Troubleshooting-Installing an RF link

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PLEASE READ THESE SAFETY PRECAUTIONS

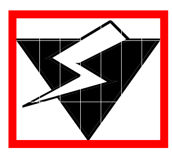
RF Energy Health Hazard

Professional installation required. The radio equipment described in this guide uses radio frequency transmitters. Although the power level is low, the concentrated energy from a directional antenna may pose a health hazard.

Use the following chart for determining the minimum safe distance. Do not allow people to come within the minimum safe distance of the antenna while the transmitter is operating.

Peak Gain of Antenna	Minimum Safe Distance
18 dBi	20 cm
20 dBi	20 cm
23 dBi	25 cm
25 dBi	32 cm
30 dBi	56 cm
37.6 dBi	135 cm

Protection from Lightning



Article 810 of the US National Electric Department of Energy Handbook 1996 specifies that radio and television lead-in cables must have adequate surge protection at or near the point of entry to the building. The code specifies that any shielded cable from an external antenna must have the shield directly connected to a 10 AWG wire that connects to the building ground electrode.

FCC Notice, USA

The AB-Access units comply with Part 15 of the FCC rules. Operation is subject to the following three conditions:

- This device may not cause harmful interference.
- This device must accept any interference received including interference that may cause undesired operation.
- Units with support for an external antenna must be professionally installed.

This device is specifically designed to be used under Part 15, Subpart E of the FCC Rules and Regulations. Any unauthorized modification or changes to this device without the express approval of Axxcelera Broadband may void the user's authority to operate this device. Furthermore, this device is intended to be used only when installed in accordance with the instructions outlined in this manual. Failure to comply with these instructions may also void the user's authority to operate this device and/or the manufacturer's warranty

Conditions specific to AB-Extender:

AB-Extender complies with Part 15 of the FCC rules. The device is specifically designed to be used under Part 15, Sub-part E of the FCC rules and regulations. Operation is subject to following conditions:

- The device to utilize a fixed mount antenna, for use on a permanent outdoor structure.
- The device to be installed by qualified installation/deployment personnel, and a minimum of 25 centimeters of separation must exist between the device and persons, when the device is operating.
- The device installers and operators should be aware of the transmitter operating conditions, specified in the AB-Extender installation manual and other associated user documentation, as well as the antenna co-location requirements of Part 1.1307 (b) (3), of FCC rules, pertaining to RF exposure.
- The device may not cause harmful interference.
- The device must accept interference received, including interference that may cause undesired operation.

The device is intended to be used only when installed in accordance with instructions outlined in this manual. Failure to comply with these instructions may void the user's authority to operate this device and/or the manufacturer's warranty. Furthermore, any unauthorized modification or changes to this device without the express approval of Axxcelera Broadband may also void the user's authority to operate this device.

CONTENTS

1 CHANGE HISTORY

REVISION	DATE	EDITOR	DESCRIPTION
Draft 1	14th Aug 2002	MOlson	First Draft
Draft 2	5th Nov 2002	DSida	Edits to section 3 (link status)
Draft 3	15th Nov 2002	MOlson	Numerous updates
Draft 4	20th Nov 2002	DSida	Edits to sections 7,8,9
Draft 5	2nd Dec 2002	DSida	Edits to sections 4,5,6
Draft 6	31st Mar 2003	MOlson	Updates for 5.2.x release
Draft 7	29th Apr 2004	Molson	Updates for 5.3.6
5.3.x, Rev 2	30th July 2004	JHiggs	Updated to include FCC and safety information

2 INTRODUCTION

This document's purpose is to help troubleshoot radio problems with the AB-Access and AB-Extender products. This document should only be used with System Software 5.1.5 or above, because some of the CLI commands described here are either different or not supported by earlier software revisions.

3 Aligning an SU

This section will discuss how align the antenna for optimal signal strength.

Line of Sight (LOS)

The first step is being able to see the tower or building the AP is mounted on. This should be possible in most deployments, however there could be times that you will not be able to see this far due to weather or you are unable to pick out the exact building or tower that the AP is mounted on. There for we described 2 methods to initially align an SU.

3.1.1 Eyeball alignment

The regular SU has a 20x20 (azimuth x elevation) so it usually very easy to eyeball the alignment. The extender SU has a 10x10 (azimuth x elevation) so it may be a little more difficult to align. This can be done by standing behind the unit while looking just over the top of the unit and adjusting the radio to point directly at the AP. As you can see in this picture the SU has been aligned by just eyeballing the tower. On the day this picture was taken there was a little bit of haze in the air so the tower is harder to see so it has been identified by a red circle. With the 20x20 antenna this is generally good enough to get a quality RSSI.

3.1.2 GPS/Compass alignment

A GPS (Global Positioning System) can be used to align the unit by taking a waypoint at the AP. This will allow you to get the proper bearing to the AP from the building the SU is on. Then by holding the GPS next the SU you can turn the SU to the proper bearing. This can also be done with a compass if the bearing has been defined by looking at a map. Or if the installer knows the general direction of the Access Point.

Note:

When purchasing a GPS make sure it has a digital compass, because if it doesn't the GPS compass is not accurate unless you are moving.

4 Fine tuning an SU

This section will discuss how to fine tune your SU alignment for optimal performance.

Fine tune alignment

The easiest and fastest way to fine tune the antenna is to look at the RSSI of the SU. This can be done by using the command *hmm modem rssi* repeatedly until you have found the best possible RSSI for the SU.

4.1.1 Procedure

Once you have either eyeballed or used a GPS to align the SU then you can use the following steps to fine tune the alignment.

1. Perform a link budget on the link with the spreadsheet provided by Axxcelera Broadband to determine the approximate RSSI that you should be receiving at the SU.
2. Telnet into the radio. This can be done from the terrestrial interface or can be done over the wireless interface if the radio is aligned close enough to get a signal that is good enough to pass some data. If you are going to telnet to the radio over the wireless link it is also a good idea to start a continuous ping to the radio. This will also help you to identify when the link is getting better or worse.
3. Type *hmm modem rssi* which will display the receive signal strength at the SU. This command can be repeated by simply typing period enter. The RSSI is highlighted in yellow below. For more information on the modem rssi command refer to Modem RSSI section.

```
192.168.4.2> hmm modem rssi
mean actual RX chain attenuation          +11.556 dB demod gain stage IN
actual RX gain                            +80.950 dB
baseband gain                             +6.000 dB
RSSI                                -75.394 dBm Fade margin too low
192.168.4.2> .
mean actual RX chain attenuation          +11.094 dB demod gain stage IN
actual RX gain                            +80.950 dB
baseband gain                             +6.000 dB
RSSI                                -75.856 dBm Fade margin too low
192.168.4.2> .
mean actual RX chain attenuation          +11.094 dB demod gain stage IN
actual RX gain                            +80.950 dB
baseband gain                             +6.000 dB
RSSI                                -75.856 dBm Fade margin too low
192.168.4.2>
```

4. Now have the installer slowly turn the SU on its horizontal axis in one direction one degree at a time. While you are continuously checking the RSSI.
5. If the RSSI gets worse have him stop and start turning it the other direction following the same procedure as in step 4.

6. Once you have located the bearing of the best RSSI tighten the screws that allow the radio to turn on the horizontal axis.
7. Now have the installer slowly tilt the SU on the vertical axis (tilt bracket is required for vertical axis adjustments). While you are continuously checking the RSSI.
8. If the RSSI gets worse have him stop and start tilting it the other direction following the same procedure as in step 7.
9. Once you have located the proper up tilt or down tilt on the SU for the best RSSI, tighten the screws that allow the tilt bracket to pivot on the vertical axis.

Note:
If the vertical or horizontal alignment is way off when you start with step 4 you may have to try changing both the horizontal and vertical axis at once until you can get a signal that you can start adjusting from.

5 SU signal quality

After you have adjusted the SU to receive a good RSSI you will want to look at the quality of the signal. This is done by using a few commands at the SU.

