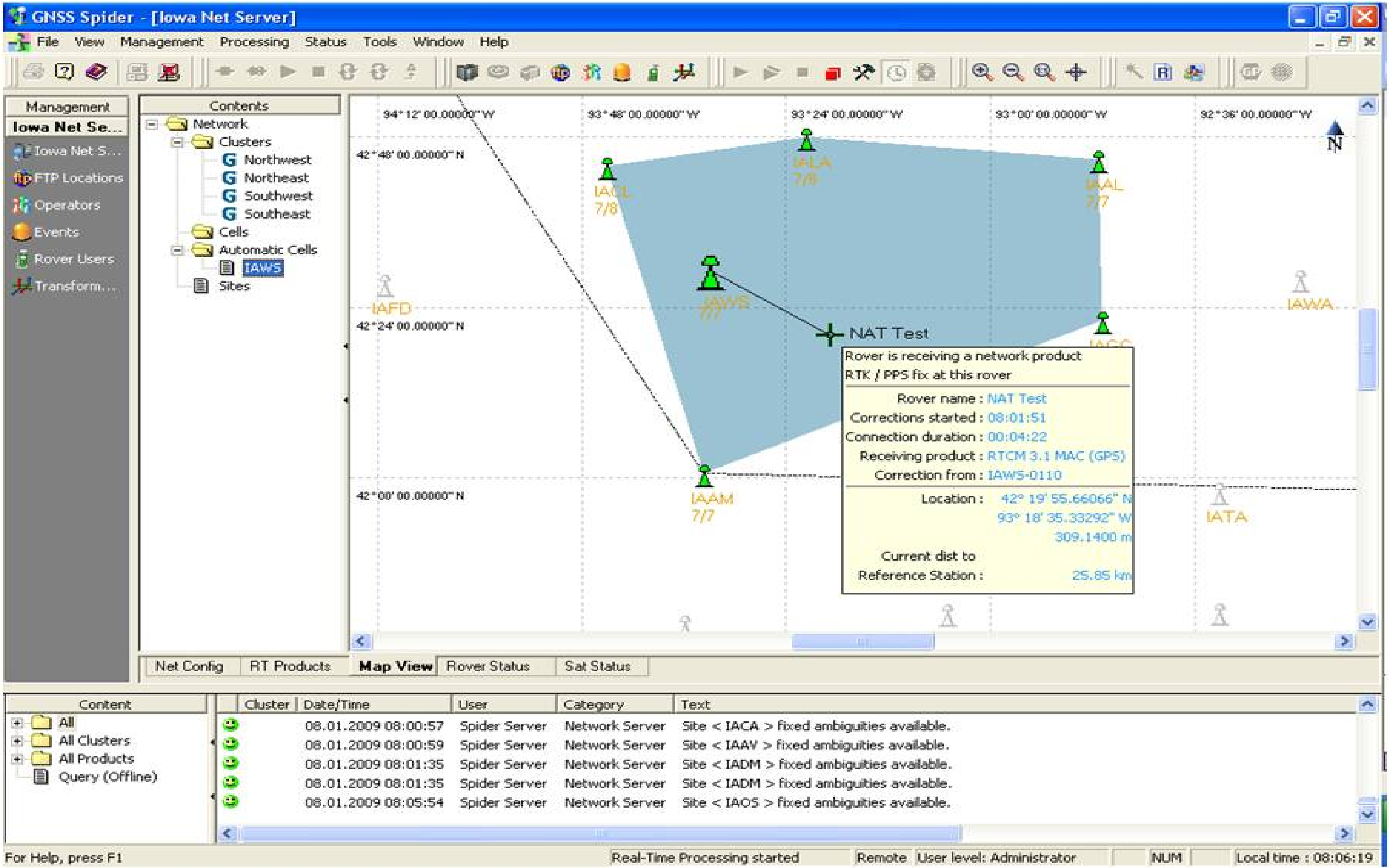
Rover Users
Transform...
Contents
Network
Clusters
Northwest
Northeast
Southwest
Southeast
Cells
Automatic Cells
IAOA
Sites
96°36'00.00000"W
96°00'00.00000"W
95°24'00.00000"W
42°48'00.00000"N
42°24'00.00000"N
42°00'00.00000"N
IALM
IACK
IASM
IASC
IASX 8/8
IASN 8/8
IAOA 8/8
IADN 8/8
IACA 8/8
Steve Milligan
Rover is receiving a network product
RTK / PPS fix at this rover
Rover name : Steve Milligan
Corrections started : 12:32:41
Connection duration : 00:01:47
Receiving product : RTCM 3.1 MAC (GPS)
Correction from : IAOA-0306
Location : -483761.3982 m -4722062.0564 m 4246426.0874 m
Current dist to Reference Station : 21.54 km
Net Config
RT Products
Map View
Rover Status
Sat Status
Content
All
All Clusters
All Products
Query (Offline)
Cluster | Date/Time | User | Category | Text
07.01.2009 12:24:39 Spider Server Network Server Site < IAJE > fixed ambiguities available.
07.01.2009 12:24:39 Spider Server Network Server Site < IAJE > fixed ambiguities available.
07.01.2009 12:32:04 Spider Server Product Real time product RTCM 3.1 MAC (GPS): User Steve Milligan is not authorized. Too many concurrent conr
07.01.2009 12:32:10 Spider Server Product Real time product RTCM 3.1 MAC (GPS): User Steve Milligan is not authorized. Too many concurrent conr
07.01.2009 12:32:30 joj Network Server Rover user Steve Milligan modified.
For Help, press F1
Real-Time Processing started
Remote
User level: Administrator
NUM
Local time : 12:34:34


