DATUM SYSTEMS

PSM-500 Application Note

Q7-IP Vyatta/Datum Quick Start Guide

Revision History
Rev 0.2   2-7-2012   Initial Release.
Rev 0.3   4-29-2012   Added initial configuration information.
Rev 0.4   5-6-2012   Expanded information, added common configuration.
Rev 0.5   5-18-2012   Minor additions and corrections.
Rev 0.6   6-4-2012   Add Vyatta and modem SNMP.

1.0   Q7 IP Interface Overview

The Datum Systems' PSM-500 series satellite modems (M500 series) can include optional IP – Ethernet based data interface cards. The M500 I-5 and GI-5 interfaces share a common processor consisting of an x86 based embedded computer on a module which is plugged into the interface card. The module itself is referred to here as a "Q7" because it follows a computer interface standard know as Q-seven. The Q7 is a complete x86 based embedded Linux computer including multiple interfaces typically found on common personal computers. The interface board with Q7 module is housed entirely within either the M500 satellite modem chassis. The smart IP interfaces based on the Q7 currently in production are:

1.   I-5 - M500 Modem High Performance IP Interface.
2.   GI-5 - M500 Modem Dual G.70s plus High Performance IP interface.

The purpose of the I-5 or GI-5 with Q7 processor is to act as an interface between IP Ethernet networks and satellite modems as part of point-to-point or point-to-multipoint data transfer. Since the software in both is almost identical this application note refers to both, although the G.703 functions are covered in a separate document.

The purpose of this Quick Start Guide is to simply get you started with IP interface cards that use the Q7 processor based platform for routing and bridging. Detailing the full capabilities of these IP cards is beyond the scope of this short guide. Our goal here instead is to:
1.   Introduce you to this card,
2.   Show initial set up the I-5 or GI-5 IP addresses allowing access for full configuration,
3.   Show a few initial Vyatta configuration methods.
4.   Show command line methods of modem control from these cards.

1.0.1   More about the Q7 Processor Cards

The Q7 Linux software starts life as a standard Vyatta Router which normally contains virtually all of a standard Debian OS overlaid with the Vyatta Router system. We modify both Debian and Vyatta for this application and also add modifications to support the M500 and M7 series of modems. The Vyatta Router provides an industry standard open source and very consistent router facility. The modem modifications consists of changes to the Linux/Debian drivers to support our custom embedded board and modem interface plus some changes to the Vyatta system and finally added programs specifically intended for monitor and control of the specific host modem. Everything added except some tweaks to the underlying kernel to aid in reboot is accomplished by standard Debian packages and the installed "apt" package management system. Users of Linux and Vyatta should feel comfortable in this environment while users standard routers should also adapt very quickly.

The Q7-IP provides the following features:

- ➢ Powerful x86 Atom processor based. Up to 1.6 GHz and dual virtual processors.

- ➢ Robust Debian Linux Operating System – currently modified Debian "Squeeze".

- ➢ Industry Standard Vyatta Router overlay on Linux for IOS/JunOS like control. One major advantage of Vyatta is that it provides a clean single point configuration interface and saved configuration file.

- ➢ Datum System's modifications and additions to both Linux and Vyatta providing modem command line and web control.

- ➢ Custom applications become relatively easy with multiple built-in user available programming languages including Bash, Perl, Python, C and C++ compilers.

Although more complex and expensive than the previous generation SnIP this system offers significant advantages. Not only does it use an industry standard router subsystem, but the full power of Debian Linux is available including many languages (like Python), standard compilers and the Debian packaging system which allow a user to install almost any program made for Linux. An installed system is even capable of compiling its own programs.

This Tech Note describes the basic resources and procedures necessary to initially install, configure, modify, and update the Q7 Vyatta system and Linux Kernel as necessary.