Procedure

1. Check the quality of the signal (not the strength) by looking at the *hmm modem mmse*. This take 1000 samples of the modem mean square error rate, and report the average and the number of samples over 50. See chart below to identify if out is good or bad. For more information on the hmm modem mmse command refer to Modem mmse section.

```
192.168.3.254 hmm> modem mmse
running please wait
0 out of 1000 mse's > threshold 50
mse average 15
```

Status	Average Value	Samples over 50
Good	<20	0
Marginal	20-35	1-30
Poor	35-50	30-50
Bad	>50	>50

2. Check the PER (Packet Error Rate) by looking at the *hmm mac stats*. The numbers themselves don't actually tell you anything it is the number rxmissed and rxbad versus the number rxok for the downlink. For the uplink look that the number of CELL TX versus the number of CELL tx (next row on left side highlighted in yellow). For information on what each column means refer to the Troubleshooting an RF Link document. For more information on the hmm mac stats command refer to the Mac stats section.

```
192.168.3.254 hmm> mac stats
                        RXOK  RXMISSED   RXBAD     TX
   FDHDR:         111296          0          0        0
     RGR:         111296          0          0     3294
     ACK:           3575          0          0     3564
    CELL:           9732          0          0     9877
tx 9877, inseq 9732, miss 0, dup 0
ticks (20mS) since last: utopia tx 0, utopia rx 0, FDHDR RXOK 0
free list: head 921 tail 253 (delta 668)
```

3. C

heck the Path loss in excess of Free Space Loss by looking at the *hmm link status* command. This calculation is a result of the difference between the expected RSSI that the SU and the actual RSSI of the SU. This should be no greater than 10 dB and should be as close to 0 as possible. Any number around 5 is just fine though. For more information on the hmm link status command refer to the Link status section.

NOTE:

If you are using anything other than the normal SU antenna that has a gain of 18 dBi you will need to account for the difference in antenna gain yourself. For example if you have an Extender SU with a 23 dBi antenna you will need to add 5 dB to the number, so the example would be 10.2 dB and not 5.2 dB. It also assumes that the SU and AP are set to transmit at the same power. If no modifications have been made to the channels.conf (international customers only) this is not a problem. If the AP and SU are not the same you will need to take into account these differences in the calculation.

```
192.168.3.254 hmm> link status
MAC type                                  Subscriber Unit
Unit MAC address                          00:C0:69:0C:52:24
Channel                                   0 horizontal
Radio Channel Mask                        7fff
Correlation sequence                      detected
MAC delay compensation                    successful (5586 metres)
Unit Range                                4.2 km
Base Station ID                           0
Radio temperature                         32 degC (OK)
RSSI                                      -68.7 dBm (Strong signal)
Path loss in excess of FSL (estimate)     5.2 dB
Downlink RSSI Fade Margin (estimate)      12.9 dB (ideal > 10.0 dB)
TX maximum backoff                        6.0 dB
TX current backoff                        0 dB
Max TX power for channel                  1.0 dBm
Actual TX power                           -7.6 dBm
Averaging MAC error rates over            2 seconds....
Downlink Header Error Rate                0.00 % (OK)
Downlink Cell Error Rate                  not available
Uplink Cell Error Rate                    not available
Registration mode                         static
Radio Link Status                         GOOD
one or more error rates not available,
for a more accurate report increase cell
rate or duration of test
```

6 Troubleshooting SU link from AP

This section will show you how to identify an SU that is having problem from an AP.

Identify SU

The *hmm mac stats* of the AP can identify that there is a problem in the sector, but is unable to identify which SU is having a problem. Follow the steps below to identify which SU is having a problem.

1. To identify a problem SU you can use the pnms sector command which will give you 5 vital statistics for each SU in the sector. You will be able to identify the SU that is having a problem by the IP address. For more information on this command refer to PNMS Sector section.

```
192.168.2.2> pnms sector 5

Sector Status
------------

MID search : 1 2 3 4 5

IP address          RSSI                      downstream   upstream
                min       max        now       error %      error %
192.168.2.254  -45.738  -45.738   -45.738     0.132        0.000
192.168.3.254  -75.143  -74.811   -75.032     0.020        0.001
```

2. Another command that can be used to identify an SU that is having problems is the *bun list channels* command. This command displays the packet count on a per PVC basis. For more information on this command refer to Bun list channels section. As you can see in the example below the SU with MID 3 is having a small problem. The PVC 0/768 which is for MID 3 has received 10 packets out of 168 with errors.

```
192.168.100.200> bun list channels
Port atm25i
 0: Enabled: true  TxPkts: 0     RxPkts:  0/0     TxVPI/VCI:  0/0    RxVPI/VCI:  0/0
 1: Enabled: true  TxPkts: 0     RxPkts:  0/0     TxVPI/VCI:  0/0    RxVPI/VCI:  0/0
 2: Enabled: true  TxPkts: 0     RxPkts:  0/0     TxVPI/VCI:  0/0    RxVPI/VCI:  0/3
 3: Enabled: true  TxPkts: 0     RxPkts:  0/0     TxVPI/VCI:  0/0    RxVPI/VCI:  0/4
Port atm25m
 0: Enabled: true  TxPkts: 0     RxPkts:  0/0     TxVPI/VCI:  0/0    RxVPI/VCI:  0/0
 1: Enabled: true  TxPkts: 0     RxPkts:  0/0     TxVPI/VCI:  0/0    RxVPI/VCI:  0/0
 2: Enabled: true  TxPkts: 0     RxPkts:  0/0     TxVPI/VCI:  0/0    RxVPI/VCI:  0/3
 3: Enabled: true  TxPkts: 0     RxPkts:  0/0     TxVPI/VCI:  0/0    RxVPI/VCI:  0/4
 4: Enabled: true  TxPkts: 127   RxPkts:  168/10  TxVPI/VCI:  0/768  RxVPI/VCI:  0/768
Port ciao does not support channel access
Port Ethernet
 0: Enabled: true  TxPkts: 723   RxPkts:  793/0
```

3. Once you have identified the SU you can focus on troubleshooting that particular SU. Refer to section Fine tuning an SU and SU signal quality for pointers on what to look for while troubleshooting an SU.

7 Link status

The link status command will display the most common information needed to characterize how a radio link is performing.

The command is implemented on both APs and SUs. However, some of the information is subtly different between the two unit types.

AP Link Status

192.168.100.200 hmm> link status

MAC type	**Access Point**
Unit MAC address	**00:C0:69:0C:52:2F**
Channel	**0 horizontal**
Radio Channel Mask	**7fff**
Base Station ID	**0**
Radio temperature	**38 degC (OK)**
TX maximum backoff	**6.0 dB**
TX current backoff	**0 dB**
Max TX power for channel	**1.0 dBm**
Actual TX power	**0.9 dBm**
Averaging MAC error rates over	**2 seconds....**
Aggregate Downlink Cell Error Rate	**0.00 % approx (OK)**
Aggregate Uplink Cell Error Rate	**0.00 % (OK)**

7.1.1 MAC type

MAC type displays what type of MAC is loaded on the unit: either AP or SU.

7.1.2 Unit MAC address

Unit MAC address displays the unit's physical MAC address which is a 12 digit hexadecimal number.

7.1.3 Channel

Channel identifies which channel and polarization the unit is set to.

7.1.4 Radio Channel Mask

Radio Channel Mask displays the current channel mask. This is not relevant to an AP, and can be ignored.

7.1.5 Base Station ID

Base Station ID is not currently used and can be ignored.

7.1.6 Radio Temperature

Radio Temperature displays the internal temperature of the radio in degrees Celsius. It is followed by an indicator to tell you if the temperature is acceptable. Possible indicators are good, marginal and bad.

7.1.7 TX maximum backoff

TX maximum backoff displays the maximum system backoff that can be placed in the system.conf file for a given band.

7.1.8 TX current backoff

TX current backoff displays the system backoff that is currently in the unit. This number is defined by the value set in the system.conf file. Axxcelera recommend that the AP and all SUs in a sector have the same backoff value.

7.1.9 Max TX power for channel

Max TX power for channel displays the maximum power in dBm that can be transmitted from the radio. The power limits set by the FCC are; high band = +14dBm, mid band = +8dBm, low band = +1dBm.

7.1.10 Actual TX power

Actual TX power is the power level that the radio is actually transmitting at. For an AP this should be very close, but slightly below the Max TX power value. It should fluctuate by less than 0.5dB over time.

7.1.11 Averaging MAC error rates over <period>

Averaging MAC error rates over <period>, displays the number of seconds during which the MAC stats are calculated. The default is 2 seconds, but this can be changed by adding the number of seconds desired to the link status command (i.e. "link status 10"). Be careful not to put to large of number here because the console is locked while these calculations are taking place.