GNSS Spider - [Iowa Net Server]
File View Management Processing Status Tools Window Help
Management
Iowa Net Se...
Iowa Net S...
FTP Locations
Operators
Events
Rover Users
Transform...
Contents
Network
Clusters
Northwest
Northeast
Southwest
Southeast
Cells
Automatic Cells
IAWS
Sites
94°12' 00.00000" W
93°48' 00.00000" W
93°24' 00.00000" W
93°00' 00.00000" W
92°36' 00.00000" W
42°48' 00.00000" N
42°24' 00.00000" N
42°00' 00.00000" N
N
IACL 7/8
IALA 7/8
IAAL 7/7
IAWS 7/7
IAFD
IAWA
NAT Test
IAAM 7/7
IATA
Rover is receiving a network product
RTK / PPS fix at this rover
Rover name : NAT Test
Corrections started : 08:01:51
Connection duration : 00:04:22
Receiving product : RTCM 3.1 MAC (GPS)
Correction from : IAWS-0110
Location : 42° 19' 55.66066" N
93° 18' 35.33292" W
309.1400 m
Current dist to
Reference Station : 25.85 km
Net Config
RT Products
Map View
Rover Status
Sat Status
Content
All
All Clusters
All Products
Query (Offline)
Cluster | Date/Time | User | Category | Text
08.01.2009 08:00:57 Spider Server Network Server Site < IACA > fixed ambiguities available.
08.01.2009 08:00:59 Spider Server Network Server Site < IAAV > fixed ambiguities available.
08.01.2009 08:01:35 Spider Server Network Server Site < IADM > fixed ambiguities available.
08.01.2009 08:01:35 Spider Server Network Server Site < IADM > fixed ambiguities available.
08.01.2009 08:05:54 Spider Server Network Server Site < IAOS > fixed ambiguities available.
For Help, press F1
Real-Time Processing started
Remote
User level: Administrator
NUM
Local time : 08:06:19

Ames File Availability

Site Overview | Quality Plots | File Summary | File Availability

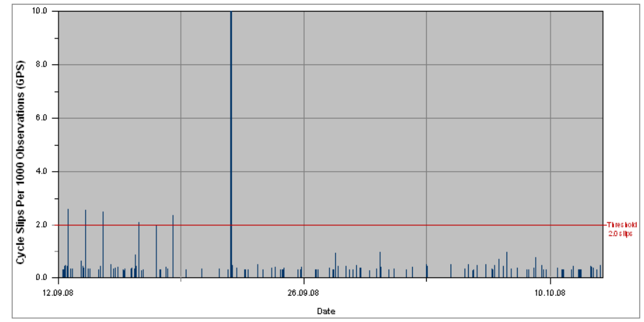
File availability for the last 186 days

Date	DOY	File(s)*																						
13 Oct 2008	287	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
12 Oct 2008	286	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
11 Oct 2008	285	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
10 Oct 2008	284	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
9 Oct 2008	283	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
8 Oct 2008	282	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
7 Oct 2008	281	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
6 Oct 2008	280	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
5 Oct 2008	279	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
4 Oct 2008	278	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
3 Oct 2008	277	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
2 Oct 2008	276	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
1 Oct 2008	275	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
30 Sep 2008	274	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
29 Sep 2008	273	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
28 Sep 2008	272	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
27 Sep 2008	271	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
26 Sep 2008	270	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
25 Sep 2008	269	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
24 Sep 2008	268	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
23 Sep 2008	267	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
22 Sep 2008	266	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
21 Sep 2008	265	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
20 Sep 2008	264	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
19 Sep 2008	263	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
18 Sep 2008	262	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x
17 Sep 2008	261	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x

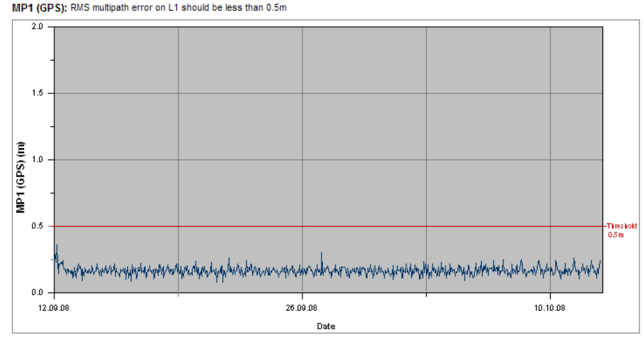
Ames Quality Plots

Site Overview | Quality Plots | File Summary | File Availability

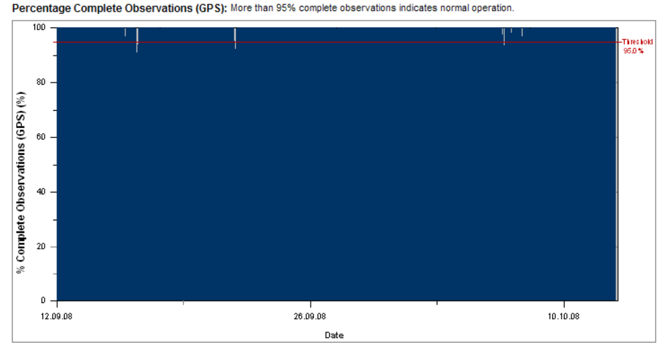
Cycle Slips Per 1000 Observations (GPS): Less than 2.0 cycle slips per 1000 observations indicates normal operation.



MP1 (GPS): RMS multipath error on L1 should be less than 0.5m



Percentage Complete Observations (GPS): More than 95% complete observations indicates normal operation.



Last Modified: 13/10/08 17:02:52 (UT-5.0)

This page was generated by Leica GNSS QC 2.1.0.18.