1.1   Naming Conventions Terms and Definitions

For the purposes of the remainder of this document the conventions for naming the different portions of the Linux operating system and technical terms are given below in short form. Almost everything here is standard terminology and more information is available on the web:

- "***Kernel and Kernel Space***". These refer to the Linux kernel itself and the modules that are compiled with the kernel to be loaded as part of the kernel. The current kernel is Version 2.6.35 minimum and some 3.x systems are in testing.
- "***User and User Space***" Multiple types of programs can exist in the user space. The user space is where all the files that a user can directly interact with reside. This includes the control programs and configuration files for the routing and bridging functions as created by Vyatta.
- "***Root Filesystem***" The Root Filesystem consists of the kernel modules not built into the kernel, common and user libraries and all of the user space programs and configuration. The Datum Systems' implementation is based on the Debian "Sqeeze" distribution of Linux with Vyatta router overlay and Datum Systems additions specific to satellite modem use.
- **"Packages"** are the Linux term for software programs and drivers. The entire Linux system consists of a small set of kernel and base programs with many packages added to provide the particular capabilities needed for its intended use. Most of the drivers and virtually all of the user space programs are packages. Packages can be installed removed and upgraded via the package manager. In the Q7 X86 card the package manager is named "APT" and common package functions are performed using the apt-get command line directives.
- **"Package Repository"** is a web location containing groups of packages which can be installed in the Linux system via the package manager. Two are necessary, the Vyatta repository and the Datum Systems repository although there are many more available including the standard Debian repository.
- **"I-5"** or **"GI-5"** These are the base IP interface cards for the M500 series modems. The Q7 processor is plugged into these base "carrier' cards as the processing element.
- **"LAN** and **WAN"** are terms for the Local Area Network and Wide Area Network interfaces standard on the I-5 or GI-5. The LAN is always the standard Ethernet TCP/IP

Gigabit Ethernet port (GbE) on the rear panel of the interface card. It's interface name is "**eth0**". The WAN is the internal custom interface port which connects to the modem. Because it appears to Linux and Vyatta as a standard Ethernet port its default name is "**eth1**", although that can be changed.

- **"Static** and **DHCP"** Are two possible ways of configuring the LAN side IP addresses and masks. By default the eth0 LAN is configured with a static IP address.
- **"Console** and **Terminal Sessions"** These refer to a command line connection to the I-5 or GI-5. The console is a standard serial RS-232 connection on the rear of the interface card which can be connected to a computer running a standard terminal emulation program such as Hyperterminal or Putty or Linux minicom and other programs. A terminal session is a more generic term and can refer to virtual terminal sessions connected via TCP/IP in either Telnet or SSH mode. Both present the standard Linux/Vyatta command line interface.
- **"Bridge"** is the standard network term for an OSI model Layer 2 process that is intended to connect two segments of the same LAN together having common IP addresses within the same LAN mask. The bridge function only looks at MAC addresses. A bridge can be compared to a smart switch.
- **"Router"** is the standard network term for Layer 3 processes intended to direct and control traffic in a transmission system between two or more networks with different addresses. It operates on the OSI Model Layer 3, working with IP Addresses. Commonly routing also includes the concepts of multiple processes including NAT, traffic shaping, QOS, etc.
- **"daemon"** is a term for a program that runs separately in the background and produces little or no output to any of the terminal sessions running, instead sending output to log files. There are a significant number of daemons always running in Linux, but in a sleep state waiting for some input that requires their attention.

2.0   Initial Installation and Configuration

A complete Debian-Vyatta-Datum Systems OS is installed at the factory, so software installation is normally not necessary. Instructions for re-installing the entire system is given at the end of this document if necessary.

It is highly advised that you also read the documentation at www.vyatta.org to get a feel for configuring and controlling the Vyatta router. Vyatta is a modern up to date router overlay on Linux comparable to Cisco or Juniper IOS and using similar language and procedures.

The following is a short list of initial configuration items:

1. Connect the two modems into your network as normal and turn on the modems. Modem parameters are configured as normal either via the front panel or remote methods. Make sure that you connect an Ethernet cable to the I-5 or GI-5, preferably with access to the Internet if you intend to download packages.
2. Wait approximately 1 to 2 minutes for the Q7 to boot completely. In the meantime determine and set your modem parameters on both ends. If you want to wait until later, the I-5 runs a full M500 series modem "m500ctl" command set and the GI-5 runs a full M7 series modem command set via the "mcl" command line program.