7.1.12 Aggregate Downlink Cell Error Rate

Aggregate Downlink Cell Error Rate is the downlink cell error rate for the entire sector. This is displayed in % and for an AP it is based on **CELL TX** and **tx** values from the AP's MAC stats. It is followed by an indicator to tell you if the aggregate error rate is acceptable (although individual AP-SU links may still have unacceptable error rates). It is actually measuring the downstream cell retransmission rate, and downstream cell retransmissions can be caused by either a downstream or upstream radio problem. From the AP link status command alone it is not possible to determine which AP-SU radio link/links is/are having a problem. A high value for this measurement simply means that at least one radio link supported by that AP has a problem.

7.1.13 Aggregate Uplink Cell Error Rate

Aggregate Uplink Cell Error Rate is the uplink cell error rate for the entire sector. This is displayed in % and is based on **CELL RXOK**, **RXMISSED**, and **RXBAD** values from the AP's MAC stats. It is followed by an indicator to tell you if the aggregate error rate is acceptable (although individual SU-AP links may still have unacceptable error rates). This is actually measuring the percentage of cells received in error, and this type of error indicates an upstream radio problem. From the AP link status command alone it is not possible to determine which AP-SU radio link/links is/are having a problem. A high value for this measurement simply means that at least one radio link supported by that AP has an upstream problem. The Aggregate Uplink Cell Error Rate measurement is a more sensitive indicator of upstream radio problems than the Aggregate Downlink Cell Error Rate measurement.

SU Link Status

```
192.168.3.254 hmm> link status
MAC type                                Subscriber Unit
Unit MAC address                        00:C0:69:0C:52:24
Channel                                 0 horizontal
Radio Channel Mask                      7fff
Correlation sequence                    detected
MAC delay compensation                  successful (5586 metres)
Unit Range                              0.0 km
Base Station ID                         0
Radio temperature                       32 degC (OK)
RSSI                                    -68.7 dBm (Strong signal)
Path loss in excess of FSL (estimate)   35.2 dB
Downlink RSSI Fade Margin (estimate)    12.9 dB (ideal > 10.0 dB)
TX maximum backoff                      6.0 dB
TX current backoff                      0 dB
Max TX power for channel                1.0 dBm
Actual TX power                         -7.6 dBm
Averaging MAC error rates over          2 seconds....
Downlink Header Error Rate              0.00 % (OK)
Downlink Cell Error Rate                not available
Uplink Cell Error Rate                  not available
Registration mode                       static
Radio Link Status                       GOOD
one or more error rates not available,
for a more accurate report increase cell
rate or duration of test
```

7.1.14 MAC type

MAC type displays what type of MAC is loaded on the unit: either AP or SU.

7.1.15 Unit MAC address

Unit MAC address displays the unit's physical MAC address which is a 12 digit hexadecimal number.

7.1.16 Channel

Channel identifies which channel and polarization the unit is set to.

7.1.17 Radio Channel Mask

Radio Channel Mask displays the current channel mask. The channel mask determines which channels will be scanned in dynamic mode and when the survey web page is used.

7.1.18 Correlation sequence

Correlation sequence displays whether or not the SU modem has detected a downstream burst (the "training/correlation sequence") from the AP modem. This has to happen before the MAC can delay compensate. If the correlation sequence is un-detected you will never get a RF link. The SU can correlate even when the received signal is too weak to decode the rest of the burst. Failure to correlate indicates that the SU cannot detect the presence of an AP. This may be caused by the AP being off-line, an AP-SU alignment or line-of-sight problem, the AP and SU operating on different channels or polarisations, or a major error in the SU software configuration or hardware.

7.1.19 MAC delay compensation

MAC delay compensation will inform you if the MAC has delay compensated. It will also display the distance in metres that it had to back itself off to appear at the edge of the sector. The delay compensation value is inversely related to the AP-SU separation.

7.1.20 Unit Range

Unit Range displays the distance that the SU is from the AP in km. This measurement is based on the delay compensation value and is only an approximate value.

7.1.21 Base Station ID

Base Station ID is not currently used and can be ignored.

7.1.22 Radio Temperature

Radio Temperature displays the internal temperature of the radio in degrees Celsius. It is followed by an indicator to tell you if the temperature is acceptable. Possible indicators are good, marginal and bad.

7.1.23 RSSI

RSSI is the Receiver Signal Strength Indicator, and is displayed in dBm. It is followed by an indicator to tell you if the signal strength is acceptable.

7.1.24 Path loss in excess of FSL (estimate)

This shows the path loss (dB) in excess of the expected free-space loss (FSL) for the AP-SU distance. This value is approximately 0dB for a perfectly aligned AP and SU, regardless of the AP-SU distance. Although the RSSI may be strong, a high value here may indicate that the SU and AP are not well aligned and the quality of the RF link may be compromised as a result. A value greater than 10dB should cause concern. Possible causes are the AP and SU set to opposight polarisations, obstructed line-of-sight, SU lying outside the main RF beam from the AP (either horizontal or vertical planes), or the SU antenna being misaligned with the AP. The calculation of this value relies on the AP and SU having the same system backoff, and the AP and SU having the same channels.conf file (where applicable). A very high value here can also indicate a hardware fault.

7.1.25 Downlink RSSI Fade Margin

The Downlink RSSI fade margin is the amount by which the RSSI can fall (in dB) before the radio link will fail totally. The minimum fade margin recommended by Axxcelera is 10dB, although units at maximum range will have slightly less than this at best. Although the radio link will still work, the RF error rates rise sharply when the fade margin drops below approximately 5dB. Operating SUs with a fade margin below 10dB may compromise the quality of the radio link in a noisy environment.

7.1.26 TX maximum backoff

TX maximum backoff displays the maximum system backoff that can be placed in the system.conf file for a given band.

7.1.27 TX current backoff

TX current backoff displays the system backoff that is currently in the unit. This number is defined by the value set in the system.conf file. Axxcelera recommend that the AP and all SUs in a sector have the same backoff value.

7.1.28 Max TX power for channel

Max TX power for channel displays the maximum power in dBm that can be transmitted from the radio. The power limits set by the FCC are; high band = +14dBm, mid band = +8dBm, low band = +1dBm.

7.1.29 Actual TX power

Actual TX power is the power level that the radio is actually transmitting at. For an SU it is dependent on the received signal strength (inversely related to RSSI), and can be anything from the Max TX power value down to 58dB below the Max TX power. The value will fluctuate over time with changes in RSSI. If the Actual Tx power rises to within 2dB of the Max TX power then the RSSI on the SU is probably too low, and the upstream radio link may be unreliable at times.

7.1.30 Averaging MAC error rates over <period>

Averaging MAC error rates over <period>, displays the number of seconds during which the MAC stats are calculated. The default is 2 seconds, but this can be changed by adding the number of seconds desired to the link status command (i.e. “link status 10”). Be careful not to put to large of number here because the console is locked while these calculations are taking place.

7.1.31 Downlink Header Error Rate

Downlink Header Error Rate is the FDHDR (Frame Descriptor Header) error rate for a specific AP-SU radio link. This is displayed in % and is based on **FDHDR RXOK**, **RXMISSED**, and **RXBAD** from the SU’s MAC stats. It is only applicable to SUs. It is followed by an indicator to tell you if the error rate is acceptable. A high FDHDR error rate indicates a downstream radio problem between the AP and this specific SU. It may be caused by a problem with received signal strength or quality, or a problem with the AP transmitter or SU receiver.

7.1.32 Downlink Cell Error Rate

Downlink Cell Error Rate is the downlink cell error rate for a specific AP-SU radio link. This is displayed in % and is based on **CELL RXOK**, **RXMISSED**, and **RXBAD** from the SU's MAC stats. It is followed by an indicator to tell you if the error rate is acceptable. This is actually measuring the percentage of cells received in error, and this type of error indicates a downstream radio problem. A high downlink cell error rate may be caused by a problem with received signal strength or quality, or a problem with the AP transmitter or SU receiver.

7.1.33 Uplink Cell Error Rate

Uplink Cell Error Rate is the uplink cell error rate for a specific SU-AP radio link. This is displayed in % and is based on **CELL TX** and **tx** from the SU's MAC stats. It is followed by an indicator to tell you if the error rate is acceptable. It is actually measuring the upstream cell retransmission rate, and upstream cell retransmissions can be caused by either an upstream or downstream radio problem. However, the Downlink Cell Error Rate measurement is a more sensitive indicator of downstream radio problems than the Uplink Cell Error Rate measurement. A high uplink cell error rate may be caused by a problem with signal strength or quality when the signal from the SU is received by the AP, a problem with the SU transmitter or the AP receiver, or a downlink problem.

