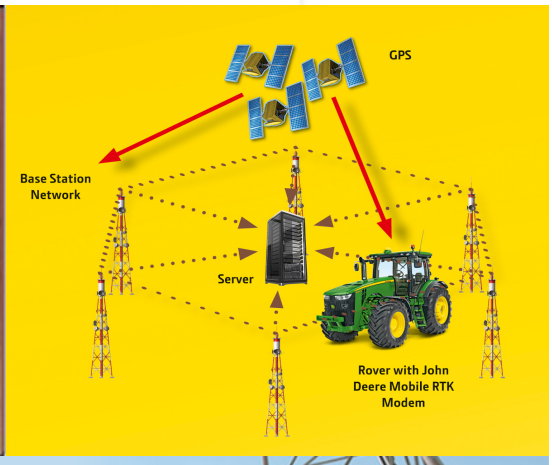
PRAIRIE
PRECISION NETWORK INC.

TECHNICAL REFERENCE MANUAL AND INSTALLATION GUIDE



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INTRODUCTION

Congratulations on the purchase of your Prairie Precision JDM-150 Modem. The JDM-150 RTK Modem represents the third generation of RTK Network communications devices allowing the John Deere SF3000 receiver to easily and reliably connect to any internet GPS/GNSS Corrections source all the while being managed remotely without any interaction required on the end-users part.

The goal of this manual is to provide technical information as well as an installation guide to aid you with the start up of your PPN Network RTK system.

If you have any further questions to this guide please contact your local PPN reseller for further information.

KEY FEATURES

- Connects to NTRIP Casters to retrieve RTK corrections
- Connects to direct TCP/IP port streams to retrieve RTK corrections
- Supports NTRIP authentications

UNIQUE FEATURES

- Integrated 2G/3G Cellular Modem able to roam on any HSPA, GSM or CDMA capable network
- Communications pecking order, which intelligently and automatically scans looking for RTK Corrections from Cellular networks, Wi-Fi, and 900 MHz
- Remotely monitor and reconfigure while device is in operation through our online admin tool as well supports local configuration via RS-232 serial port commands.
- Standard RS232 port for easy cable setup and prototyping
- Cached GPS positions allows the JDM-150 to function without position from internal GPS receiver improving its robustness over older generation RTK Bridges
- High performance integrated aGPS receiver (no external cables required) that will typically achieve a positional fix in under 10 seconds
- Integrated 900 MHz radio (optional) for signal repeating to slave JDM-150 Modem systems
- Creates an automatic Wi-Fi hotspot when connected to your cellular carrier for use by other Wi-Fi enabled devices.

DISCLAIMER

While every effort has been made to ensure the completeness and accuracy of the PPN RTK Modem Users Guide (this document), PPN assumes no responsibility for omission and errors. Nor is any liability assumed for losses or damages resulting for the user of the information contained herein. As with all wireless communication devices and GPS systems, numerous factors affect the availability and accuracy of these systems (e.g. obstructions, interference, system maintenance, availability, etc.).

Therefore, Prairie Precision Network, your cellular provider, your GPS/GNSS corrections provider and even the manufacturer of your GPS system cannot guarantee the accuracy, continuity, or availability of the complete system due to the numerous variables. Being well educated on these many factors will improve your ability to plan, troubleshoot, and overcome these limitations insuring maximum productivity with our equipment. Contact your local PPN reseller regarding education classes on your compete equipment.