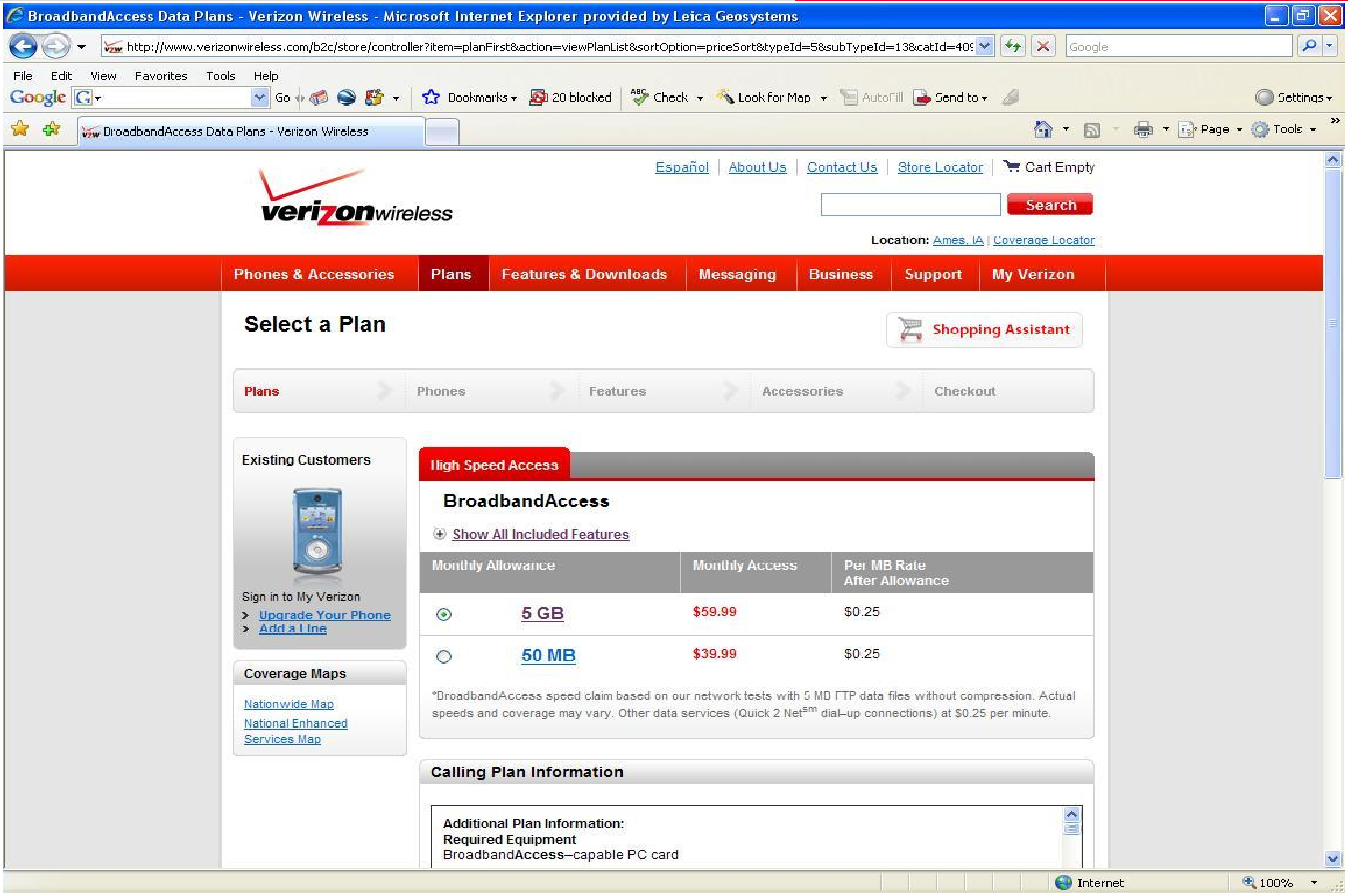
Preparing to Use the RTN Network

Need a rover that at a minimum, can:

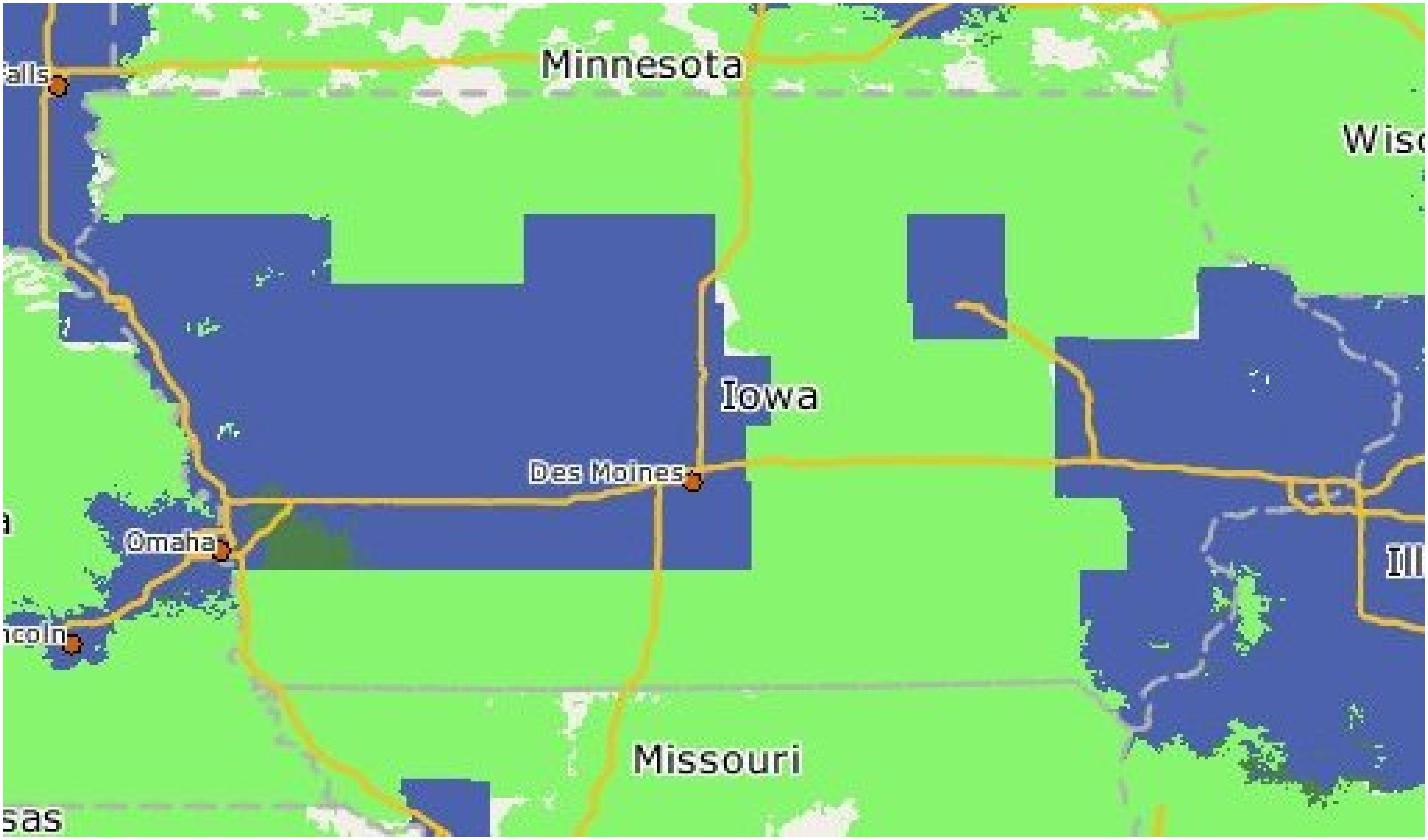
- **Connect to the internet via cell phone or cell modem**
  - Network is independent of cell service provider, select the provider with best service in the area you work in!
- **Send a NMEA message with account username and password, or has NTRIP functionality**
- **Can utilize RTCM 2.3, RTCM 3.x, CMR or CMR+ message formats**