   On the modem front panel you use the "Intf" button, then scroll right to the "IO" column and select the mode as "Ethernet IP" (8). Scroll right one more column to "IP" will show "Q7". Scroll down to show and set the Q7 parameters.

3. **Setting the IP Address** - The I-5/GI-5 interface card is factory configured with a default static IP address, for example 192.168.2.130 or similar, which can be read on the modem front panel display in the interface section. If this is not within your network either set a new IP address on the modem front panel or log into the console port of the Interface board IG5 or GI-5 at: 9600,N,8,1 and use Vyatta to set an IP address.

Setting the LAN IP address on the modem front panel is the easiest method to get started with a new modem.- Simply navigate to the interface and scroll right to the IP column and then down until you see the listed IP address. Enter or edit to input the new desired IP address and press enter.

For later setting or resetting of IP addresses and all of the Vyatta configuration it is most easily done via the console or an SSH or telnet session To log in the default user is vyatta and the default password is vyatta. You can change these and add other users easily.

- The M500 modem IP address setting will not "save" but will **add** this new address to its current configuration. To remove the previously configured eth0 address you would go into the console as described below and use the configure command, but replace the "set" word by "delete" and save the configuration. Note that this requirement may change in the future to make a front panel change replace the current configured IP address.
- Alternately to enter a new address from the console in Vyatta type:

```
$ configure
# set interfaces ethernet eth0 address aaa.bbb.ccc.ddd/mask-prefix
# commit
# save
# exit
```

4. Once you have a working IP address you can then SSH into the I-5/GI-5 at this new set address. From any computer's command line you
   ssh vyatta@<ipaddress>.
   The default user is vyatta and the default password is vyatta.

5. Some sample Vyatta commands: Note the leading **"$"** prompt is shown in normal mode while the **"#"** prompt is shown when in "**configure**" mode.

```
$ show configuration – shows the full configuration.
$ configure – enter the configuration mode.
# show – shows the full configuration from configure mode.
# set – Set a parameter or variable.
# delete – Delete a parameter or variable.
# commit – commits or executes currently entered commands.
# save – Saves the currently committed configuration in the configuration file.
# exit – Leaves the configuration mode.
```

6. You will need to set up Vyatta for your network needs. The Vyatta command line interface is similar to both JunOS and Cisco IOS, but is unique. All the same functions however should be possible. Reading the Vyatta documentation is very helpful.

Note again that this initial configuration may result in the eth0 interface having two IP addresses in the M500 modem. If the default address is not needed it can be deleted using the form of the set interfaces command replacing the "set" with "delete". Alternately both IP addresses can be used, one for data and the other for monitor and control. Vyatta does not have a command to replace an IP address, only to add or delete.

M500 Modem Note: The setting of an IP address via the modem front panel goes through the same process as shown above except that it does not perform the "save" function. Save will save the full configuration to a file which is automatically loaded on boot. Therefore a modem IP address added via the modem front panel will not be restored on reboot unless the configure mode is entered and the configuration saved.

2.0.1   About LAN IP Addresses and Network Masks

The modem only displays a single IP address and mask for the LAN interface. Vyatta however is capable of having multiple IP addresses for each interface. Vyatta also enters and displays

network masks in the CIDR mask-prefix format – that is the class C mask of 255.255.255.0 is shown and entered as "/24". This mask-prefix refers to the number of leading 1's in the mask.

The standard operation of the M500 modem front panel entries is to replace the <u>first</u> address in the Vyatta configuration. If there is no address currently then the front panel entry will add that as the first address. The polling software does this by detecting the front panel change and first deleting the existing first address and then adding the new one entered. That is also the normal Vyatta method for replacing an IP address, delete the current and set (add) the new one.

In Vyatta if an interface is to get its IP address and mask via DHCP then its address is actually set to "dhcp". On the M500 modems there is no front panel "dhcp" parameter setting, so a Vyatta dhcp setting attempts to forward the obtained leased address to the modem's IP address parameter. If DHCP is then disabled it will retain the leased address. To set a new static IP address you enter the new desired address either on the front panel or in Vyatta's configure mode.