8 Modem RSSI

RSSI is the Receiver Signal Strength Indicator for an SU, and is displayed in dBm. RSSI is not available on an AP, because all SUs transmit so that there signal is received at the AP in the range of -71 to -78. The RSSI is displayed by the "hmm modem rssi" command, but is also displayed by the "hmm link status" and "hmm modem txpower" commands.

SU Modem RSSI

192.168.3.254 hmm> modem rssi

mean actual RX chain attenuation	**+35.375 dB demod gain stage OUT**
actual RX gain	**+80.100 dB**
baseband gain	**+6.000 dB**
RSSI	**-50.725 dBm Strong signal**

Of the four numbers reported by the "hmm modem rssi" command, only one - the "RSSI" – is of any real value for debugging RF problems.

8.1.1 mean actual RX chain attenuation

The amount of attenuation placed in the receive path, to prevent the receiver from being overloaded. When the SU is receiving no signal, it has maximum receiver gain, so the mean actual RX chain attenuation would be 0dB. (The RSSI would typically be –85dBm when no signal is received).

8.1.2 actual RX gain

This is the total amount of RX gain in the radio. This is deduced from the calibration data for each radio. This number is of no practical use.

8.1.3 baseband gain

This is the total amount of baseband gain in the radio. This is a constant, and is of no practical use.

8.1.4 RSSI

Receiver Signal Strength Indicator displayed in dBm. It is followed by an indicator to tell you if the signal strength is acceptable. The RSSI is calculated by adding the total gain and subtracting it from the attenuation:-

RSSI = mean actual RX chain attenuation - (actual RX gain + baseband gain)

9 Mac stats

The MAC stats show the RF-link statistics. It is one of the primary tool for diagnosing RF-problems. The "hmm link status" command reports some error rates based on the MAC stats, but these are sampled over a very short period of time, and only show the performance at that instant. In contrast, the "hmm mac stats" command can be used to look at average error rates over any period of time. Between them the MAC stats and the Modem RxDC stats (see section 15) will show the presence of either intermittent or permanent RF problems, and will give an indication of the likely causes. Other commands may then be required to pin-point the exact cause.

AP MAC Stats

The following MAC stats example is for an AP with perfect RF links to all SUs. ***(Note - in this example ping traffic was being sent, so the number of cells transmitted and received are equal).***

```
192.168.100.200 hmm> mac stats
                      RXOK   RXMISSED    RXBAD       TX
        FDHDR:           0          0        0   134296
          RGR:        4502          0        0   134296
          ACK:        4887          0        0     4822
         CELL:       13506          0        0    13506
tx 13506, inseq 13506, miss 0, dup 0
ticks (20mS) since last: utopia tx 0, utopia rx 0, FDHDR RXOK 237065
free list: head 141 tail 493 (delta 671)
```

Definition of terms

Acronym	Interface	Description
FDHDR	Air interface	Frame Description Headers (1 per frame at start of frame). Downlink only.
RGR	Air interface	Reservation Grant (downlink) or Reservation Request (uplink)
ACK	Air interface	Acknowledgements (downlink or uplink)
CELLS	Air interface	ATM traffic cells (downlink or uplink)
RXOK	Air interface	Correctly received, no errors
RXMISSED	Air interface	Expected, but not received (correlated, but sync word was wrong).
RXBAD	Air interface	Something was received with a CRC failure
TX	Air interface	ATM cells sent over RF link (includes re-tranmissions)
tx	UTOPIA interface	ATM cells entering MAC to be sent on air interface (excludes retransmissions)
inseq	UTOPIA interface	ATM cells received with expected sequence number
miss	UTOPIA interface	ATM cells received with sequence number wildly out
dup	UTOPIA interface	ATM cell received with sequence number too low (indicates a duplicated cell, i.e. one that was retransmitted over the RF link, but was received both times).

ticks	UTOPIA interface	# of 20 mS ticks since last received…
Utopia tx	UTOPIA interface	# of ticks since the last cell was transmitted from the UTOPIA interface (to the air interface)
Utopia rx	UTOPIA interface	# of ticks since the last cell was received at the UTOPIA interface (from the air interface)
FDHDR RXOK	UTOPIA interface	# of ticks since the last FDHDR was received OK from the air interface
Free list	UTOPIA interface	Relates to internal pointers, and is not relevant to this document.
Head	UTOPIA interface	Relates to internal pointers, and is not relevant to this document.
Tail	UTOPIA interface	Relates to internal pointers, and is not relevant to this document.
Delta	UTOPIA interface	Relates to internal pointers, and is not relevant to this document.

Interpreting AP MAC Stats

9.1.1 FDHDR

FDHDR stands for Frame Description Header. These are only transmitted from an AP, and are received by all SUs in the sector.

9.1.1.1 RX

FDHDR RX counter should not increment on an AP. However, some receive errors cannot be correctly identified by the AP, and as a result the FDHDR RXOK counter is incremented. The FDHDR RXOK count therefore represents errors. The AP MAC cannot decode FDHDRs, so this count does not mean that FDHDRs are being received.

9.1.1.2 TX

This is the number of FDHDR transmitted since the MAC stats were last reset. The FDHDR TX count should increase by about 10,000 per second, but it depends on the traffic loading and the type of MAC used (i.e. 5.6km, 8.0km or 11.4km).

9.1.2 RGR

Reservation (Grant) Request (Rx) / Reservation (Grant) Request Acknowledgement (Tx)

9.1.2.1 RX

Reservation Request received from an SU. This is one method the SU can use to request upstream bandwidth. (The other method is to piggy-back requests on to cells sent upstream. Piggy-backed requests do not appear in the MAC stats).

9.1.2.2 TX

Reservation Request Acknowledgment sent to an SU, in response to receiving a Reservation Request from that SU. Upstream bandwidth may be granted to the SU in the same frame, but doesn't have to be.

9.1.3 ACK

(Cell) Acknowledgement

9.1.3.1 RX

Acknowledgements received from the SU. These are generated by the SU when it receives a valid cell or cells in the downstream portion of the frame.

9.1.3.2 TX

Acknowledgements transmitted by the AP. These are generated by the AP when it receives a valid cell or cells from an SU in the upstream portion of the previous frame.

9.1.4 CELLS

CELLS are the number of ATM CELLS that have been transmitted from, or received by the MAC, and carried by the RF link.

9.1.4.1 RX

RX cells are cells that are received by the AP from all SUs. These counts include duplicate cells (i.e. . the relevant count is incremented every time a cell is received over the RF link, regardless of whether it is a new cell, or a duplicate - one that was retransmitted by an SU and received more than once).

9.1.4.2 TX

TX cells are cells that are transmitted from the AP to all SUs. This count includes cell retransmissions (i.e. the count is incremented every time a cell is sent over the RF link, regardless of whether it is a new cell, or a retransmission).

9.1.5 tx

The tx is the number of ATM cells entering the MAC from the Helium processor, to be sent downstream on the air interface. This does not include retransmissions: it is the number of unique cells that need to pass over the air. This number may be significantly less that the CELL TX count (see above).

The aggregate downstream cell retransmission rate (i.e. average for all AP-SU links) can be calculated approximately from the “tx” and “CELL TX” counts, as follows:

Aggregate Downstream Cell re-transmission rate = ((CELL TX – tx) / tx) x 100%

The result is dependent on the traffic to each SU. A value of 0% means that cells are only sent once, a value of 100% means that on average each cell is sent twice, and a value of 500% means that every cell is sent six times - the maximum.

Note – This formula is only valid for a large number of cells (minimum recommended = 10000), because of a 64 cell buffer that can distort the cell re-transmission calculation for small numbers of cells.

9.1.6 inseq

The “inseq” count is the number of ATM cells that the UTOPIA interface has received from the MAC for this MID (i.e. MID 0 for the AP). This number represents the number of unique, error-free ATM cells that the AP has received in the correct sequence. For an AP this number should be close to the number of CELL RXOK, although it will probably be slightly lower.

9.1.7 miss

The “miss” count represents the number ATM cells the UTOPIA interface has received with the sequence number wildly out. These represent errors. The missed count is usually close to zero, and should be orders of magnitude lower than the inseq count.