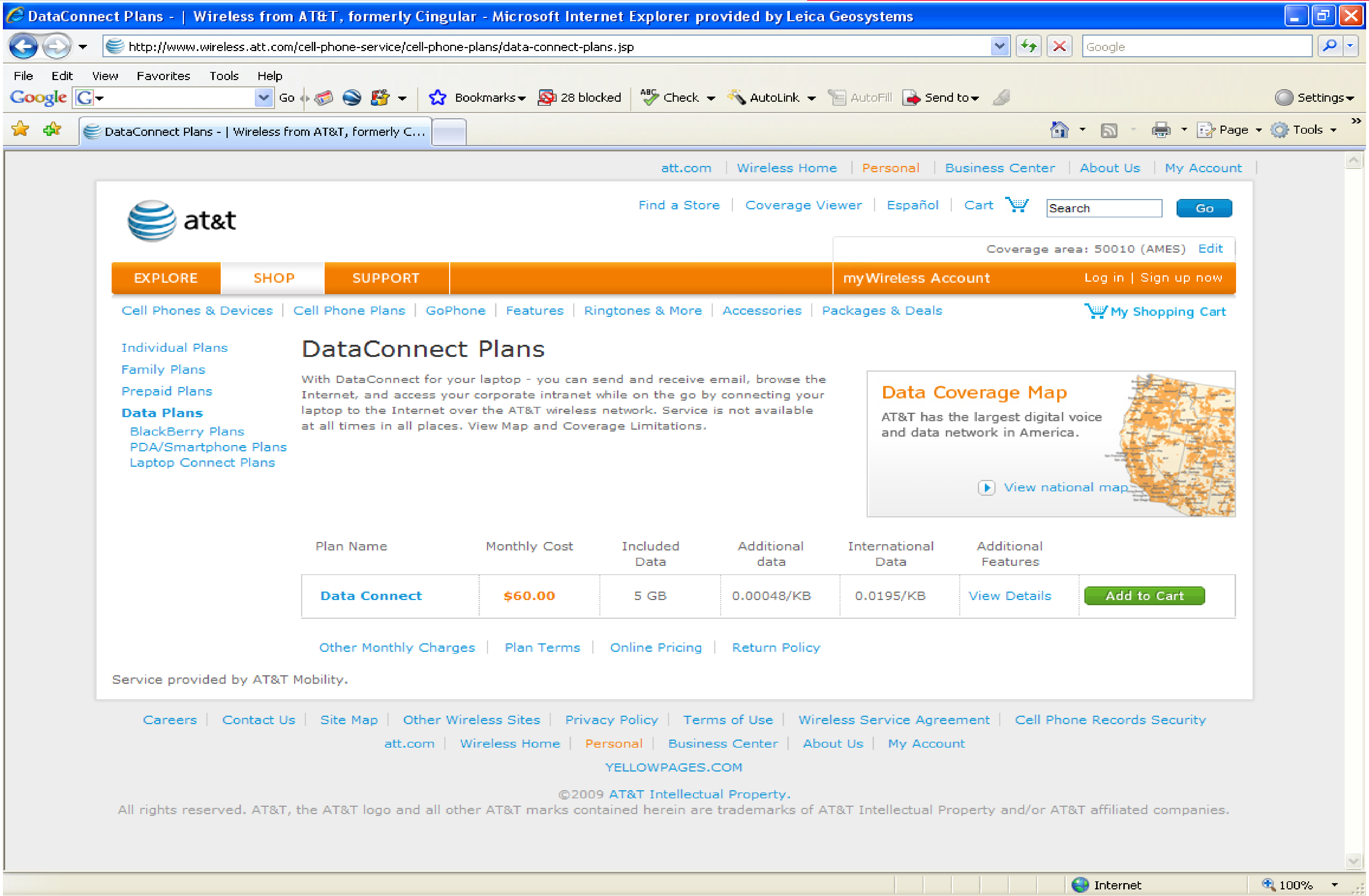
Strongly encourage all users to run the most recent firmware for the rover they are using.

For construction machine control or project areas in cell service voids solutions exist to provide on-site radio broadcast of baseline and network solutions.