The comparable IP entries on the Modem front panel vs the Vyatta configuration are shown in the table below. In Vyatta a single configuration entry encompasses the 3 controls on the modem from panel of the M7. In the M500 Modem there is only the IP Address and Mask entries.

Vyatta Configuration	M500 Modem FP Display
Address: 192.168.2.131/24 [Optional additional addresses]	IP Address: 192.168.2.131 Mask: 255.255.255.0
Address: dhcp Note: DHCP lease address sent to modem.	IP Address: 192.168.4.109 Mask 255.255.255.0

2.1   Essential Initial Configuration Tasks

The Debian/Vyatta/Datum system is initially shipped with a default set of parameters including the standard user "vyatta" with password "vyatta", SSH enabled, a standard router complement including RIP BGP, several repository pointers and others. Additional configuration will probably be required to operate within your network topology.

The configuration is initially set up as a minimal router architecture. That is port forwarding is enabled and only static routing is enabled, but only set up for routing between the two modem internal WAN ports.

If your configuration is relatively simple, such as connecting a remote office via a satellite link then bridging may be the easiest configuration option. Bridges require that the network on both ends of the link share the same network mask. For most configurations more complex routing is probably the best connection type. Routing is Vyatta's specialty and much of their documentation centers around setting up sophisticated routing schema.

Currently one service is added to the Vyatta configuration suite – that is modem polling. To see all of the configuration settings you use Vyatta's "show configuration" command. Vyatta includes very good command completion much like Cisco IOS, so to use this command you could just type "sh" and the tab key which will complete the "show" with a space after it. If you hit the tab key again it will show all of the possible commands appropriate for show. If you type "conf" and tab again it will complete the command and then hitting Enter will show the current configuration. In Linux a display like this is long and includes methods of moving up and down via the arrows or page up and page down. The space bar works like page down and the "q" key quits.

Note in the "service" category there should be an entry for "modem poll". If it was not there then the method for enabling this, or other services would be similar to: Note that some short explanation is shown after the actual commands which are in bold.

$ configure – *enter the configuration mode.*

 # set service modem-poll

 # set other parameters desired.

 # commit – *commits or executes currently entered commands.*

 # save – *Saves the currently committed configuration in the configuration file.*

 # exit – *Leaves the configuration mode.*

2.2 Further Configuration

The default configuration does not include telnet, but SSH instead. To add telnet as an additional service you would follow the above configure process using the set command:

set service telnet

Most users will want to use a custom user name and password plus other values in their systems. Customization is relatively easy in Vyatta and the following is a sample of several parameters you may wish to set. Of course use your own values for all the parameters, e.g. replace <myname> with the short user name – maybe "lucy" and the password with your desired one.

```
$ configure
# set system gateway-address 192.168.15.1  //[use your gateway]
# set system name-server 205.171.3.25       //[use your own name-server]
# set system host-name test1
# set system time-zone US/Pacific
# set service https
# set system login user <myname> authentication plaintext-password mydoghasfleas
# set system login user <myname> full-name "Your Full Name"
# set system login user <myname> level admin
# commit
# save
# exit
$
```

In Vyatta all configuration involves going into the configure mode, setting or deleting parameters, committing those parameters and finally saving the changes to the configuration file. Vyatta offers a very complete set of commands allowing configuring the Q7 as a router or bridge with features such as filtering, fire-walling, QOS, NAT, etc. See the Vyatta documentation for more information.

2.2.1 Enabling SNMP

All versions of the Vyatta based software contain SNMP capabilities for the router and standard Linux control functions. Software from the factory after June 2012 also contains M500 Modem SNMP control capability. Modem SNMP functions can be added to earlier builds via the apt-get package manager by installing the "*m500-snmp*" package (See Section 3 on package management). The SNMP processing in the I5 is provided by the full Net-SNMP software set, currently version 5.6.1 and the modem control extensions are provided by an "AgentX" written in C.

