FireBrick FB6202

User Manual

FB6000 Versatile Network Appliance

FireBrick FB6202 User Manual

This User Manual documents Software version V1.22.001

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Preface

The FB6000 device is the result of several years of intensive effort to create products based on state of the art processing platforms, featuring an entirely new operating system and IPv6-capable networking software, written from scratch in-house by the FireBrick team. Custom designed hardware, manufactured in the UK, hosts the new software, and ensures FireBrick are able to maximise performance from the hardware, and maintain exceptional levels of quality and reliability.

The result is a product that has the feature set, performance and reliability to handle mission-critical functions, effortlessly handling huge volumes of traffic, supporting thousands of customer connections.

Chapter 1. Introduction

1.1. The FB6000

1.1.1. Where do I start?

The FB6000 is shipped in a *factory reset* state. This means it has a default configuration that allows the unit to be attached directly to a computer, or into an existing network, and is accessible via a web browser on a known IP address for further configuration.

Besides allowing initial web access to the unit, the factory reset configuration provides a starting point for you to develop a bespoke configuration that meets your requirements.

A printed copy of the QuickStart Guide is included with your FB6000 and covers the basic set up required to gain access to the web based user interface. If you have already followed the steps in the QuickStart guide, and are able to access the FB6000 via a web browser, you can begin to work with the factory reset configuration by referring to Chapter 3.

Initial set up is also covered in this manual, so if you have not already followed the QuickStart Guide, please start at Chapter 2.

Tip

The FB6000's configuration can be restored to the state it was in when shipped from the factory. The procedure requires physical access to the FB6000, and can be applied if you have made configuration changes that have resulted in loss of access to the web user interface, or any other situation where it is appropriate to start from scratch - for example, commissioning an existing unit for a different role, or where you've forgotten an administrative user password. For details on the factory reset procedure please refer to Appendix A, or consult the QuickStart Guide.

The remainder of this chapter provides an overview of the FB6000's capabilities, and covers your product support options.

Tip

The latest version of the QuickStart guide for the FB6000 can be obtained from the FireBrick website at : http://www.firebrick.co.uk/pdfs/quickstart-6000.pdf

1.1.2. What can it do?

The FB6000 series of products is a family of high speed ISP/telcos grade routers and firewalls providing a range of specific functions.

Key features of the FB6000 family:

- 1U 19" rack mount
- Very low power consumption (typical 20W) - all important with today's power charges in data centres
- Two small fans are the only moving parts for high reliability
- Dual 120/230V AC power feed
- IPv6 built in from the start
- Gigabit performance

1.1.3. Ethernet port capabilities

The FB6000 has two Ethernet network ports that operate at 1Gb/s. The ports implement auto-negotiation by default, but operation can be fine-tuned to suit specific circumstances. The function of these ports is very flexible, and defined by the device's configuration. The ports implement one or more *interfaces*.

Multiple interfaces can be implemented on a single physical port via support for IEEE 802.1Q VLANs, ideal for using the FB6000 with VLAN-capable network switches. In this case, a single physical connection can be made between a VLAN-capable switch and the FB6000, and with the switch configured appropriately, this physical connection will carry traffic to/from multiple VLANs, and the FB6000 can do Layer 3 processing (routing/firewalling etc.) between nodes on two or more VLANs.

1.1.4. Product variants in the FB6000 series

- **FB6102** High capacity ping monitoring box
- **FB6202** Gigabit L2TP LNS with detailed monitoring of all lines
- **FB6302** Gigabit BGP router
- **FB6402** Gigabit stateful firewall
- **FB6502** Gigabit core VoIP SIP switch for ISTP use
- **FB6602** Mobile GTPv1 GGSN/L2TP gateway

1.2. About this Manual

1.2.1. Version

Every major FB6000 software release is accompanied by a release-specific version of this manual. This manual documents software version V1.22.001 - please refer to Section 4.3 to find out more about software releases, and to see how to identify which software version your FB6000 is currently running.

If your FB6000 is running a different version of system software, then please consult the version of this manual that documents that specific version, as there may be significant differences between the software versions. Also bear in mind that if you are not reading the latest version of the manual (and using the latest software release), references in this manual to external resources, such as the FireBrick website, may be out of date.

Tip

If this is the correct manual for your current software version, then note that there may be a newer *revision* of this manual available, still covering the same software version, but with improvements or corrections to the documentation. We recommend you always ensure you are using the latest revision available, to be sure you are using the most accurate and up-to-date information. The revision of this manual can be identified via the Revision History table - this can be found on the home page of the documentation (when viewing the web based documentation), or near the front of the PDF version of the documentation.

You can find the latest revision of a manual for a specific software version on the FB6000 software downloads website [http://www.firebrick.co.uk/software.php?PRODUCT=6000].