SPECIFICATIONS

Size	35 mm x 79 mm x 140 mm (1” x 3” x 5.5”)
Weight	450 g (1.0 lbs.)
Voltage Range	9 – 25 VDC
Max Power Consumption	1 amps at 12VDC when Wi-Fi & 900 MHz active
Operating Temperature	-30°C to +70°C (-40°F to +158°F)
Storage Temp Range	-40°C to +85°C (-40°F to +185°F)
Humidity	100%
Condensing Ruggedness Rating	IP67 MIL-STD-810G 527
Cellular Functionality Compatibility:	• EV-DO/EV-DO Rev. A 800MHz* • EV-DO/EV-DO Rev. A 1900 MHz* • HSDPA/HSUPA 800MHz* • HSDPA/HSUPA 850MHz* • HSDPA/HSUPA 900MHz* • HSDPA/HSUPA 1900MHz* • HSDPA/HSUPA 2100MHz* • GSM/GPRS/EDGE 850MHz • GSM/GPRS/EDGE 900MHz • GSM/GPRS/EDGE 1800MHz • GSM/GPRS/EDGE 1900MHz * Receive Diversity on all HSPA/UMTS/EV-DO/CDMA bands Data Speeds: • HSDPA/HSUPA DL/UL – 7.2 Mbps/5.76 Mbps • WCDMA DL/UL – 384 kbps/384 kbps • GSM DL/UL – 14.4 kbps/14.4 kbps • GPRS DL/UL – 85.6 kbps/42.8 kbps • EDGE DL/UL – 236.8 kbps/118.4 kbps • EV-DO FL/RL – 3.1 Mbps/1.8 Mbps • CDMA 1xRTT FL/RL – 153 kbps/153 kbps
Cellular Connector	TNC Female
Wi-Fi Capabilities	Client, WAP (Wireless Access Point) 802.11 b 802.11 g WEP WAP WAP2
Wi-Fi Antenna	No Connector (Internal Antenna)
900 MHz SSR Transceiver	SMA Female FHSSR – Frequency Hopping Spread Spectrum 100 – 1000 mW Selectable Master / Multiple Slave

L1 GPS	No Connector (Internal Antenna) Standalone Positioning and aGPS Indoor GPS utilizing OneXTRA Position caching for indoor operation with complete GPS blockage TTFF < 10 seconds
Serial	3 Wire RS232 MOLEX – Numerous Connector Solutions
Power Connector	2 Wire MOLEX – Numerous Connector Solutions Available (see parts listing for complete list): • SAE • Unterminated • Serial power using device power
Status Indicators	Status Lights (Power, Cellular/Wi-Fi, John Deere Translator, Radio, Mode)

INSTALLATION

Modem Antenna Location:
If you are operating in areas of questionable cellular coverage utilize the supplied external antenna mount and/or amplifier. Mount the cellular antenna as high as possible and as perpendicular to the surface as possible.

Most high gain antennas require a "Ground Plane" for optimal operation. Refer to your antenna's documentation on the size of the ground plane as it relates to the operational frequency (bigger is always safer, i.e. a 24" ground lane will work with frequencies all the way down to VHF.

Also, an important consideration in determined the location to mount the PPN Modem is to avoid mounting in close proximity to any of the GPS guidance antennas / globes as poorly filtered GPS Receivers can be affected by any cellular / Wi-Fi device. Recommended distance from GNSS receiver is 3 feet or more for the JDM-150 modem.

Internal GPS Antenna
The main requirement of the internal GPS Antenna is that the JDM-150 modem be mounted vertically so that the internal GPS antenna has a good view of the sky. If it does not, it may delay the acquisition of the correct position delaying the login time to your RTK Provider and therefore it will take longer to achieve a Fixed RTK Position. In the situation where the internal GPS receiver cannot obtain a GGA position, the PPN Modem will fall back to the last stored/cached position after 3 minutes.

INSTALLATION INSTRUCTIONS

Requirements

- John Deere GNSS Receiver (SF3000 or higher)
- RTK activation on Receiver
- GS2 1800/2600, GS3 2630, GS4 4100/4600
- PPN RTK Modem
- Standard SIM card with active data plan
- Brackets and high gain antenna
- AutoTrac Activation on Display

Installation steps

1) INSTALL SIM CARD INTO MODEM*

a. A standard size SIM card will need to be purchased and activated by a local Telco to install into the modem. We work with all major carriers, Bell, Telus, Rogers and Sasktel. If using MTS please contact your PPN reseller as an internal settings update will need to be done.

b. Take all 6 screws out of cover of modem and set aside

c. Open Sim card slot by pushing back and lifting cover (figure 1)

d. Insert SIM card with printed circuit board facing you with the SIM card slot open (figure 3)