9.1.8 dup

The "dup" count represents cells that have been received with their sequence number to low, i.e. cells that have been received multiple times (because they were re-transmitted over the RF link). There are two mechanisms that cause duplicates; CELL errors and ACK errors. These are described below.

Duplicates caused by CELL errors

Up to 6 cells can be sent from any unit in a single burst. If the last cell is received in error, then only that cell will be repeated in another frame. However, if the first cell is received in error, then all of the cells in that burst will be repeated in another frame (i.e. six cells may be resent, even though the last five were received correctly). This results in duplicates. If the errored cell is in the middle of the burst, then cells from that one on will be retransmitted.

Duplicates caused by ACK errors

Another cause of duplicates is failure of the ACKs to be received at the other end of the RF link. All cells may be received correctly, but if the ACKs sent as a result of receiving the cells are not received correctly by the other unit then all the cells will be resent. This results in duplicates.

A high duplicate count but low CELL RxMissed and CELL RxBad counts indicates ACK problems at the other end of the link (i.e. at one or more SU receivers). If the majority of SUs have high duplicate counts then the problem may lie with the AP transmitter.

SU MAC Stats

The following MAC stats example is for an SU with a perfect RF link. In this example there is only one SU (so the CELL RXOK and inseq counts are identical).

```
192.168.3.254 hmm> mac stats
                    RXOK  RXMISSED    RXBAD     TX
   FDHDR:         111296         0        0      0
     RGR:         111296         0        0   3294
     ACK:           3575         0        0   3564
    CELL:           9732         0        0   9877
tx 9877, inseq 9732, miss 0, dup 0
ticks (20mS) since last: utopia tx 0, utopia rx 0, FDHDR RXOK 0
free list: head 921 tail 253 (delta 668)
```

Interpreting SU MAC Stats

9.1.9 FDHDR

FDHDR stands for Frame Description Header. These are only transmitted from an AP, and are received by all SUs in the sector.

9.1.9.1 RX

This is the number of FDHDRs received since the MAC stats were last reset. The total of the FDHDR RX counts should increase by about 10,000 per second, but it depends on the traffic loading and the type of

MAC used (i.e. 5.6km, 8.0km or 11.4km). The FDHDR error rate should be less than 1/10000 for a good link. Between 1/10000 and 1/1000 is marginal, and an error rate higher than 1/1000 is bad.

9.1.9.2 TX

The FDHDR TX counter should never increment because an SU cannot transmit FDHDRs.

9.1.10 RGR

Reservation (Grant) Request (Rx) / Reservation (Grant) Request Acknowledgement (Tx)

9.1.10.1 RX

Reservation Request Acknowledgment received by the SU. This is sent by the AP in response to it receiving a Reservation Request from the SU. Upstream bandwidth may be granted to the SU in the same frame, but doesn't have to be.

9.1.10.2 TX

Reservation Request sent to the AP from an SU. This is one method the SU can use to request upstream bandwidth. (The other method is to piggy-back requests on to cells sent upstream. Piggy-backed requests do not appear in the MAC stats).

9.1.11 ACK

(Cell) Acknowledgement

9.1.11.1 RX

Acknowledgements transmitted by the SU. These are generated by the SU when it receives a valid cell or cells from the AP in the downstream portion of the frame.

9.1.11.2 TX

Acknowledgements received from the AP. These are generated by the AP when it receives a valid cell or cells from the SU in the upstream portion of the previous frame.

9.1.12 CELLS

CELLS are the number of ATM CELLS that have been transmitted from, or received by the MAC, and carried by the RF link.

9.1.12.1 RX

RX cells are cells that are received from the AP. This count is includes cells destined for other SUs.

9.1.12.2 TX

TX cells are cells that are transmitted from the SU to the AP. This count includes retransmitted cells (i.e. the count is incremented every time a cell is transmitted over the RF link, regardless of whether it is a new cell, or a repeat).

9.1.13 Tx

The tx is the number of ATM cells entering the MAC from the Helium processor, to be sent upstream on the air interface. This does not include retransmissions: it is the number of unique cells that need to pass over the air. This number may be significantly less that the CELL TX count (see above).

The upstream cell retransmission rate (i.e. average for this SU-AP link) can be calculated approximately from the "tx" and "CELL TX" counts, as follows:

Upstream Cell Re-Transmission Rate = ((CELL TX – tx) / tx) x 100%

A value of 0% means that cells are only sent once, a value of 100% means that on average each cell is sent twice, and a value of 500% means that every cell is sent six times - the maximum.

Note – This formula is only valid for a large number of cells (minimum recommended = 10000), because of a 64 cell buffer that can distort the cell re-transmission calculation for small numbers of cells.

9.1.14 inseq

The "inseq" count is the number of ATM cells that the UTOPIA interface has received from the MAC for this MID (i.e. this SU). This number represents the number of unique, error-free ATM cells that the SU has received in the correct sequence. For an SU this number may be much lower than the number of CELL RXOK, because CELL RXOK relates to the cells for all SUs, whereas inseq relates to the cells for this specific SU.

9.1.15 miss

The "miss" count represents the number ATM cells the UTOPIA interface has received with the sequence number wildly out. These represent errors. The missed count is usually close to zero, and should be orders of magnitude lower than the inseq count.

9.1.16 dup

The "dup" count represents cells that have been received with their sequence number to low, i.e. cells that have been received multiple times (because they were re-transmitted over the RF link). There are two mechanisms that cause duplicates; CELL errors and ACK errors. These are described below.

Duplicates caused by CELL errors

Up to 6 cells can be sent to a specific SU in a single burst. If the last cell is received in error, then only that cell will be repeated in another frame. However, if the first cell is received in error, then all of the cells in that burst will be repeated in another frame (i.e. six cells may be resent, even though the last five were received correctly). This results in duplicates. If the errored cell is in the middle of the burst, then cells from that one on will be re-transmitted.

Duplicates caused by ACK errors

Another cause of duplicates is failure of the ACKs to be received by the AP at the other end of the RF link. All cells may be received correctly by the SU, but if the ACKs sent as a result of receiving the cells are not received correctly by the AP then all the cells will be resent. This results in duplicates.

A high duplicate count but low CELL RxMissed and CELL RxBad counts indicates ACK problems at the other end of the link (i.e. at the AP receiver). If the majority of SUs have high duplicate counts due to ACK errors at the AP receiver then the problem may lie with the AP receiver or the AP's transmitter: if the AP transmits at the wrong power downstream then the upstream power is also wrong, causing errors at the AP's receiver. If only one SU has a high duplicate count due to ACK errors at the AP then the problem may lie with this SU's transmitter.

10 Modem txpower

The “hmm modem txpower” command is available on both APs and SUs.

AP Modem Txpower

192.168.100.200 hmm> modem txpower

corrected FCC backoff tx attenuation	**+17.466 dB**
nominal TX chain attenuation	**16 dB**
actual TX chain attenuation	**+16.937 dB**
digital baseband attenuation	**+0.638 dB**
nominal TX power	**+1.000 dBm**
actual TX power	**+0.891 dBm**

Of the six numbers reported by “hmm modem txpower” on an AP, only three are of any real value for debugging RF problems : “actual TX chain attenuation”, “nominal TX power” and “actual TX power”.

10.1.1 corrected FCC backoff tx attenuation

Corrected FCC backoff tx attenuation is the amount of attenuation required in the transmit path to keep the transmit power at or below the FCC limit for that channel/polarization.

10.1.2 nominal TX chain attenuation

Nominal TX chain attenuation is the amount of attenuation (in terms of 2dB attenuator pads in the radio) that should be placed in the transmit path to achieve the nominal TX power.

10.1.3 actual TX chain attenuation

Actual TX chain attenuation is the amount of attenuation that is actually placed in the transmit path if the nominal TX chain attenuation is switched in. This uses unique calibration information to calculate the actual attenuation of each 2dB attenuator pad in the radio. If this number is zero, or very close to it, then the unit may not be able to transmit at the requested nominal TX power level. This may cause intermittent downstream or upstream RF problems.

10.1.4 digital baseband attenuation

The digital baseband attenuation is the amount of attenuation that is placed in the transmit path by the radio processor. It is used to set the radio attenuation very close to, but slightly below, the desired nominal TX power level.

