

BROADBAND MAX

MYTHS AND LEGENDS



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Broadband Max is supplied under the Conditions for BT IPstream Service and the Conditions for BT Datastream Service and you should ensure that you have read these thoroughly, in case of conflict between this document and the Conditions, the Conditions shall take precedence. This document is for information purposes only and is not intended to form part of the Contract.

1 Introduction

This document is aimed to dispel the various myths and legends that have arisen around the Broadband Max product. It is designed to give Communication Providers (CP's) an accurate understanding of how the various aspects of the product work to improve the quality and usability of the product.

2 Max and DLM

2.1 What is RAMBo?

RAMBo is the Rate Adaptive Management Box and is the key component in the Broadband Max product. It has two main components – Max and DLM and it monitors real-time and historic data from the DSLAMs in order to make each Broadband Max line as fast and as stable as possible.

2.2 What is Max and what does it do?

Max is part of the RAMBo system, which monitors the line rate of each end user's line and in the case of IPstream, adjusts the BRAS accordingly. Additionally, for IPstream it also notifies BBCR of changes in the BRAS profile via the downstream line rate parameter. For DataStream, Max purely passes the DSL line rate to the CP via BBCR.

2.3 What is DLM and what does it do?

DLM is the other part of the RAMBo system, which analyses the bulk performance statistics from the DSLAMs for each end user's line. As a result of this analysis, DLM adjusts the DSLAM line profile to gain the optimum level of rate and stability. For both IPstream and DataStream any changes due to this analysis are notified to the CP via BBCR.

2.4 How are Max and DLM related?

Max and DLM are independent modules that have an indirect relationship as well as direct linkages between them. An example of the indirect relationship is when a DLM change that increases margin, causes a rate change. That rate change will be detected by Max, which will in turn perform a change of the BRAS profile if required.

DLM is responsible for the generation of the "heartbeat". The "heartbeat" does not cause a retrain of the modem and will be invisible to the end user, this is a pseudo sync event that is sent directly to Max to ensure that lines in constant sync receive the correct BRAS profile.

Max is responsible for the detection of "flapping" lines" in real-time. When Max detects a flapping line, it notifies DLM, so that DLM can re-profile the line in order to stabilise it as rapidly as possible.

3 Fixed rate verses Broadband Max

3.1 What is Rate adaptation and why is it different from fixed rate?

With fixed rate services, the ADSL modem is informed by the DSLAM what line rate to train up at, irrespective of line conditions. Rate adaptive services are designed to allow the DSLAM and the modem to negotiate the optimum speed between a maximum and minimum rate using a parameter called target margin.

3.2 What are target margins and why does BT increase them using DLM?

The target margin is the required signal to noise ratio needed to keep the line in synchronisation and it is this parameter that DLM flexes to optimise the rate and stability. By increasing the target margin, DLM can force the line to take more margin and therefore make it more immune to noise variations. Without this dynamic control, a static value would have to be selected, with the consequence that many lines would run slower than required and others less stable.

3.3 What is the modems role in rate adaptation?

During rate adaptation, the modem has to measure the line characteristics and agree a downstream rate with the DSLAM for a given target margin. If the modem is bad at measuring margin, then the line can either run too conservatively or too aggressively depending on whether the modem underestimates, or overestimates the margin respectively.

3.4 Programs that change line rate and margin on modems – should I use them?

As the modems and DSLAM negotiate the parameters that control the rate adaptation process, it is possible for the modem to manipulate the margin and rate that the line runs at.

In skilled hands, this could lead to an improvement in performance, but in general it is a rather risky practice for two reasons. Firstly, the software needs to tweak the DSL chipset in the modem and any mistakes in this configuration could cause serious stability issues. Secondly this bypasses DLM, which is designed to resolve stability issues and could cause very serious performance issues.

4 Sticky BRAS

4.1 What happens the first time I sync my line?

When the modem trains up for the first time, it agrees a rate with the DSLAM, this new rate is detected and analysed by Max within an hour.