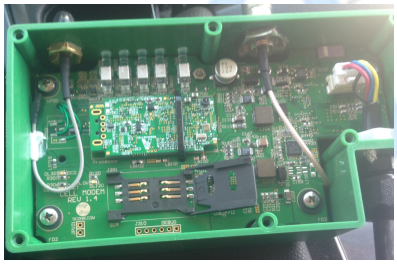


Figure 1

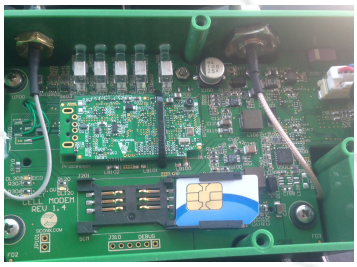


Figure 2

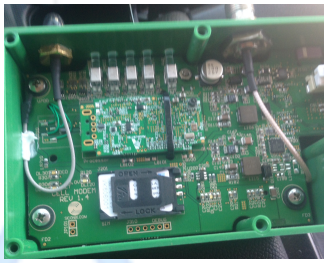


Figure 3

SIM CARD DATA USAGE

The PPN Modem does have a wifi antenna in it that can create local hotspots. You can choose to turn on or off this feature.

WIFI OFF – approx. 30-40 Mb of data will be used during an average working day for the RTK Network corrections. Meaning a 1-2 Gb data plan for a month will cover this setup

WIFI ON – this amount of data usage is completing dependant on WIFI usage. You should only be using an unlimited plan to make sure to cover all data usage.

2. MODEM CONNECTION TO STARFIRE

a. Open the receiver by removing the three screws underneath so that you can locate the 4 pin square connector (figure 4)

b. Connect the PPN Modem harness to this connector through the back rubber grommet on receiver and close receiver. (figure 5 & 6)

Figure 4

Figure 5

Figure 6

3. MOUNTING THE PPN MODEM

a. You can choose to mount the PPN Modem either on the roof or inside the cab.

Inside Cab Mount

a. Order JDB-150CBK (figure 7) and JDB-150EXT (figure 8)
b. Install JDB-150EXT into globe as described in step# 2
c. Run JDB-150EXT back into cab and connect it to the JDM-150 Modem
d. Choose any "lower" cab bolt to mount the JDB-150CBK to and then fasten modem to this bracket (do not mount on a bolt close to cab roof)
e. Make sure that the JDM-150 is mounted vertically and has a good view of the sky (figure #9)
f. Connect high gain antenna to modem and run out to top of cab to get best possible cellular reception. Place antenna plate under one roof bolt and then place antenna on plate

Figure 7

Figure 8

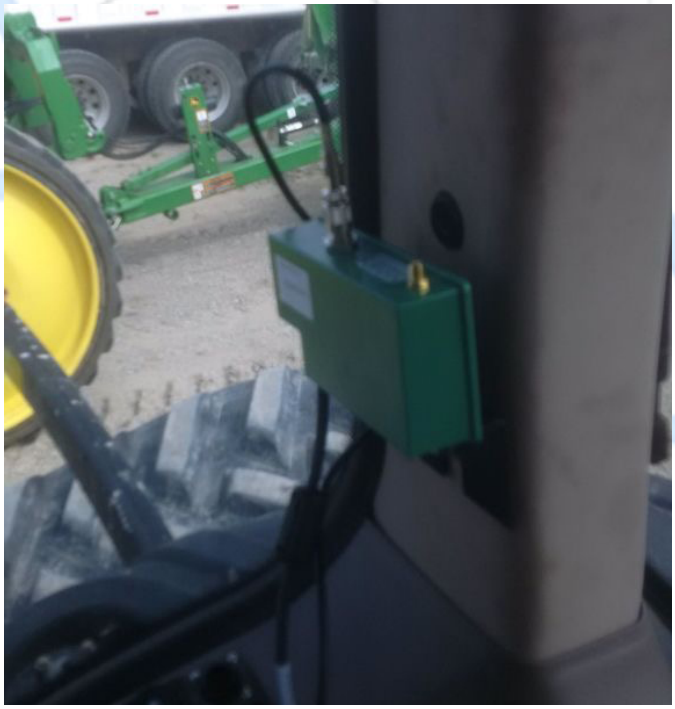


Figure 9

Roof Mount

a. Order JDB-150RMK (figure 10)
b. Remove Plastic cover and mount modem to bracket (figure 11)
c. Replace plastic cover by making sure to connect both wire leads in it to the corresponding connector on the modem (figure 11 & 12)
d. Mount JDB-RMK under one of the roof bolts on top of cab (figure 13)
e. Connect High gain Antenna to TNC connector on JDB-150RMK (Figure 13)
f. Mount antenna plate to other roof bolt and place antenna on it