10.1.5 nominal TX power

Nominal TX power is the maximum amount of power (dBm) that should be transmitted from the AP radio, based on FCC regulations, i.e;

FCC High-Band = +14dBm (+14dBm for AB-Extender)
FCC Mid-Band = +8dBm (+4dBm for AB-Extender)
FCC Low-Band = +1dBm (-2dBm for AB-Extender)

The nominal TX power value also takes into account any deviations from the standard FCC limits, such as a System Backoff adjustment or a non-FCC power scheme. Nominal TX power can therefore be used to see if the AP and SUs in a sector are using the same power scheme, e.g. a difference between the AP's nominal TX power, and the SU's actual (AP) TX power indicates that the units have been incorrectly configured.

10.1.6 actual TX power

Actual TX power is the actual power level (dBm) being transmitted from the AP radio. It should be very close to, but slightly below, the nominal TX power. The difference between the nominal and actual TX powers represents the error in the transmit power level. A large difference indicates that the unit is transmitting at the wrong power level, and is likely to cause RF problems. Because the actual TX power is calculated from calibration data, the accuracy of the actual TX power calculation is dependent on the accuracy of the calibration data.

SU Modem Txpower

192.168.3.254 hmm> modem txpower

corrected FCC backoff tx attenuation	**+18.494 dB**
AGC: RX pointer is 8, TX pointer is 9	
nominal TX chain attenuation	**18 dB**
actual TX chain attenuation	**+19.000 dB**
digital baseband attenuation	**+1.904 dB**
nominal (AP) TX power	**+1.000 dBm**
actual (AP) TX power	**+1.000 dBm**
actual TX power	**-1.410 dBm**
rssi at SU	**-72.638 dBm**
path loss to AP	**-73.638 dB**
valid rssi range at AP	**-78 dBm to -71 dBm**
Offset to fix uplink cell errors	**+0.000 dB**
estimated rssi at AP	**-75.048 dBm (OK)**

Of the fourteen numbers reported by "hmm modem txpower" on an SU, only five are of any real value for debugging RF problems : "actual TX chain attenuation", "nominal (AP) TX power", "actual TX power", "rssi at SU" and "estimated rssi at AP".

10.1.7 corrected FCC backoff tx attenuation

Corrected FCC backoff tx attenuation is the amount of attenuation required in the transmit path to keep the transmit power at or below the FCC limit for that channel/polarization.

10.1.8 AGC

The AGC Rx pointer is the number of 2dB attenuator pads currently switched into the SU's receive path. The AGC Tx pointer is the number of 2dB attenuator pads currently switched into the SU's transmit path.

10.1.9 Nominal TX chain attenuation

Nominal TX chain attenuation is the amount of attenuation (in terms of 2dB attenuator pads in the radio) that should be placed in the transmit path to achieve the appropriate TX power, which is derived from the current received signal strength (RSSI). This value is always twice the value of the AGC Tx pointer.

10.1.10 Actual TX chain attenuation

Actual TX chain attenuation is the amount of attenuation that is actually placed in the transmit path if the nominal TX chain attenuation is switched in. This uses unique calibration information to calculate the actual attenuation of each 2dB attenuator pad in the radio. If this number is zero, or very close to it, then the unit may not be able to transmit at the appropriate power level. This may cause intermittent upstream and downstream RF problems.

10.1.11 Digital baseband attenuation

The digital baseband attenuation is the amount of attenuation that is placed in the transmit path by the radio processor. It is used to adjust the radio transmit power very close to, but slightly below, the appropriate transmit power level.

10.1.12 Nominal (AP) TX power

Nominal (AP) TX power is the power that the AP is supposed to TX at.
Nominal (AP) TX power is the maximum amount of power (dBm) that should be transmitted from the AP radio, based on FCC regulations, i.e;

FCC High-Band = +14dBm (+14dBm for AB-Extender)
FCC Mid-Band = +8dBm (+4dBm for AB-Extender)
FCC Low-Band = +1dBm (-2dBm for AB-Extender)

The nominal (AP) TX power value takes into account deviations from the standard FCC limits for a non-FCC power scheme, but not for a System Backoff adjustment. It is calculated from information at the SU only.

10.1.13 Actual (AP) TX power

Actual (AP) TX power is the maximum amount of power (dBm) that should be transmitted from the AP radio, based on FCC regulations, and any deviations from the standard FCC limits, such as a System Backoff adjustment or a non-FCC power scheme. This value is an estimate, because the SU cannot calculate the actual AP transmit power level.

Actual (AP) TX power can therefore be used to see if the SUs and AP in a sector are using the same power scheme, e.g. a difference between the SU's actual (AP) TX power, and the AP's nominal TX power indicates that the units have been incorrectly configured.

10.1.14 Actual TX power

Actual TX power is the actual power level (dBm) being transmitted from the SU radio. The difference between the actual and actual (AP) TX powers represents the amount by which the SU transmit power can increase before it is capped. A small difference indicates that if the RSSI drops then the SU may not be able to transmit at the correct level, and the signal from this SU may be too weak when it arrives at the AP receiver. This is likely to cause RF problems. Because the actual TX power is calculated from calibration data, the accuracy of the actual TX power calculation is dependent on the accuracy of the calibration data.

10.1.15 Rssi at SU

The RSSI at the SU is the Received Signal Strength Indicator which measures the strength of the signal received at the SU, and is displayed in dBm. The SU transmit power is derived from the strength of the received signal.

10.1.16 Path loss to AP

Path loss to the AP is an estimate of the free space path loss between the SU and the AP. This is calculated from the SU's RSSI, and the actual (AP) TX power (which is the SU's best guess at the AP's transmit power). The path loss is calculated for the downstream direction, and is then used to calculate the SU's required transmit power.

10.1.17 Valid rssi range at AP

Valid rssi range at AP is the valid range for the estimated RSSI at AP. This is the same for all SUs and is between -78dBm to -71dBm. You should typically see a value of -74dBm to -76dBm (see section 10.1.19).

10.1.18 Offset to fix uplink cell errors

Offset to fix uplink cell errors will display +3dB or -3dB if the SU detects that there is problem with the uplink. If it displays 0dB then it hasn't had to make any adjustments. These adjustments are based on the modem txoffset, which will display why a correction was made.

10.1.19 Estimated RSSI at AP

Estimated RSSI at AP is estimated RSSI at the AP for this SU. The estimate is based on the SU's actual TX power and the calculated path loss to AP. The accuracy of this calculation is dependent on the accuracy of the calibration data. A low value here may arise because of a very high path loss between the AP and SU, i.e. the units are badly aligned and the SU's transmit power is capped below the ideal power level.

11 Modem mmse

The modem mmse command measures the modem's mean-squared-error (MSE) for each burst, which can be used to determine the quality of the signal being received.

The mean squared error indicates how closely the received data coincides with the four QPSK constellation points, the expected data values. A high MSE indicates that the received signal quality is poor, either because there is noise/interference on the signal, or because the signal level is incorrect.

AP/SU Modem mmse

The default "hmm modem mmse" command measures the mean-squared-error over 1000 bursts of received data. It reports the average mean-squared-error, and reports the number of bursts where the MSE exceeded 50.

192.168.3.254 hmm> modem mmse
running please wait
0 out of 1000 mse's > threshold 50
mse average 15

11.1.1 *n* out of 1000 mse's > threshold 50

Number of samples *n* where the modem reported an MSE greater than 50. On a good link this should be 0. The more samples over 50 the worse the link is.

11.1.2 mse average

This is the average of the 1000 MSE samples taken from the modem. A link with a low average MSE, but a high number with MSE over 50 may indicate the presence of a bursty interferer (i.e. another SU). A high average MSE and a high number with MSE over 50 may indicate a power problem, or the presence of a fairly permanent interferer (i.e. another AP).

Status	Average Value	Samples over 50
Good	<20	0
Marginal	20-35	1-30
Poor	35-50	30-50
Bad	>50	>50

The "hmm modem mmse" command can be used to show problems on individual downlinks (when used on individual SUs), but only shows problems on some or all of the uplinks (when used on the AP). The command only works properly on an AP if there is a lot of upstream traffic (1 upstream burst per 10ms). Individual uplinks can be tested if traffic is suspended from all but one SU, and the SU under test is made to transmit a lot of upstream traffic (i.e. by sending a stream of 100 pings/second to the SU).

The MSE measurements are meaningless if made on an SU that has not locked to an AP, or on an AP that is not receiving data from an SU.