For IPstream, as this is the first sync event, Max reports the new downstream line rate (associated with the selected BRAS profile) to BBCR. After 15 minutes of this report, the BRAS profile is changed

For DataStream, Max immediately reports the new downstream line rate (actual DSL rate) to BBCR and no further action taken.

4.2 How long before the BRAS changes to match my line rate (IPstream only)?

For the initial sync it can take up to 75 minutes for the BRAS profile to change in relation to the line rate in accordance with the process described in 4.1 . This includes the time taken to report the change on BBCR and the time taken to change the BRAS profile.

After the initial sync, if another sync event occurs that indicates to Max that a downward BRAS profile change is required, this BRAS change will again occur after 15 minutes of the new downstream line rate reporting on BBCR.

If the sync event indicates to Max that an upward BRAS profile change is required, nothing occurs until the end user line has sustained this higher line rate for 3 days. On the 3rd day when either the sync event or "heartbeat" is analysed by Max the change in BRAS profile will again occur after 15 minutes of the new downstream line rate reporting on BBCR.

4.3 How can my line run at a rate which is in a higher line rate range than my associated BRAS profile (IPstream only)?

This could be down to two different reasons. Either the line is still in the 3 day period awaiting an upward BRAS profile change or possibly the line experiences periodic low sync events, which would keep resetting the 3 day period. This would have the effect that the BRAS profile would stay constant.

As BBCR only reports changes in BRAS profile and the periodic low sync events cause the BRAS profile to stay constant at a lower rate, these "low" sync events are not visible to the SP.

4.4 If my line is stable for an extended period and briefly runs at a low rate, before returning to its previous higher rate – how long before the BRAS recovers?

An enhancement to Max, called the "Blip logic" was developed for this eventuality. If a line has not seen a downward BRAS profile change within a period of time and then experiences a single lower rate sync event, the BRAS will decrease in line with the standard rules as described previously.

If the line rate then increases again before the next "heartbeat" from DLM, then the 3 day rule is bypassed and the BRAS will change within 15 minutes of the BBCR report.

4.5 I have heard that retraining my line ten times fixes a sticky BRAS profile – is this true?

This is half true. Retraining the line ten times in one hour actually indicates to Max that your line is flapping and notifies DLM. DLM then re-profiles the line, such that the line rate reduces and therefore generates a sync event that causes Max to perform BRAS change. The net effect of this is to reduce the line rate for the user, therefore this action is not recommended.

4.6 What is the granularity of BRAS profiles and how does Max move between them?

The BRAS profiles used by the Broadband Max products vary in 500kbps steps IP rate except for a few exceptions. The complete list of the profiles used is as follows.

| ADSL Line Rate Range kbit/s | BRAS Profile (IP Rate) kbit/s |
|------------------------------------|--------------------------------------|
| 288-575 | 250 |
| 576-1151 | 500 |
| 1152-1727 | 1000 |
| 1728-2271 | 1500 |
| 2272-2847 | 2000 |
| 2848-3423 | 2500 |
| 3424-3999 | 3000 |
| 4000-4543 | 3500 |
| 4544-5219 | 4000 |
| 5120-5695 | 4500 |
| 5696-6239 | 5000 |
| 6240-6815 | 5500 |
| 6816-7391 | 6000 |
| 7392-7967 | 6500 |
| 7968-8127 | 7000 |
| 8128 | 7150 |

Note: The downstream Line Rates on BCCR shown are the values that represent the lowest line rate value of the ranges that determine the BRAS profiles.

Max can move from any profile to any other profile, it does not increase by stepping through the profiles until the required one is reached.

For example if a line is currently on the 1500kbps BRAS profile and Max calculates it can now apply the 4000kbps BRAS profile, it will move directly to that BRAS profile without using the intermediate profiles (provided that there have been 3 consecutive days at qualifying line rates with no lower rates in that period).

5 The 10 day stabilisation period

5.1 What is the 10 day stabilisation period and what is it for?

The 10 day period is to allow DLM to re-profile the line, in order to stabilise it and to determine the MSR.