Figure 10

Figure 11

Figure 12

Figure 13

Display Example (Will vary based on the display and firmware version)

a. Press 

b. Press 

then Press 

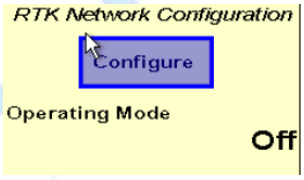
c. The SF3000 Main Info screen will display.

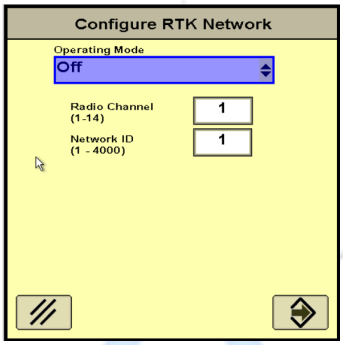
d. Press 

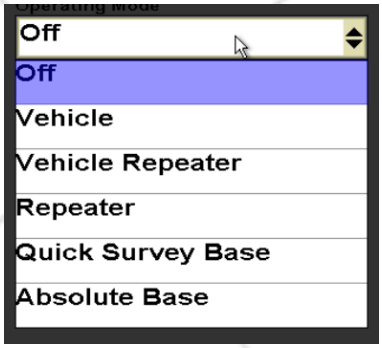
to display the base station status and radio configuration screen.

e. Press Configure to access the RTK Network Configuration page

f. Select the box under "Operating Mode" that will say "OFF"







g. From the List choose "Vehicle" and you will be returned to the configure RTK Network Page

h. Leave the Radio and Channel ID at "1" then hit 

i. Your RTK Setup Page should look like the image to the right. Most of the information on this page is not needed for a VRS network solution.

INSTALLATION NOTES

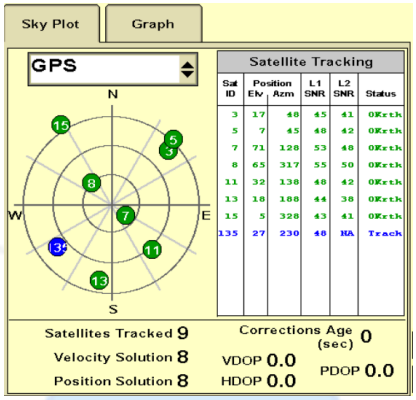
RTK Status

a. You can also press the  to view more information on the RTK Status.

b. If you are in a very sparse area of the VRS network the Deere receiver may take a bit longer to initialize to an RTK Solution

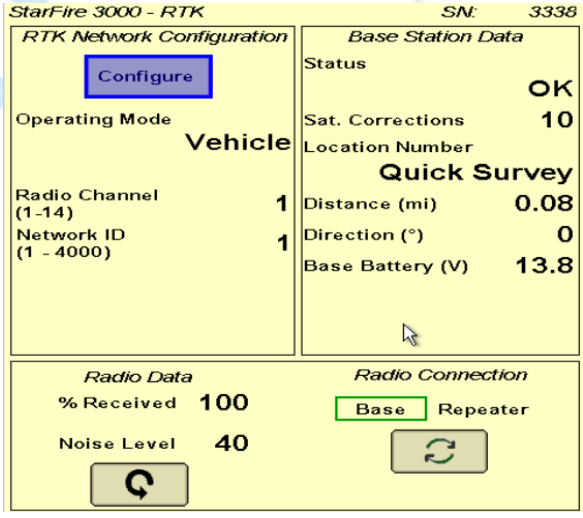
c. Correction Age gives us an indication of RTK Network coverage. If this starts to count up your vehicle is moving out of network coverage.

d. PDOP is a calculation of the overall quality of your GNSS solution. Depending on areas this number will change however the lower the number the better GNSS accuracy your vehicle will have.