12 PNMS Sector

The pnms status command retrieves the RF related stats from an entire sector with one command. It is only available on an AP. It scans the sector up to MID <n> and display results for each SU that responds. Values are updated every 10 minutes and are only updated when there is sufficient traffic to make the calculations meaningful. For the first 10 minutes the unit is powered up the values will be zero.

AP pnms sector

192.168.2.2> pnms sector 5

Sector Status

MID search : 1 2 3 4 5

IP address	RSSI			downstream	upstream
	min	max	now	error %	error %
192.168.2.254	-45.738	-45.738	-45.738	0.132	0.000

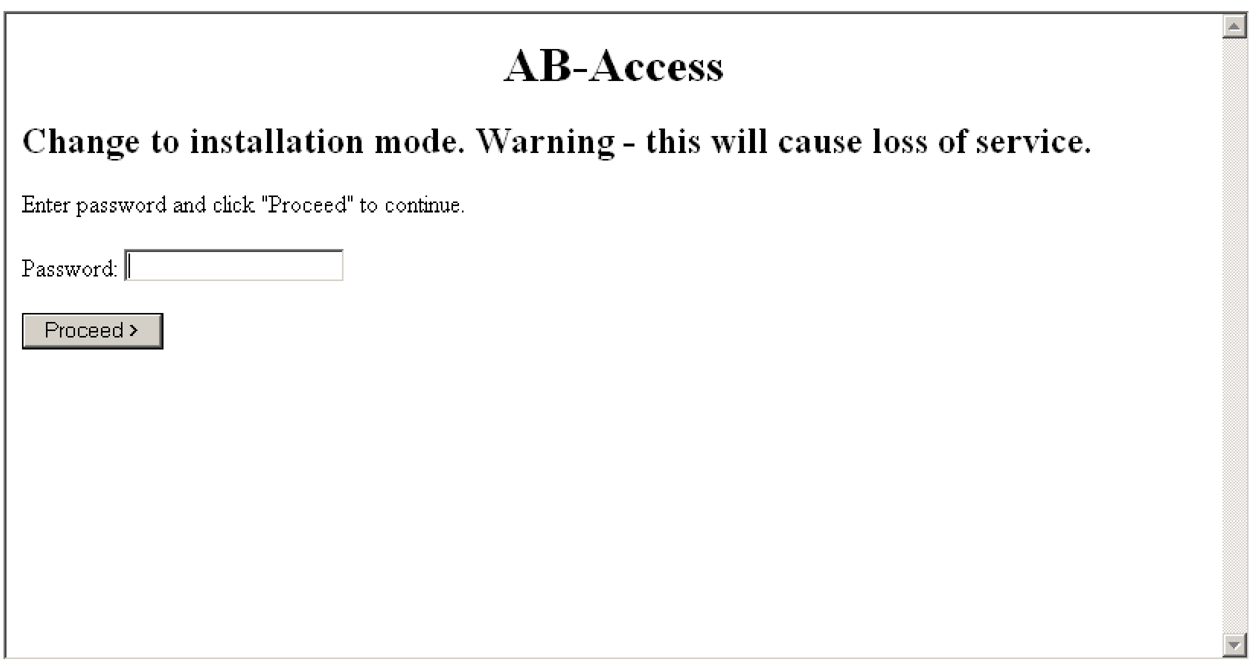
13 Survey Scan

A Survey Scan can be conducted from the CLI or the web interface. This feature is only applicable to FPGA APs and SUs. The "survey scan" CLI command and 'radio survey' web page now provide additional data on RF energy in each channel. Continuous or bursty energy can be detected, regardless of the source (i.e. it does not have to be Axxcelera equipment), providing it is present during the scan. However, the RF-energy-scan process interrupts normal service for the entire duration of the scan. Survey results are saved in a temporary file called "ap_scan" or "su_scan", as appropriate. The file contains results of the last scan to be performed, and is overwritten by a new scan. The file is normally lost when the unit reboots, but the file is saved if a "config save" is performed, or if the unit is upgraded. Therefore, it is now possible to use the "survey scan" command remotely, i.e. executing on an SU via the RF link.
This feature can be used at the time of unit installation, or when trying to investigate and mitigate an interference problem. It can also be used before performing a sector channel change to look for potential interference problems.
When performed on an AP the sector itself is quiet, so any RF energy detected must be coming from other sources. However, when a scan is done on an SU the AP and other SUs may still be transmitting. This may confuse the results. The RF energy from other units in the SU's sector will be detected on-channel, but will also appear to a lesser extent in adjacent channels (e.g. 23dBm lower than in the main channel). This should be borne in mind, and if necessary the scan should be performed with the AP transmitter disabled, which will silence that sector (e.g. using "hmm modem rf disable/enable").

Web Interface

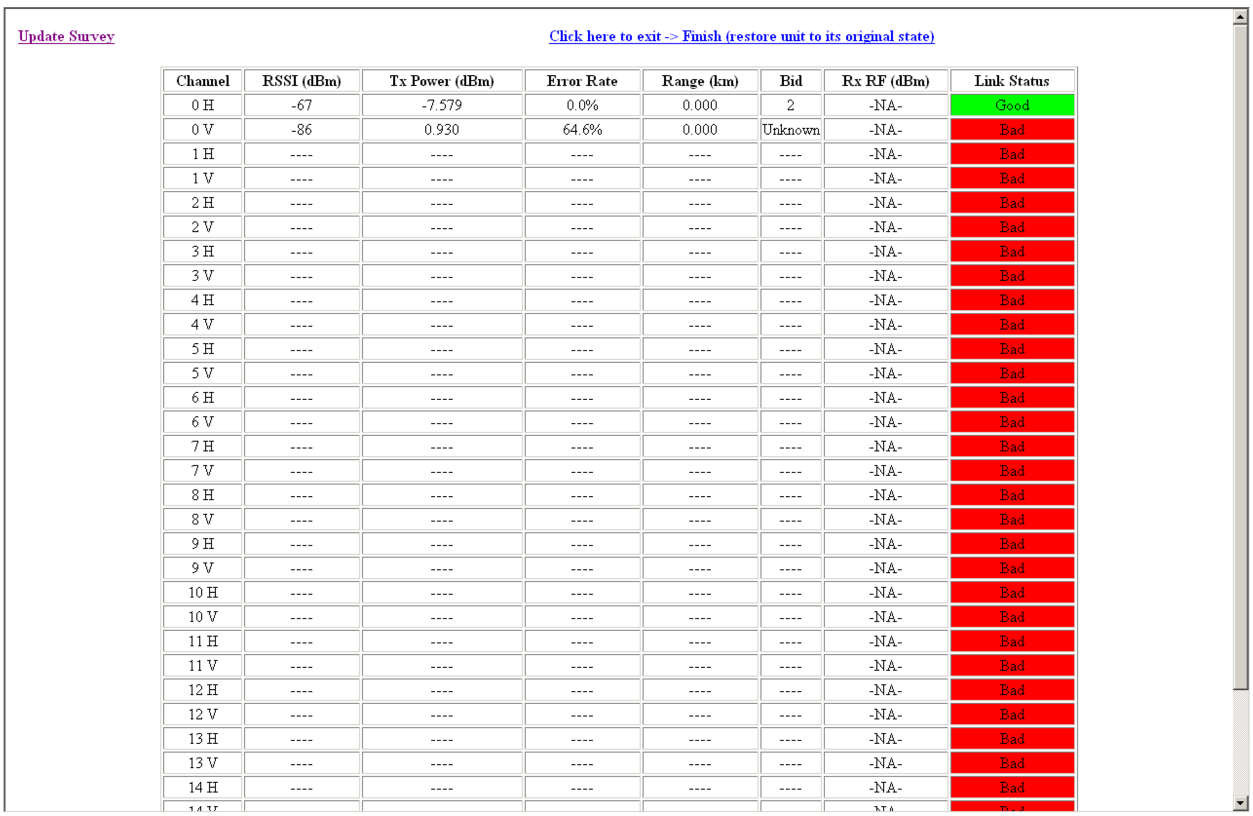
1. To open web page type <**http://ipaddress:8000/index** > in the URL of your web browser.