BroadbandAccess Data Plans - Verizon Wireless - Microsoft Internet Explorer provided by Leica Geosystems
http://www.verizonwireless.com/b2c/store/controller?item=planFirst&action=viewPlanList&sortOption=priceSort&typeId=5&subTypeId=13&catId=40
File Edit View Favorites Tools Help
Español | About Us | Contact Us | Store Locator | Cart Empty
verizonwireless
Search
Location: Ames, IA | Coverage Locator
Phones & Accessories
Plans
Features & Downloads
Messaging
Business
Support
My Verizon
Select a Plan
Shopping Assistant
Plans
Phones
Features
Accessories
Checkout
Existing Customers
Sign in to My Verizon
Upgrade Your Phone
Add a Line
Coverage Maps
Nationwide Map
National Enhanced Services Map
High Speed Access
BroadbandAccess
Show All Included Features
Monthly Allowance
Monthly Access
Per MB Rate After Allowance
5 GB
$59.99
$0.25
50 MB
$39.99
$0.25
*BroadbandAccess speed claim based on our network tests with 5 MB FTP data files without compression. Actual speeds and coverage may vary. Other data services (Quick 2 Net sm dial-up connections) at $0.25 per minute.
Calling Plan Information
Additional Plan Information:
Required Equipment
BroadbandAccess–capable PC card
Internet
100%

Verizon Coverage Map




DataConnect Plans - | Wireless from AT&T, formerly Cingular - Microsoft Internet Explorer provided by Leica Geosystems
http://www.wireless.att.com/cell-phone-service/cell-phone-plans/data-connect-plans.jsp
att.com | Wireless Home | Personal | Business Center | About Us | My Account
at&t
Find a Store | Coverage Viewer | Español | Cart
Coverage area: 50010 (AMES) Edit
EXPLORE SHOP SUPPORT
myWireless Account Log in | Sign up now
Cell Phones & Devices | Cell Phone Plans | GoPhone | Features | Ringtones & More | Accessories | Packages & Deals
My Shopping Cart
Individual Plans
Family Plans
Prepaid Plans
Data Plans
BlackBerry Plans
PDA/Smartphone Plans
Laptop Connect Plans
DataConnect Plans
With DataConnect for your laptop - you can send and receive email, browse the Internet, and access your corporate intranet while on the go by connecting your laptop to the Internet over the AT&T wireless network. Service is not available at all times in all places. View Map and Coverage Limitations.
Data Coverage Map
AT&T has the largest digital voice and data network in America.
View national map
Plan Name | Monthly Cost | Included Data | Additional data | International Data | Additional Features
Data Connect | $60.00 | 5 GB | 0.00048/KB | 0.0195/KB | View Details | Add to Cart
Other Monthly Charges | Plan Terms | Online Pricing | Return Policy
Service provided by AT&T Mobility.
Careers | Contact Us | Site Map | Other Wireless Sites | Privacy Policy | Terms of Use | Wireless Service Agreement | Cell Phone Records Security
att.com | Wireless Home | Personal | Business Center | About Us | My Account
YELLOWPAGES.COM
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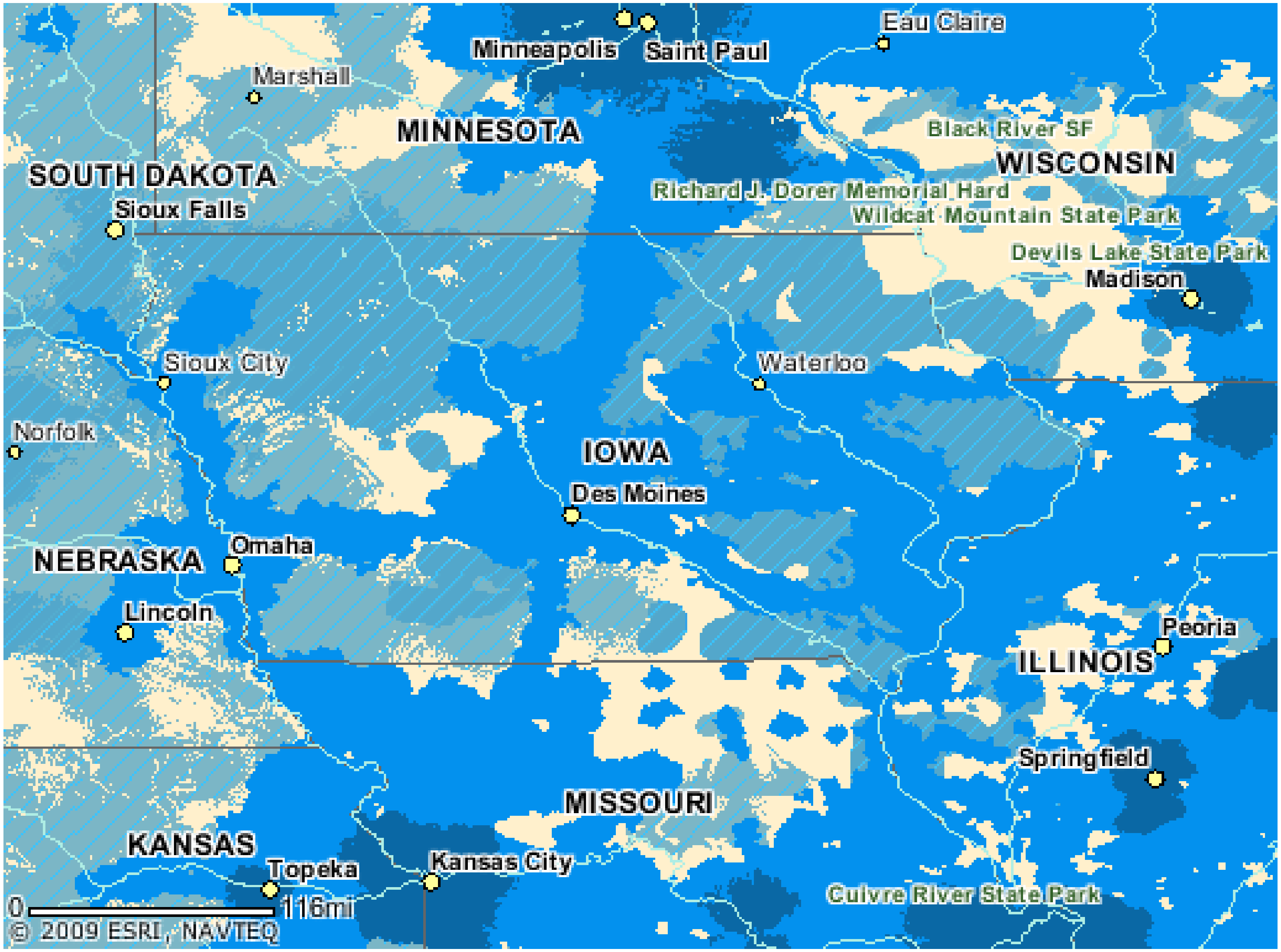
AT & T Coverage Map