The Datum Systems M500 modem MIBs are available on-line or directly from the I5 card when the m500-snmp package is installed. MIBs in the I5 are normally placed in the "/usr/share/snmp/mibs" folder.

To enable SNMP service in the I5, commands similar to the following would be used. These enable SNMP service and set a community name of "public" for reading and a community name of "private" for read and write operations. Normally you would replace the community names public and private with your own desired names.

```
$ configure
# set service snmp
# set service snmp community public
# set service snmp community public authorization ro
# set service snmp community private authorization rw
# commit
# save
# exit
$
```

The M500 modem MIBs and Net-SNMP agent is common to that used in the SnIP interface. The Application Note titled "*SnIP SNMP Guide*" available on the datumsystems.com web site contains additional information on their use. The Vyatta configuration procedures are however different.

2.2.1.1 Testing SNMP

As a quick check that SNMP is running properly on the I5 you can run a simple test from a terminal session, console, ssh or telnet. After enabling the SNMP service you should be able to get responses to the commands below. The first checks the IF::MIB function, whose MIB is loaded locally be default, and the second checks that the M500 modem SNMP agent is installed and running. To view the modem MIB parameters by name you must first load the appropriate MIB text files as shown. Both of these tests use the community name of "public" which may need to be replaced by the community name for reading that you have configured.

Currently Net-SNMP based MIB file names end in ".txt" and they use the Unix line ending of line-feeds only. Windows Notepad does not always show files with these line endings properly and another editor may be needed.

```
$ snmpwalk -v 2c -c public localhost interface
```

This second test will only work if the m500-snmp package is installed.

```
$ export MIBS=DATUM-GLOBAL-REG
$ export MIBS=DATUM-M500-MODEM
$ snmpwalk -v 2c -c public localhost modem
```

Since these are "walk" commands they will output a lot of information which will scroll by quickly.

2.3 Modem Configuration

Three modem control packages are installed by default and able to be updated. In the I-5 they are the "*m500-control*" and "*m500-web*" and "*m500-snmp*" packages. The control package contains a group of Linux user space programs necessary to communicate with the modem including a polling daemon that functions as a keep-alive to let the modem know it is present and ready. This package is necessary to the functioning of the web and snmp packages.

Web control of the modem is available via a browser by pointing to the LAN IP address of the Q7. Command line control is provided by the modem control language "m500ctl" command which is part of the m500-control package.

SNMP control of the modem is available via an external SNMP browser or the Net-SNMP command line programs. The modem's SNMP access are also provided by the modem control language "m500ctl" command which is part of the m500-control package.

2.3.1   M500 Modem Configuration

The I-5 interface uses a modem control language named "**m500ctl**".

To use m500ctl the general form of the command is:

```
$ sudo m500ctl [option switches] [unit-address] mnemonic-command [parameter]
```

The simplest form uses none of the optional elements in brackets [ ] which defaults to the address 0 and a request. An example would be:

```
$ sudo m500ctl us
```

which requests the Unit Status (us) from the modem with unit address 0, representing the modem that the Q7 is mounted within.

Some m500ctl commands for setting or reading common parameters might be as in the following examples:

```
$ sudo m500ctl mif 72500000 mil -185 mdr 2048000
```

Which would set the modulator transmit IF frequency to 72.5 MHz, the transmit level to -18.5 dBm and the transmit data rate to 2.048 Mbps.

To see a more complete list of usage information use the m500ctl with no parameters. To see a list of all of the available mnemonic-commands type "m500ctl -c". It is good practice to precede all m500ctl commands with "sudo" to act as a super user as required for serial port access.

The m500ctl protocol and usage is described in more detail in the "*SnIP Modem Control Guide*", which shares the control language with both the SnIP and the Q7 in an M500 modem.

3.0   *Updating the Software – the Package Manager*

Standard Linux packages that can either be included in the initial load and/or installed and updated in the factory or field via "apt-get". Adding or updating software depends on access to the Internet where the package repositories are located. Therefore to perform any of the following actions you must have a connection to the Internet. The standard form for showing if a package is currently installed might be:

```
$ aptitude show <package-name>
```

Once those packages are installed on the interface card, one can upgrade the packages by the commands:

```
$ sudo apt-get update
The next command should be used with caution as it might overwrite modem packages
$ sudo apt-get upgrade
```

Note that the update command does not update software, just the list of available packages.