2. Enter the password of the unit. This is the same password that is used for telnet access.



3. Click on **SU and AP Radio Survey scan**.

4. The survey page is displayed. It will take up to 2 minutes to appear so be patient.



Channel	RSSI (dBm)	Tx Power (dBm)	Error Rate	Range (km)	Bid	Rx RF (dBm)	Link Status
0 H	-67	-7.579	0.0%	0.000	2	-NA-	Good
0 V	-86	0.930	64.6%	0.000	Unknown	-NA-	Bad
1 H	----	----	----	----	----	-NA-	Bad
1 V	----	----	----	----	----	-NA-	Bad
2 H	----	----	----	----	----	-NA-	Bad
2 V	----	----	----	----	----	-NA-	Bad
3 H	----	----	----	----	----	-NA-	Bad
3 V	----	----	----	----	----	-NA-	Bad
4 H	----	----	----	----	----	-NA-	Bad
4 V	----	----	----	----	----	-NA-	Bad
5 H	----	----	----	----	----	-NA-	Bad
5 V	----	----	----	----	----	-NA-	Bad
6 H	----	----	----	----	----	-NA-	Bad
6 V	----	----	----	----	----	-NA-	Bad
7 H	----	----	----	----	----	-NA-	Bad
7 V	----	----	----	----	----	-NA-	Bad
8 H	----	----	----	----	----	-NA-	Bad
8 V	----	----	----	----	----	-NA-	Bad
9 H	----	----	----	----	----	-NA-	Bad
9 V	----	----	----	----	----	-NA-	Bad
10 H	----	----	----	----	----	-NA-	Bad
10 V	----	----	----	----	----	-NA-	Bad
11 H	----	----	----	----	----	-NA-	Bad
11 V	----	----	----	----	----	-NA-	Bad
12 H	----	----	----	----	----	-NA-	Bad
12 V	----	----	----	----	----	-NA-	Bad
13 H	----	----	----	----	----	-NA-	Bad
13 V	----	----	----	----	----	-NA-	Bad
14 H	----	----	----	----	----	-NA-	Bad

5. Once you are finished click on **Click here to exit**.

CLI

```
192.168.2.2> survey scan

Please wait while a channel scan is performed by this AP.
This will take up to 1 minute to perform.


+------+-------+
| Chan | Rx RF |
|      | (dBm) |
+------+-------+
|  0 H | None  |
|  0 V | None  |
|  1 H | None  |
|  1 V | None  |
|  2 H | None  |
|  2 V | None  |
|  3 H | None  |
|  3 V | None  |
|  4 H | None  |
|  4 V | None  |
|  5 H | None  |
|  5 V | None  |
|  6 H |  -76  |
|  6 V |  -81  |
|  7 H | None  |
|  7 V | None  |
|  8 H | None  |
|  8 V | None  |
|  9 H | None  |
|  9 V | None  |
| 10 H | None  |
| 10 V | None  |
| 11 H | None  |
| 11 V | None  |
| 12 H | None  |
| 12 V | None  |
| 13 H | None  |
| 13 V | None  |
| 14 H | None  |
| 14 V | None  |
| 15 H | None  |
| 15 V | None  |
| 16 H | None  |
| 16 V | None  |
+------+-------+
192.168.2.2>
```

14 Modem msreg 6 1

The modem msreg 6 1 command will display the RX digital AGC level. This is a fine gain adjustment. It is the only dynamic gain adjustment on APs. SUs also have a course gain adjustment, the Radio AGC, which adjusts the gain over a wide range.

On SUs the Rx digital AGC does not assist in debugging, because of the presence of the Radio AGC. However, for APs it indicates if the received signal is too strong or too weak.

AP Modem msreg 6 1

The signal from all SUs should be about –74dBm on arrival at the AP receiver.

If the signal is too strong then the gain of the digital AGC drops. If the signal is too weak then the gain of the digital AGC increases. The digital AGC is fast-acting and is reset at the end of each burst to its starting point of maximum gain (corresponding to a register value of 127). As the signal is received, the gain of the digital AGC drops whenever the signal level is above the correct level.

When the received signal level is about –74dBm the digital AGC drops from 127 to an average range of 30-50. If the signal level is too strong the digital AGC may drop to its lowest gain (corresponding to a register value of 21). Readings of 21 indicate that the receiver is overloaded. If the signal level is too weak then the digital AGC will not drop as far as expected, and it may even remain at its starting position of 127.

192.168.100.200 hmm> modem msreg 6 1
001: [0x06] 0x33 51

Average : 51.0

Status	Average value
Bad	**21**
Marginal	**22-25**
Good	**25-55**
Marginal	**55-70**
Bad	**>70**

Values for the Rx digital AGC can range from 21 to 127, and should be 25-55 for typical AP receiver.

The command only works properly on an AP if there is upstream traffic (one burst per reading of msreg 6). Individual uplinks can be tested if traffic is suspended from all but one SU, and the SU under test is made to transmit upstream traffic (i.e. by sending a stream of pings/second to the SU).

The digital AGC measurements are meaningless if the AP is not receiving data from an SU.

15 Modem rxdc stats

The "hmm modem rxdc stats" command can help to spot intermittent problems with radio links. It displays the number of times the receiver dc offsets were recalibrated, and for what reason, e.g.

AP/SU modem rxdc stats

```
192.168.100.200 hmm> modem rxdc stats
TRIGGER       : TEMPERATURE   FDHDR ERROR   CELL ERROR    ACK ERROR
FREQUENCY     : 1             0             0             0

OFFSET        : MIN       MAX
I             : 0         0
Q             : 3         4
```

The stats can be reset to zero with the "hmm modem rxdc stats z" command.

Recalibrations are required when the temperature changes, and may occasionally be triggered by errors when the offesets change without a temperature change. However, because the recalibrations are triggered by a high error rate in any one second interval, the rxdc stats tend to show intermittent radio problems that may not be obvious from the MAC stats (because the average error rate may be low). As a rule of thumb, error-triggers should be less than temperature-triggers. If the number of error-triggers are more than ten times the number of temperature-triggers then there is a definite problem with the received signal. Where an AP has a poor signal at its receiver (due to interference or a power-control issue, for example) then the error-triggers are typically one hundred times the number of temperature-triggers. Once a calibration is triggered by errors there is a 1 minute delay before it can be triggered again. Therefore, as an example, a unit with an uptime of 10 hours (i.e. 600 minutes) and a total of 600 error-triggered rx dc offset calibrations means that high error rate was always present.

The "hmm modem mmse" and "hmm modem msreg 6" commands can be used to confirm a problem, and diagnose a possible cause.

16 Bun list channels

Bun list channels can be used to determine which PVC (SU) traffic is coming from. This command is somewhat obsolete with the introduction of the "pnms sector" command in the 5.2.x and later releases.

```
192.168.100.200> bun list channels
Port atm25i
 0:  Enabled:  true   TxPkts: 0        RxPkts:    0/0     TxVPI/VCI:  0/0     RxVPI/VCI:  0/0
 1:  Enabled:  true   TxPkts: 0        RxPkts:    0/0     TxVPI/VCI:  0/0     RxVPI/VCI:  0/0
 2:  Enabled:  true   TxPkts: 0        RxPkts:    0/0     TxVPI/VCI:  0/0     RxVPI/VCI:  0/3
 3:  Enabled:  true   TxPkts: 0        RxPkts:    0/0     TxVPI/VCI:  0/0     RxVPI/VCI:  0/4
Port atm25m
 0:  Enabled:  true   TxPkts: 0        RxPkts:    0/0     TxVPI/VCI:  0/0     RxVPI/VCI:  0/0
 1:  Enabled:  true   TxPkts: 0        RxPkts:    0/0     TxVPI/VCI:  0/0     RxVPI/VCI:  0/0
 2:  Enabled:  true   TxPkts: 0        RxPkts:    0/0     TxVPI/VCI:  0/0     RxVPI/VCI:  0/3
 3:  Enabled:  true   TxPkts: 0        RxPkts:    0/0     TxVPI/VCI:  0/0     RxVPI/VCI:  0/4
 4:  Enabled:  true   TxPkts: 127      RxPkts:  168/10   TxVPI/VCI:  0/768  RxVPI/VCI:  0/768
Port ciao does not support channel access
Port Ethernet
 0:  Enabled:  true   TxPkts: 723      RxPkts:  793/0
```

16.1.1 RxPkts:

The receive packets will tell you if a link is having problems. There are 2 numbers for the received packets, the first is for the total number (168), the second is for packets received with an error(10). If the second number is large compared to the first number this would indicate a problem. You don't really care what the exact numbers are, because you are only using this to identify a possible problem.