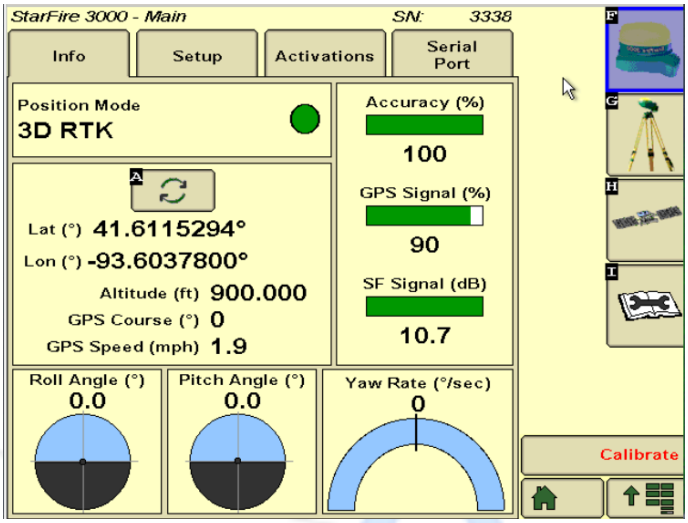


RTK HomePage (Starfire – G)

a. When properly connected to the PPN RTK Network you will typically see 50% Data received and a distance to the base station (if running on a VRS style network a very small distance will be shown). The Data received % may vary based on your network providers Hz rate. DO NOT WORRY, 30% to 100% are all the same, Deere duplicates the RTK correction message 10 times to improve reception in poor RF environments so there is no loss in accuracy from a 10% value to a 100% value. Values less than 30% when "Vehicle" only is set, will cause the system to switch between Base and Repeater in some firmware revisions.



Starfire Homepage (Starfire – F)

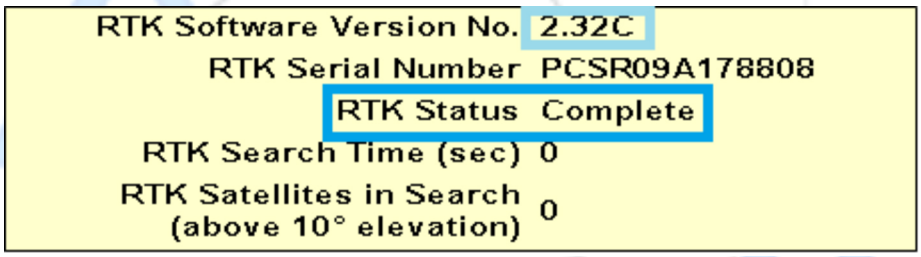


a. The Main Starfire Page will show the current Position Mode as well as your Accuracy and GPS Signal %.
b. These values may change depending on the day but should remain around 90-100% if you are within proper RTK Network coverage.

RTK Diagnostics

a. If you press the  in the Starfire menu you will enter the diagnostics menu.

b. For our purposes with the RTK system you can choose the dropdown in middle and page and choose RTK System to be taken to the RTK diagnostics menu
c. The first line shows the firmware version. The letter after the firmware version also shows your system status.

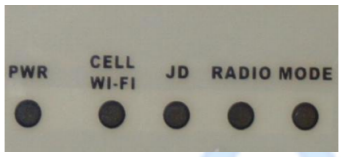


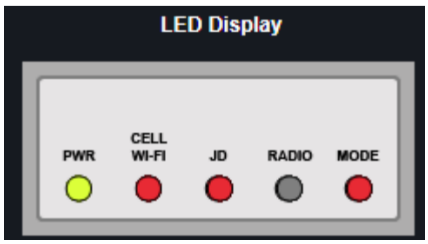
d. X : no cell or WiFi connection
e. C: Cell of WiFi is connected but there is no RTK Data
f. N: Receiving RTK data, everything is good.

g. The RTK Serial number is relating to the PPN Modem serial number, but only the last 6 digits. The “PCSR09A” is not information from the PPN Modem but the last 6 digits are.

h. RTK Status shows the current overall system status. Please refer to our JDM-150 troubleshooting guide for more info on this status.