To upgrade just one of our packages, or any single package you use the install method even though it is already installed. For example to update the m7-control package you simply say:

```
$ sudo apt-get install m5-control
```

There is an enormous amount of information available on the web on using the apt package manager as it is common to Debian, Ubuntu, Mint and many other Linux distributions.

3.6   Re-Installing the Software

If for some reason the kernel or filesystem is completely destroyed or a full system upgrade is required it is possible to relatively easily re-install the entire system from scratch. A minimum 4 GB USB flash drive is required for system installation in addition to the normal 4 or more GB flash drive supplied with the IP card.

The Datum Systems software is provided as a standard "ISO" file which could be loaded onto a CD ROM as a "live-CD" for installation, but the standard method is to load it onto a secondary USB flash drive that acts like a live-USB. First download the current Datum Systems ISO file from www.datumsystems.com

To create a live-USB drive from the Datum ISO file there are very good instructions on the Ubuntu main web site at
http://www.ubuntu.com/download/help/create-a-usb-stick-on-windows
or for Linux computers at
http://www.ubuntu.com/download/help/create-a-usb-stick-on-ubuntu

You will be substituting the downloaded Datum ISO name instead of the Ubuntu one however.

Next connect your computer's serial port or USB to serial adapter to the physical console port, dB9, on the I-5 or GI-5 card. The connection is at 9600,N,8,1.

With the modem turned off the live-USB created above is plugged into one of the rear panel USB ports on the I-5/GI-5 and all other USB drives are removed, then the modem is turned on and the Q7 is booted from that live-USB drive. This runs a system image that is fairly complete but not usable for anything but testing and installation because it does not store information. Next the final destination USB drive is plugged into the other USB port on the rear and the live session is used to install the system onto the destination drive. First we determine which is the drive just plugged in. Type:

```
$ ls /dev/sd*
```

Which should show two drives – one will be /dev/sda and /dev/sda1 which is the drive that you booted from. The second will probably be /dev/sdc which should be the drive you just inserted. You can verify this by now typing

```
$ dmesg | tail
```

which should show the last 10 log messages and should display some lines about a USB drive just inserted. They should also refer to sdc but it could be another letter depending on exactly how your system is set up. Just remember this drive designation – e.g. "sdc". You will use it when the installation asks which drive to use.

With that knowledge you type

```
$ install-system
```
 - Note on some later Vyatta setups it might not have the hyphen and be "install system" instead. Follow the instructions to put the system onto the sdc drive as the destination.

If a previously used USB drive is used for the destination then the install-system process will offer to recover and use the encryption keys and configuration files from the previous version. This is highly recommended to avoid having to re-enter everything. If you feel that any of that may have been corrupted or compromised then it is still easy to just start from scratch.

During installation several questions will be asked. Make sure that you answer sdc in the appropriate places. No data is written to the sda drive containing the live-USB.

After install is complete you can turn off the modem power and remove the live-USB. Then power on with only the newly created flash drive, log in and you're ready to go.

Have a look at the configuration and see if this version has the appropriate repository settings for the m5 modem series already configured. If not do the following

In Vyatta to be persistent the new Datum Systems repository is entered like this.

```
$ configure
# set system package repository modem
# set system package repository modem distribution m5
# set system package repository modem components main
# set system package repository modem url http://dsi-eng.com/packages/m5
# commit
# save
# exit
$ sudo apt-get update
$ sudo apt-get install m5-control
$ sudo apt-get install m5-snmp
```

After installation of the modem control software package, Vyatta must be configured to run the modem polling daemon beginning at start-up. This should have been recovered from the old configuration file if the install-system process found one during installation. You can determine if it is set by using the Vyatta "show configuration" command, and if it is not set then configure it using the following commands.

```
$ configure
# set service modem-poll
# commit
# save
# exit
$
```

End of Document.