5.2 What actually happens during the 10 day period?

DLM collects performance data and determines the stability of the line. If the line is unstable, it re-profiles the line and then monitors it again. This process repeats until the line is stable and can take up to the 10 day to complete.

During the 10 day period, Max tracks the lowest BRAS rate and once the period is complete, the MSR is set accordingly.

5.3 What happens once the 10th day has passed and the MSR and FTR are set?

Max and DLM continue to work every day even after the MSR and FTR are set. If a line becomes unstable after the 10 day period DLM will still attempt to stabilise the line in the same way that MAX will continue to change the BRAS profile if the line rate fluctuates after the 10 day period.

The MSR and FTR are purely for reporting purpose as described below. The MSR and FTR are fixed after the 10 day period, unless a recalculation is triggered by BT Wholesale Broadband Assurance. This initiates a new 10 day period, purely for the MSR / FTR calculation.

5.4 What happens if I do not use my modem until (e.g.) the 7th day?

The MSR and FTR will be set after the 10th day using the data available since your first log-in. DLM will continue to try and stabilise the line as described above if necessary.

5.5 What happens if I've been on holiday and haven't used the service in the first 10 days?

The MSR and FTR process uses a 10 day rolling window in order to capture circumstances like this. Stabilisation will occur as described in the answers above. See section 7.2.

5.6 Does this mean I'll get the same Line Rate when I retrain the modem after the stabilisation period?

Not necessarily. Broadband Max is a rate adaptive service and will always try to sync up to the highest line rate your line can support reliably. When you sync on subsequent occasions you may experience different Line Rates. The Line Rate achieved is dependent on a number of factors including line conditions and any local sources of electrical interference (see the section on REIN in this document). Line conditions can be affected by weather conditions such as rain or prolonged dry periods. Electrical storms can also have a significant impact on line rates you may achieve.

6 The MSR / FTR mystery

6.1 What is the MSR?

MSR stands for Maximum Stable Rate and is to indicate to the CP the maximum rate at which the line can perform while showing an acceptable level of stability. This is to allow the CP to market services and products that require an indication of a sustainable line rate for each end user. It is also used to calculate a FTR, which is described below.

6.2 What is the FTR?

FTR stands for Fault Threshold Rate and is the lowest rate a line can run before an CP can report a line rate fault into BT Wholesale using the Lower Threshold Breach fault code.

The FTR is calculated as 70% of the MSR.

6.3 What effect do they have on Max and DLM?

MSR has no effect on Max or DLM in any way, shape or form! As previously mentioned it is only for reporting purposes to the CP.

FTR has no effect on MAX but does impact DLM. Once the FTR has been set, DLM is unable to increase target margin such that it would breach the FTR. The exception to this is for lines that are 'flapping'.

Neither the MSR nor the FTR prevent the line from achieving higher line rates should the line conditions improve. Higher throughput may also be achievable if subsequent sync events justify a higher BRAS profile.

7 Reports from BBCR

7.1 What is the Downstream Line Rate and when is it updated?

For IPstream, the Downstream Line Rate as reported on BBCR is the minimum DSL line rate associated with the BRAS profile. It is only updated when a BRAS profile change is due to occur and will be updated in BBCR approximately 15 minutes before the BRAS profile change occurs.

As a BRAS profile change depends on sync events occurring and the rules as described previously in this document, the Downstream Line Rate on BBCR can be updated a number of times per day or conversely never if the BRAS remains constant.

For DataStream, the Downstream Line Rate in BBCR is updated every time the line rate changes.

7.2 When are MSR / FTR set and are they ever updated?

The MSR / FTR are set 10 days after the initial Customer Agreed Date assuming at least one sync event is detected by Max during the 10 day period.

If Max detects no sync events during the first 10 days then the 10 day period rolls over for another 10 days, this continues until at least one sync event is detected by Max. At which point once the latest 10 day window has completed the MSR and FTR will be set.