- when it has to be **right**

Leica Geosystems

US Cellular Coverage Map

Data Coverage

U.S. Cellular

U.S. Cellular® network

U.S. Cellular and strategic partners' networks
(standard rates apply, no additional charge for roaming)

Rev. 05.20.08

- when it has to be **right**

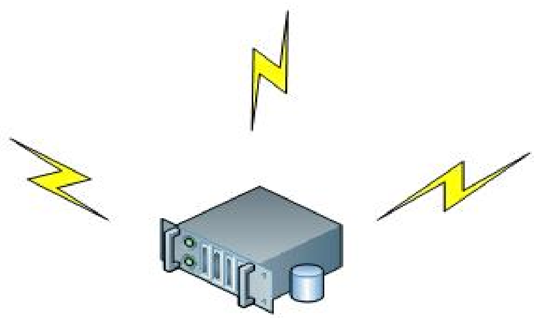
Leica Geosystems

The Iowa RTN Real Time Products Schema

IADOT Network RTK (NTRIP, Username & Password)	
Port 10000	
RTCM 3.1 MAC (GNSS)	RTCM3_MAX
RTCM 3.1 iMAX (GNSS)	RTCM3_IMAX
RTCM 3.1 Nearest (GNSS)	RTCM3_NEAR
RTCM 2.3 iMAX (GPS)	RTCM2_IMAX
RTCM 2.3 Nearest (GPS)	RTCM2_NEAR
CMR Nearest (GPS)	CMR_NEAR
CMR+ Nearest (GPS)	CMRP_NEAR

IADOT Baseline RTK (NTRIP, Username & Password)
Port 31x00 – District number in place of "x"
RTCM 3.1 – Single (GNSS) - RTCM3_IAxx
Example: Port 31100 – Single Baselines for District 1
RTCM3_IAAM – Single Baseline Correction for Ames
Port 23x00 – District number in place of "x"
RTCM 2.3 - Single (GPS) – RTCM2_IAxx (Site Name)
Example: Port 23100 – Single Baseline for District 1
RTCM2_IAAM – Single Baseline Correction for Ames
Port 24x00 – District number in place of "x"
CMR - Single (GPS) – CMR_IAxx (Site Name)
Example: Port 24100 – Single Baseline for District 1
CMR_IAAM – Single Baseline Correction for Ames
Port 25x00 – District number in place of "x"
CMR+ - Single (GPS) – CMRP_IAxx (Site Name)
Example: Port 25100 – Single Baseline for District 1
CMRP_IAAM – Single Baseline Correction for Ames

IADOT Raw LB2 Data (NTRIP, Username & Password)	
Port 9999	RAW_IAxx (Site Name)
Example:	RAW_IAAM – Raw Data Feed for Ames



Iowa GNSS Network
Proxy Server

IP 165.206.203.10

Maximum Estimated Number of Ports:		
NTRIP:	6	(with 407 mountpoints)
TCP/IP:	85	
Total:	91 ports estimated	

IADOT Network RTK (TCP/IP, Username & Password)		
Port 11000	RTCM 3.1	iMAX (GPS)
Port 11001	RTCM 2.3	iMAX (GPS)
Port 11002	RTCM 2.3	Nearest (GPS)
Port 11003	CMR	Nearest (GPS)
Port 11004	CMR+	Nearest (GPS)

IADOT Baseline RTK (TCP/IP, Username & Password)
All baseline products are GPS only
RTCM 2.3 Format:
Port 23xyz – RTCM-ID-xyz
Example:
Ames – Port 23105 – District 1 Site No. 05
CMR Format:
Port 24xyz – CMR-ID-xyz
Example:
Ames – Port 24105 – District 1 Site No. 05
CMR+ Format:
Port 25xyz – CMR+-ID-xyz
Example:
Ames – Port 25105 – District 1 Site No. 05

LABEL

IADOT Port Schema Rev 3.0

- when it has to be **right**

Leica Geosystems

Iowa RTN: RTCM Identifiers

note: The first digit of the identifier indicates the District in which the the site resides, the second and third digits do not indicate any particular order or significance