APPENDIX A – STATUS INDICATORS





This section describes the meaning of the five LED indicator lights on the top of the PPN RTK Modem and on the Information screen in the remote web setup tool.

POWER

This light is used to indicate the status of the modem power source and to signal remote updating of firmware or settings:

Solid	Unit is powered
Flashing (for only 6 seconds at startup)	Indicates that the modem is checking the PPN Master Control server for settings which were changed while the modem was offline.
Flashing (for a long time + Cell/Wi-Fi light is ON)	Indicates that the modem is downloading a new firmware.
Flashing (for a long time & Cell/Wi-Fi light is OFF)	Indicates that the modem is in the process of installing the newly downloaded firmware (do NOT remove power until this process is complete).

CELL Wi-Fi

This light indicates if there is an active data connection to the corrections server:

Off	No internet connection
Solid	Connected to the Internet and attempting to login to the programmed corrections provider. *If the modem stays in this state for an extended amount of time, verify that you have an active RTK Network subscription
Flash	Data is being transferred from configured server to the serial port

JD

This light indicates that the PPN RTK Modem is licensed to operate on a John Deere system and that it is actively communicating with the SF3000 receiver:

Off	Not connected to a Deere Receiver or Not Authorized
Solid	Communicating with a Deere Receiver and emulating the Deere 900 MHz Radio

RADIO

This light indicates the status of the internal 900 MHz radio:

Off	Radio is either not installed or is turned OFF
Solid	Radio is transmitting
Flash	Radio is receiving corrections from another Modem with the 900MHZ set to ON

MODE

This light indicates the general status of the Modem:

Off	Firmware not loaded in memory yet
Solid	Modem has booted and is able to be communicated with via its serial port (i.e., any HyperTerminal program – CTRL+Z @ 19,200 Baud).

APPENDIX B - CELLULAR ANTENNAS AND AMPLIFIERS

Cellular Connection

One of the main problems with a VRS Network RTK solution is the need to maintain a reliable and constant cellular connection. When considering an RTK VRS problem, make sure to FIRST check for cellular connection.

You can check for cellular connection real quickly by looking at the lights on the Modem to see if the Cell/Wifi light is blinking. Refer to the Status Indicators section in this guide for more info.

Also make sure that ALL connections between the PPN RTK Modem and the antenna in use are all tight. Also make sure on the antenna to have the base tight and any set screws in the antenna whip tight as well.

Antennas & Amplifiers

If you are still not happy with the cellular service in your area and are entering RTK-X mode quite a bit then you should upgrade to a high gain antenna and/or a cellular amplifier.

By utilizing an External Cellular Antenna and/or Cellular amplifier, not only will you increase the areas that you get reception but you will increase your data speed. By increasing your data speed you will decrease your latency, which will improve your RTK accuracy. There is one high gain antenna and one amplifier that PPN supports and is available through your local PPN reseller.

PPN High Gain Antenna

We carry a very good 5dBi high gain antenna that works very well at receiving even sparse cellular signal. It is a Magnet Mount Antenna with a 14" Mast, 3" Magnet Base and Enclosed Coils with FME Female Connector. Please check with your local PPN reseller for availability.

Antenna Gain	5dBi
Frequencies (MHz)	• 698-806 LTE • 806-894 IDEN / HSPA+ • 1710-1755 AWS / LTE • 1850-1995 HSPA+ • 2110-2155 AWS / LTE
VSWR	1.1483 to 1.9796
Input Impedance	50 ohm
Radiation	Omni-directional
Polarization	Vertical

PPN Cellular Amplifier

While there are many wireless cellular amplifiers on the market, for our purposes we want to use a 'direct connect' amplifier to reduce loss and latency when trying to boost low cellular coverage areas.