As mentioned previously once the MSR and FTR are set they are fixed, unless a recalculation is triggered by BT Wholesale BB Assurance. This initiates a new 10 day period, purely for the MSR / FTR calculation. This new 10 day window will roll over in the same way if no sync events are detected by Max.

The MSR and FTR are updated to BBCR once only on the day it has been set or been updated, so it should never be possible that an MSR and FTR changes value more than once on the same day (excluding data refreshes performed by BT Wholesale)

7.3 What are run mode and margin level and when are they set and updated?

The run mode indicates whether the end user line is running in Fast or Interleaved mode. This will be due to DLM making a profile change to stabilise the line, currently this can only transition from Fast mode to Interleaved Mode and will only occur once and will be displayed on BBCR after the change has occurred.

The margin level on BBCR indicates to the SP that the margin level has been changed by DLM. For most lines the margin level will only change once per day, but for lines which are 'flapping' it

can change a number of times. As with the run mode the indication that the margin level has changed will be displayed on BBCR after the change has occurred.

7.4 Does the run mode change if I ask for Interleaving to be removed?

Yes. Fast mode will be shown. Fast Mode will also be shown for Interleaving set to Auto until DLM applies interleaving to attempt to stabilise the line.

8 Retrains / resyncs

8.1 Why do modems retrain?

Modems can retrain for two main reasons, either due to the margin dropping below 0dB, or if large numbers of errors are detected.

8.2 What happens when they retrain?

The DSLAM and modem renegotiate the rate at which the line runs and signals the change of line rate to Max.

8.3 Does my modem automatically retrain to a higher line rate?

No, currently the end user will have to force a retrain by turning the modem off and back on, or via the GUI to retrain to a higher speed.

It has been reported that some modems are appearing to retrain to a higher rate. The retrain may have been caused by to a short term noise event. When the modem and DSLAM renegotiate the rate, the noise event has gone and thus a higher rate may be achieved.

8.4 Should I retrain my modem regularly?

There is no need to retrain the modem routinely, as DLM provides a "heartbeat" to Max to ensure BRAS alignment. The modem only needs to be retrained to overcome low sync events, which can be detected by a low sync rate and higher than normal margin (e.g. above 20dB in the downstream).

8.5 How many times can my line retrain per day before DLM acts?

This is a BT Wholesale configurable parameter, but currently if a line retrains more than 10 times in any single hour period DLM will take action.

It is therefore inadvisable to manually retrain a line more than 10 times in a single hour as DLM will interpret this as line instability.

9 Margin variation

9.1 Is Broadband Max afraid of the dark?

No, but the evening can be more hostile in terms of impulse noise issues. This is due to the additional electrical equipment being turned on that can generate impulse noise that affects the DSL signal.

This impulse noise can affect the performance and stability of DSL, therefore some end users may witness low line rates at night time or occasional retrains by the modem. Improving the quality of home wiring may reduce this effect, information regarding home internal wiring can be found in this document.

9.2 Why does my margin vary over time?

Impulse noise and crosstalk vary throughout the day and the margin is designed to absorb this variation without affecting the line rate. Varying margin is to be expected and nothing to worry about.

10 DSL modem statistics

10.1 My modem reports a number of performance parameters, but what do they mean?

Code Violations – a count of line transmission errors

Errored Seconds – the number of seconds that contained at least one code violation

FEC count – a count of Forward Error Corrections – errors corrected by interleaving

FEC seconds – the number of seconds that contains at least one FEC

HEC count – a count of ATM Header Error Counts – transmission errors that cause ATM cell discard

Margin – Signal to noise ratio for the line

Attenuation – a measure of the electrical loss of the line

Line rate – actual ATM speed that the line is running at

10.2 Which ones should I actually be concerned about?

The key parameters are the ones concerned with physical layer errors –

Errored Seconds

Code Violations

FECs

11 Home wiring repair

11.1 I have heard that cutting the bell wire helps stabilise my line – is it true?

Home wiring is unbalanced due to the use of a bell wire. This means that the wiring can act as an aerial, which allows impulse noise to enter the pair carrying ADSL. Cutting the bell wire removes the imbalance, but can also prevent some phones from ringing. This should never be done by unqualified personnel unless the line has a removable faceplate on the master socket. (e.g. NTE5).