SITE	RTCM ID	Constellations	Laititude	Longitude	Ellipsoidal HT.	Antenna	Cluster
IAAM	101	GPS & GLONASS	42° 00' 34.52725" N	93° 33' 35.03229" W	266.551	AX1202 GG	Northwest; Northeast; Southwest; Southeast
IADM	102	GPS & GLONASS	41° 39' 25.81755" N	93° 35' 52.63576" W	256.503	AX1202 GG	Southwest; Southeast
IAFD	103	GPS & GLONASS	42° 27' 19.57659" N	94° 11' 11.52094" W	324.382	AX1202 GG	Northwest
IAGC	104	GPS & GLONASS	42° 22' 09.41009" N	92° 46' 45.68544" W	275.305	AX1202 GG	Northeast
IAJE	105	GPS & GLONASS	42° 01' 16.06219" N	94° 22' 55.44009" W	303.933	AX1202 GG	Northwest; Southwest
IAML	106	GPS & GLONASS	41° 41' 13.66192" N	92° 33' 01.24839" W	271.266	AX1202 GG	Southeast
IAMT	107	GPS & GLONASS	42° 00' 20.82373" N	92° 55' 59.26626" W	279.595	AX1202 GG	Northeast; Southeast
IANT	108	GPS & GLONASS	41° 41' 04.15198" N	93° 04' 55.03440" W	239.667	AX1202 GG	Southwest; Southeast
IATA	109	GPS & GLONASS	41° 58' 01.64651" N	92° 33' 05.03347" W	248.387	AX1202 GG	Southeast
IAWS	110	GPS & GLONASS	42° 29' 03.00035" N	93° 32' 51.10994" W	347.985	AX1202 GG	Northwest; Northeast
IASW	201	GPS & GLONASS	43° 23' 06.97094" N	94° 18' 51.00407" W	338.467	AX1202 GG	Northwest; Northeast
IAAG	202	GPS & GLONASS	43° 04' 47.10437" N	94° 16' 01.15033" W	350.811	AX1202 GG	Northwest
IAGA	203	GPS & GLONASS	43° 06' 25.32956" N	93° 35' 59.30748" W	348.129	AX1202 GG	Northwest; Northeast
IACL	204	GPS & GLONASS	42° 43' 51.59357" N	93° 45' 04.85748" W	334.079	AX1202 GG	Northwest; Northeast
IAHT	205	GPS & GLONASS	43° 17' 02.35554" N	93° 22' 06.64421" W	345.498	AX1202 GG	Northwest; Northeast
IALA	206	GPS & GLONASS	42° 47' 55.01723" N	93° 21' 32.74025" W	359.424	AX1202 GG	Northeast
IAOE	207	GPS & GLONASS	43° 17' 04.67561" N	92° 50' 32.29195" W	332.408	AX1202 GG	Northeast
IAAL	208	GPS & GLONASS	42° 44' 49.37839" N	92° 47' 14.20479" W	292.136	AX1202 GG	Northeast
IANH	209	GPS & GLONASS	43° 03' 29.22811" N	92° 18' 16.44903" W	327.035	AX1202 GG	Northeast
IAWA	210	GPS & GLONASS	42° 28' 05.29411" N	92° 23' 27.20975" W	240.897	AX1202 GG	Northeast
IADE	211	GPS & GLONASS	43° 16' 15.80562" N	91° 49' 53.48415" W	317.54	AX1202 GG	Northeast
IAWU	212	GPS & GLONASS	42° 56' 09.67824" N	91° 48' 55.81897" W	325.848	AX1202 GG	Northeast
IAWK	213	GPS & GLONASS	43° 16' 40.00317" N	91° 28' 33.79617" W	372.451	AX1202 GG	Northeast
IAEL	214	GPS & GLONASS	42° 52' 40.45014" N	91° 21' 41.48879" W	300.032	AX1202 GG	Northeast
IARR	301	GPS & GLONASS	43° 26' 00.58453" N	96° 08' 55.47233" W	405.94	AX1202 GG	Northwest
IARV	302	GPS & GLONASS	43° 11' 51.94881" N	96° 18' 50.74836" W	360.201	AX1202 GG	Northwest
IAAK	303	GPS & GLONASS	42° 49' 21.83683" N	96° 33' 48.53255" W	330.493	AX1202 GG	Northwest
IASX	304	GPS & GLONASS	42° 33' 00.13894" N	96° 20' 54.47594" W	329.126	AX1202 GG	Northwest
IASN	305	GPS & GLONASS	42° 14' 20.40104" N	96° 13' 52.00458" W	308.258	AX1202 GG	Northwest
IAOA	306	GPS & GLONASS	42° 01' 39.25624" N	96° 06' 28.67084" W	301.587	AX1202 GG	Northwest; Southwest
IADN	307	GPS & GLONASS	41° 59' 50.56276" N	95° 22' 32.52942" W	351.18	AX1202 GG	Northwest; Southwest
IACA	308	GPS & GLONASS	42° 04' 40.00999" N	94° 54' 40.40182" W	366.026	AX1202 GG	Northwest; Southwest
IACV	309	GPS & GLONASS	42° 28' 52.77140" N	95° 46' 24.69055" W	325.533	AX1202 GG	Northwest
IASC	310	GPS & GLONASS	42° 25' 16.43287" N	95° 01' 05.44078" W	373.672	AX1202 GG	Northwest
IASM	311	GPS & GLONASS	42° 38' 53.58611" N	95° 12' 58.68816" W	418.883	AX1202 GG	Northwest
IAPS	312	GPS & GLONASS	42° 44' 16.91837" N	94° 40' 45.28575" W	353.432	AX1202 GG	Northwest
IACK	313	GPS & GLONASS	42° 46' 06.07968" N	95° 32' 31.86230" W	362.399	AX1202 GG	Northwest
IALM	314	GPS & GLONASS	42° 47' 53.00372" N	96° 08' 55.35723" W	365.925	AX1202 GG	Northwest
IASP	315	GPS & GLONASS	43° 07' 41.67618" N	95° 09' 41.82069" W	381.868	AX1202 GG	Northwest
IAEM	316	GPS & GLONASS	43° 06' 24.79741" N	94° 41' 40.34443" W	345.559	AX1202 GG	Northwest
IAAS	317	GPS & GLONASS	43° 18' 20.16910" N	95° 46' 44.57596" W	430.604	AX1202 GG	Northwest
IASL	318	GPS & GLONASS	43° 25' 15.18234" N	95° 08' 09.07824" W	414.6	AX1202 GG	Northwest