Frequency	Uplink: 824-849/1850-1920 Mhz; Downlink: 869-894/1930-1990Mhz
Input Impendance	50 ohm
Average Gain	19dB Cellular / 19 dB PCS
Maximum Gain	19dB
VSWR	<2:0
Standards Supported	• CDMA/WCDMA • GSM • EDGE • HSPA+ • EVDO • LTE
AC Power Transformer	Input: AC 100 -240V, 50-60 Hz Output: 5 – 15V
DC Power	12V
Maximum RF Output	1 Watt EIRP
Noise Figure	5dB
Cable	RG58
Dimensions	4.72" x 2.72" x 0.98"
Weight	0.57 lbs

APPENDIX C – GLOSSARY

APN (Access Point Name)
Identifies an IP packet data network, that a wireless mobile data user communicate with. An APN may also be used to define the type of service and the priority of that service. For example a group of users may setup a special APN for their RTK data that insures high priority and low latency vs. a generic APN which detects RTK data as a stagnant webpage and therefore lowers its priority and can even cause a loss of data. APN's are used in 3GPP data access networks like Bell, Telus and Rogers. CDMA networks do not use APN's as they always prioritize data on its own channel.

CDMA
Is a family of 3G mobile technology standards used primarily by Bell, Telus, Rogers, Sasktel and MTS. It uses CDMA channel access, to send voice, data, and signaling data between mobile phones and cell sites. The set of standards includes: CDMA2000 1X, CDMA2000 EV-DO Rev. 0, CDMA2000 EV-DO Rev. A, and CDMA2000 EV-DO Rev. B. All are approved radio interfaces for the ITU's IMT-2000. CDMA2000 has a relatively long technical history and is backward-compatible with its previous 2G iteration IS-95 (cdmaOne). The successor to CDMA2000 is LTE, part of the competing 3GPP family.

dGPS
A form of corrected GPS giving enhanced accuracy in the few decimeter range (better than standalone GPS, not as good as RTK). Several dGPS services are available ranging from Coast Guard Beacons, WAAS, LAAS, private and government operated CORS / Network GPS systems.

Encryption Mode
Encrypting your wireless network accomplishes two things: it helps keep out bandwidth hogs (i.e., your neighbours) who would otherwise use your Wi-Fi for free Internet, and it helps prevent intruders from 1breaking into your system to snoop around your PC. Because there are multiple encryption modes the question is then which is the best? Of course, most wireless routers have encryption turned off by default, so any choice you make is better than none at all.

The three prevailing standards for wireless encryption are described below:

- *WEP*: Wired Equivalent Privacy (or Wireless Encryption Protocol) is the original protection scheme included with early wireless routers, and it is also the weakest. With the right software, an intruder can easily break into a WEP-protected network in a few minutes using the Related-key attack. This is considered almost obsolete technology so use WEP only if you have older PCs or devices that don't support the newer types described below.
- *WPA*: Wi-Fi Protected Access was established as a stopgap measure to remedy the vulnerabilities in WEP. Specifically, the Temporal Key Integrity Protocol (TKIP), was brought into WPA. TKIP uses R64 encryption for securing data.
- *WPA2/PSK*: Also known as 802.11i or PSK for Pre-Shared Key, WPA2 is the completed form of WPA, and is considered the strongest nonproprietary encryption scheme for 802.11x wireless networks. WPA2 implements the mandatory elements of 802.11i. In particular, it introduces a new AES-based algorithm which is considered fully secure and better than TKIP.

GNSS
Global Navigation Satellite System - Generic term for systems such as GPS and Galileo.

GPRS
General Packet Radio Service - a non-voice data service for the mobile telephone network.

GPS
Global Positioning System - US owned positioning satellite constellation. Gives 10-20 m accuracy as standard.

GSM
Global System for Mobile communications - a non-voice data service for the mobile telephone network. Predates
GPRS and currently covers about 70% of the world mobile non-voice market.