11.2 What is a SSFP and what do they do?

The SSFP is a Service Specific Face-Plate and it replaces the front part of the NTE5 (BT Master Socket). This provides a dedicated port for ADSL and a dedicated port for the telephones. By using this type of centralised splitter, rather than microfilters, the home wiring can be dramatically improved, giving higher rates and improved stability.

Any extension sockets which previously required a microfilter will now be filtered at the SSFP and will therefore no longer carry the DSL signal and will only be available for telephony services. Adding microfilters to these extensions can cause a detriment in performance.

11.3 I do not have an NTE5 and instead have a line jack unit. Does this affect Broadband Max?

Not necessarily. The line jack unit prevents the end user from testing without the home wiring connected. They will also not be able to fit an SSFP without an NTE5.

11.4 Do I need Micro filters on all devices connected to my phone line and what happens if I don't?

Absolutely yes, unless you have a centralised splitter like the SSFP. This includes fax machines, answer phones, dial up modems and set-up boxes. Failure to fit microfilters will cause line instability or detrimental performance. You may not have noticed any impact on your fixed rate service but rate adaptive Broadband Max is impacted.

11.5 What is REIN it and how does it affect me?

REIN is Repetitive Electrical Impulse Noise and can be very harmful to ADSL and is generated by things such as power supply units. REIN can be prevented from interfering with the ADSL signal by having good home wiring, or ideally a centralised filter.

By removing the source of the REIN, it is likely that a faster Max service will be possible.

12 Interleaving

12.1 What is interleaving and how does it improve my line?

Forward error correction (FEC) is a system of error control for data transmission, which allows the modem to detect and correct errors without the data needing to be resent.

Interleaving maximises the effectiveness of the FEC by introducing a delay to rearrange the data, such that error events are spread so that no two errors hit the same block. Thus reducing further the need for retransmission of the data and dramatically improving throughput.

It is DLM's first action to improve the stability of a line by enabling interleaving, as this has no impact on the line rate, except for lines running at 8128kbps, unlike increasing the margin that does cause a reduction in line rate.

12.2 What does the maximum line rate fall to if interleaving is applied?

The line will be reduced to 7616 kbps.

12.3 I have heard that interleaving is bad for gaming – is it true?

In order to maximise the effectiveness of the FEC, a delay is introduced to rearrange the data (interleaving), such that errors events are spread and that the probability of two errors hitting the same block is reduced. This allows the FEC to correct all the errors.

This does however introduce delay, or latency that can affect ping times and possibly online gaming. However, there is a compromise here as the constant delay as introduced by interleaving is easier to deal with than random packet loss due to transmission errors.

12.4 There are three options for interleaving status, what do they mean?

| | |
|----------------|---|
| Opt in | - The line is always run in interleaved mode |
| Opt out | - The line is always run in fast mode |
| Auto | - BT Wholesale will only interleave the line if required. |

13 Line rate, BRAS rate and throughput

13.1 What is the line rate?

The line rate is the ATM cell rate of the DSL line.

13.2 What is the BRAS rate?

The BRAS rate is the shaping rate of the BRAS in the network. This is aligned to the line rate to ensure that packet discard does not occur at the DSLAM. For example:

DSL line rate of 2368, requires a BRAS ATM rate is 2272 and the IP rate is 2000, giving a BRAS profile of adsl2000.

13.3 How do the line rate and BRAS rate affect my throughput (download speeds)

The maximum speed that data can be downloaded is set by the BRAS profile, which is in turn set by the DSL line rate.

The maximum download rate is then dependent on a number of things:

- TCP receive window size
- Round Trip Delay
- Packet loss
- Congestion

13.4 My internet browser shows download rates different to my line rate – why is this?

This is just an issue of units. Things like line rate are measured in kilobits and file sizes are measured in kilobytes. Therefore, when your browser is downloading a file it reports a speed eight times lower than the real bit rate.