Iowa RTN: RTCM Identifiers

note: The first digit of the identifier indicates the District in which the the site resides, the second and third digits do not indicate any particular order or significance

SITE	RTCM ID	Constellations	Laititude	Longitude	Ellipsoidal HT.	Antenna	Cluster
IAMV	401	GPS & GLONASS	41° 34' 15.68376" N	95° 51' 30.05970" W	291.101	AX1202 GG	Southwest
IAAV	402	GPS & GLONASS	41° 29' 12.12442" N	95° 20' 14.52886" W	325.656	AX1202 GG	Southwest
IAAD	403	GPS & GLONASS	41° 29' 45.81183" N	94° 38' 29.38602" W	426.103	AX1202 GG	Southwest
IADS	404	GPS & GLONASS	41° 33' 06.29268" N	94° 00' 28.48163" W	247.44	AX1202 GG	Southwest
IACB	405	GPS & GLONASS	41° 13' 26.38336" N	95° 51' 11.59397" W	277.92	AX1202 GG	Southwest
IAAT	406	GPS & GLONASS	41° 24' 19.52320" N	94° 59' 16.80676" W	343.715	AX1202 GG	Southwest
IARO	407	GPS & GLONASS	41° 01' 19.74860" N	95° 14' 00.58962" W	291.661	AX1202 GG	Southwest
IACO	408	GPS & GLONASS	41° 00' 51.70529" N	94° 44' 14.35854" W	368.957	AX1202 GG	Southwest
IACR	409	GPS & GLONASS	41° 03' 11.11780" N	94° 21' 05.29491" W	366.3	AX1202 GG	Southwest
IASD	410	GPS & GLONASS	40° 44' 58.49898" N	95° 38' 10.30847" W	303.07	AX1202 GG	Southwest
IABE	411	GPS & GLONASS	40° 39' 56.13120" N	94° 43' 17.59069" W	315.699	AX1202 GG	Southwest
IAMA	412	GPS & GLONASS	40° 42' 30.43616" N	94° 15' 06.39104" W	347.841	AX1202 GG	Southwest
IAMD	501	GPS & GLONASS	41° 22' 16.79963" N	93° 44' 38.84771" W	232.961	AX1202 GG	Southwest; Southeast
IAOS	502	GPS & GLONASS	41° 01' 40.27417" N	93° 47' 08.43810" W	324.585	AX1202 GG	Southwest
IALN	503	GPS & GLONASS	40° 43' 44.48380" N	93° 45' 42.86096" W	318.566	AX1202 GG	Southwest
IACH	504	GPS & GLONASS	40° 58' 57.52634" N	93° 18' 25.39174" W	272.271	AX1202 GG	Southwest; Southeast
IAKN	505	GPS & GLONASS	41° 17' 58.28725" N	93° 06' 03.40437" W	256.368	AX1202 GG	Southwest; Southeast
IACE	506	GPS & GLONASS	40° 42' 07.27150" N	92° 52' 12.62620" W	286.795	AX1202 GG	Southwest; Southeast
IAOK	507	GPS & GLONASS	41° 17' 35.36889" N	92° 41' 04.79153" W	208.701	AX1202 GG	Southeast
IABL	508	GPS & GLONASS	40° 44' 26.73777" N	92° 25' 51.03652" W	241.003	AX1202 GG	Southeast
IASI	509	GPS & GLONASS	41° 19' 03.32257" N	92° 12' 24.14627" W	199.162	AX1202 GG	Southeast
IAWN	510	GPS & GLONASS	41° 18' 34.11968" N	91° 40' 44.74869" W	206.489	AX1202 GG	Southeast
IAWO	511	GPS & GLONASS	41° 10' 30.97232" N	91° 11' 29.06826" W	150.936	AX1202 GG	Southeast
IAWB	512	GPS & GLONASS	40° 50' 00.48614" N	91° 12' 33.79299" W	187.976	AX1202 GG	Southeast
IADO	513	GPS & GLONASS	40° 38' 48.98297" N	91° 33' 57.38978" W	188.678	AX1202 GG	Southeast
IAAA	514	GPS & GLONASS	41° 00' 49.06467" N	92° 48' 45.62838" W	268.131	AX1202 GG	Southeast
IAIN	601	GPS & GLONASS	42° 26' 39.02847" N	91° 53' 00.91974" W	272.06	AX1202 GG	Northeast
IANW	602	GPS & GLONASS	41° 57' 41.91514" N	91° 58' 07.31635" W	245.296	AX1202 GG	Northeast; Southeast
IAWM	603	GPS & GLONASS	41° 42' 09.45049" N	92° 00' 22.02592" W	244.089	AX1202 GG	Southeast
IACI	604	GPS & GLONASS	41° 42' 38.03093" N	91° 36' 33.23790" W	222.285	AX1202 GG	Southeast
IAAN	605	GPS & GLONASS	42° 06' 12.96702" N	91° 15' 24.18956" W	228.121	AX1202 GG	Northeast; Southeast
IATI	606	GPS & GLONASS	41° 38' 33.88902" N	91° 06' 37.55668" W	185.887	AX1202 GG	Southeast
IADA	607	GPS & GLONASS	41° 36' 36.18235" N	90° 37' 49.54861" W	201.692	AX1202 GG	Southeast
IAMQ	608	GPS & GLONASS	42° 04' 25.20052" N	90° 38' 42.15399" W	188.66	AX1202 GG	Northeast; Southeast
IADU	609	GPS & GLONASS	42° 27' 21.31702" N	90° 40' 25.97318" W	217	AX1202 GG	Northeast
IAMR	610	GPS & GLONASS	42° 29' 04.33678" N	91° 28' 22.77785" W	269.074	AX1202 GG	Northeast
IASA	611	GPS & GLONASS	42° 05' 00.09625" N	90° 11' 55.17784" W	160.743	AX1202 GG	Northeast; Southeast

Thank you all very much!

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