NTRIP
The NTRIP "network" consists of three types of applications namely NTRIPClient, NTRIPServer and NTRIPCaster. The NTRIPCaster operates as a real server or splitter (HTTP) and the programs NTRIPClient and NTRIPServer act more like clients according to the classical internet communication that is usually based on the classic server / client principle (one or more servers share resources with users within a network). The communication between NTRIPServer and NTRIPCaster as well as NTRIPClient and NTRIPCaster is fully compatible HTTP 1.1. In case of losing the TCP (Transmission Control Protocol) connection between the described communicating system components (NTRIPServer-NTRIPCaster, NTRIPClient-NTRIPCaster) the involved TCP-sockets will recognize this and ensure a fully automated reconnection.

NTRIP "network" consists of
- NTRIPSources, generating DGPS and RTK data streams at specific locations
- NTRIPServers, transferring data from one or multiple sources to NTRIP
- NTRIPCaster, major broadcaster, integrated between data sources and data receivers

NTRIPSource ID's are called "mount points" so a NTRIPClient has the choice to select a mount point where he thinks this fits in best. To provide the NTRIPClient with suitable information the NTRIPCaster offers a list of mount points that is called the source-list. This source-list is maintained by the NTRIPCaster and provides the Client with a variety of attributes such as coordinates and format identifier. When an NTRIPClient requests a wrong mount point and/or no mount point is available, the NTRIPCaster answers by uploading a new source table via HTTP. The NTRIPClient gets new information via this new source-list, an eventual GNSS data stream is blocked due to no availability.

NTRIPSource
The NTRIPSource is a GNSS receiver that provides continuous GNSS data such as RTCM-104 corrections that refer to a known or specific location. A US organization, the Radio Technical Commission for Maritime Services (RTCM), works within a special Committee No. 104 (SC- 104) with standards for real time transfer of observations of satellite based navigation systems for differential applications. The special committee is responsible for RTCM standards for differential GNSS. The HTTP-based TCP protocol NTRIP is currently undergoing this procedure via the special committee No. 104 to become a worldwide standard.

NTRIPServer
In practice, the NTRIPServer is software running on a conventional PC that sends correction data from a GNSS receiver (COM-port) to a third installation (from NTRIPSource to NTRIPCaster). As an example NTRIP could be used within a virtual reference network where the protocol is able to transport RTCM data. The RTCM corrections could be taken into consideration at the user's approximate position. As an example this virtual reference station data is comparable with a NTRIPSource that could be transmitted by one of the NTRIP components, the NTRIPServer. As a summary the NTRIPServer transports GNSS data of an NTRIPSource (GNSS receiver) directly to the NTRIPCaster. Before doing this in the described way the NTRIPServer sends a request to the mountpoint via HTTP 1.1. After the connection is established the data can be sent via TCP/IP.

NTRIPCaster
The NTRIPCaster is in general a HTTP server and acts, as already described, as a broadcaster integrated between the data sources (NTRIPServer) and the data receiver (the NTRIPClients). The NTRIPCaster receives data streams from NTRIPServers (generated by NTRIPSources) and manages, for example, the handling of mount points for NTRIPSources, passwords, billing, and access. The NTRIPCaster is based on the GNU General Public License developed Icecast software (http://www.icecast.org/) that was originally developed to stream MP-3 data with bit rates from 32 kbit/s up to 128 kbit/s. The current NTRIPCaster used by the Federal Agency for Cartography and Geodesy (BKG) is designed for:

- DGNSS corrections (about 0.5 kbit/s per stream)
- RTK GPS corrections (about 5 kbit/s per stream)
- Raw GNSS receiver data (about 9 kbit/s per stream).

RTCM
Radio Technical Commission for Maritime Services - an industry standard format for GPS data exchange based on real-time data.

RTK
Real Time Kinematic - a form of corrected GPS giving accuracy down around 10 mm and requires both a base station (or virtual base station) and a rover usually within a distance of about 20 miles of each other.

VRS/CORS
The **Virtual Reference Station** (VRS) method extends the use of RTK to a whole area of a reference station network. Operational reliability and accuracy depend on the density and capabilities of the reference station network.

A **Continuously Operating Reference Station** (CORS) network is a network of RTK base stations that broadcast corrections, usually over an Internet connection. Accuracy is increased in a CORS network, because more than one station helps ensure correct positioning and guards against a false initialization of a single base station.