For example, for the DSL line rate of 2368, the maximum download rate would be ~1900kbps, or 240kBps.

13.5 Why don't I get the full BRAS rate?

At each layer of the OSI stack, there are overheads in the form of headers and footers added to enable transmission. These overheads consume a percentage of the payload from the next layer down.

Taking the adsl2000 BRAS profile. The "raw" ATM payload is 2272, but this is reduced by ATM headers, AAL5 headers and PPP headers, leaving 2000kbps for IP layer payload.

Into this IP layer payload TCP or UDP have protocol overheads, which further reduce it to approximately 1900kbps.

13.6 Why do my download speeds vary over time?

This is due to the nature of the internet and the network. Both have peak periods and during this time, everybody's download rates are reduced.

For example if you consider your Broadband Max service as a fast car and the internet and the network as the roads. During quiet periods you can drive faster because the roads have less traffic on them. But during peak periods such as rush hour even though your car has the ability to go faster, its actual speed is reduced by the other traffic using the roads.

13.7 How to I get an accurate measure of the throughput my line can support?

The BT Performance tester has been designed and developed to address the question of measuring throughput for Broadband Max services as well as the fixed rate services and is therefore the definitive answer to throughput questions.

14 End User hardware

14.1 What is the "RWIN" and how does it affect throughput?

The RWIN is the TCP Receive Windows size. This determines the maximum number of TCP segments that can be sent and are un-receipted at any time. This determines the maximum throughput.

Windows XP dynamically resizes this window to match conditions and therefore should not require any changes.

14.2 What is the "MTU" and how does it affect throughput?

The MTU is the Maximum Transmission Unit. This determines the maximum size packet that can be sent over a network. For ADSL the MTU should be less than 1488 kilobytes to ensure that fragmentation does not occur on Ethernet segments of the network.

14.3 Which is best connection via Ethernet or USB?

If possible, an Ethernet connection is best – either via wireless or wired. This is due to USB1 having some limitations such as a maximum of 11Mbps unidirectional traffic. USB1 also has an issue with the mode of operation – modems can have a maximum throughput of ~4Mbps if it operates in isochronous mode.

When using Wi-Fi, it is best to use equipment that supports Ethernet 802.11g, and not 802.11b, this is due to possible throughput limits as 802.11b only supports a maximum TCP throughput of ~6Mbps even in ideal conditions.

15 Glossary

| Term | Meaning |
|-------------|--|
| ADSL | Asymmetric Digital Subscriber Line |
| ATM | Asynchronous Transfer Mode |
| BBCR | BroadBand Customer Reporting |
| BRAS | Broadband Remote Access Service |
| BRAS rate | ATM shaping rate at the BRAS |
| CV | Code Violations |
| DLM | Dynamic Line Management capability of Rambo |
| ES | Errored Seconds |
| Ethernet | Local Area Network technology |
| FEC | Forward Error Correction |
| Flapping | A frequently retraining line |
| FTR | Fault Threshold Rate |
| HEC | Header Error Count (ATM) |
| IP | Internet Protocol |
| Line rate | ATM rate of the ADSL line |
| MAX | BRAS alignment capability of Rambo |
| MSR | Maximum Stable Rate |
| MTU | Maximum Transmission Unit |
| NTE5 | Network Termination Equipment - the BT master socket |
| RAMBo | Rate Adaptive Management Box |
| REIN | Repetitive Electrical Impulse Noise |
| Reprofile | A change of DSL line performance parameters |
| RWIN | Receive WINdow |
| SP | Service Provider |
| SSFP | Service Specific FacePlate - BT centralised splitter |
| Sync | An ADSL line achieving synchronisation |
| Sync event | A notification of a line achieving sync |
| TCP | Transmission Control Protocol |
| UDP | User Datagram Protocol |
| USB | Universal Serial Bus |