1.2.2. Intended audience

This manual is intended to guide FB6000 owners in configuring their units for their specific applications. We try to make no significant assumption about the reader's knowledge of FireBrick products, but as might be expected given the target market for the products, it is assumed the reader has a reasonable working knowledge

of common IP and Ethernet networking concepts. So, whether you've used FireBrick products for years, or have purchased one for the very first time, and whether you're a novice or a network guru, this Manual sets out to be an easy to read, definitive guide to FireBrick product configuration for all FireBrick customers.

1.2.3. Document style

At FireBrick, we appreciate that different people learn in different ways - some like to dive in, hands-on, working with examples and tweaking them until they work the way they want, referring to documentation as required. Other people prefer to build their knowledge up from first principles, and gain a thorough understanding of what they're working with. Most people we suspect fall somewhere between these two learning styles.

This Manual aims to be highly usable regardless of your learning style - material is presented in an order that starts with fundamental concepts, and builds to more complex operation of your FireBrick. At all stages we hope to provide a well-written description of how to configure each aspect of the FireBrick, and - where necessary - provide enough insight into the FireBrick's internal operation that you understand *why* the configuration achieves what it does.

1.2.4. Document conventions

Various typefaces and presentation styles are used in this document as follows :-

- Text that would be typed as-is, for example a command, or an XML attribute name is shown in `monospaced_font`
- Program (including XML) listings, or fragments of listings are shown thus :-

```
/* this is an example program listing*/
printf("Hello World!\n");
```

- Text as it would appear on-screen is shown thus :-

```
This is an example of some text that would
appear on screen.
Note that for documentation purposes additional
line-breaks may be present that would not be in the on-screen text
```

- Notes of varying levels of significance are represented thus (colour schemes may differ depending on signficance) :-

> **Note**
>
> This is an example note.

The significance is identified by the heading text and can be one of : Tip - general hints and tips, for example to point out a useful feature related to the current discussion ; Note - a specific, but not critical, point relating to the surrounding text ; Caution - a potentially critical point that you should pay attention to, failure to do so may result in *loss of data, security issues, loss of network connectivity etc.*

1.2.5. Comments and feedback

If you'd like to make any comments on this Manual, point out errors, make suggestions for improvement or provide any other feedback, we would be pleased to hear from you via e-mail at : `docs@firebrick.co.uk`.

1.3. Additional Resources

1.3.1. Technical Support

Technical support is available, in the first instance, via the reseller from which you purchased your FireBrick. FireBrick provide extensive training and support to resellers and you will find them experts in Firebrick products.

However, before contacting them, please ensure you have :-

- upgraded your FB6000 to the latest version of software (see Section 4.3) and
- are using the latest revision of the manual applicable to that software version and
- have attempted to answer your query using the material in this manual

Many FireBrick resellers also offer general IT support, including installation, configuration, maintenance, and training. You may be able to get your reseller to develop FB6000 configurations for you - although this will typically be chargeable, you may well find this cost-effective, especially if you are new to FireBrick products.

If you are not satisfied with the support you are getting from your reseller, please contact us [http://www.firebrick.co.uk/contact.php].

1.3.2. IRC Channel

A public IRC channel is available for FireBrick discussion - the IRC server is `irc.z.je`, and the channel is `#firebrick`.

1.3.3. Application Notes

FireBrick are building a library of Application Note documents that you can refer to - each Application Note describes how to use and configure a FireBrick in specific scenarios, such as using the device in a multi-tenant Serviced Office environment, or using the FireBrick to bond multiple WAN connections together.

1.3.4. White Papers

FireBrick White Papers cover topics that deserve specific discussion - they are not related to specific Applications, rather they aim to educate interested readers regarding networking protocols, common/best practice, and real-world issues encountered.

1.3.5. Training Courses

FireBrick provide training courses for the FB2x00 series products, and also training course on general IP networking that are useful if you are new to networking with IP.

To obtain information about upcoming courses, please contact us via e-mail at : `training@firebrick.co.uk`.

Chapter 2. Getting Started

2.1. IP addressing

You configure your FireBrick using a web browser - to do this, you need IP connectivity between your computer and the FireBrick. For a new FB6000 or one that has been factory reset, there are three methods to set this up, as described below - select the method that you prefer, or that best suits your current network architecture.

- *Method 1* - use the FireBrick's DHCP server to configure a computer.

  If your computer is already configured (as many are) to get an IP address automatically, you can connect your computer to port 1 on the FireBrick, and the FireBrick's inbuilt DHCP server should give it an IPv4 address.

- *Method 2* - configure a computer with a fixed IP address.

  Alternatively, you can connect a computer to port 1 on the FireBrick, and manually configure your computer to have the fixed IP address(es) shown below :-

  Table 2.1. IP addresses for computer

IPv6	IPv4
`2001:DB8::2/64`	`10.0.0.2` ; subnet mask : `255.255.255.0`

- *Method 3* - use an existing DHCP server to configure the FireBrick.

  If your LAN already has a DHCP server, you can connect port 1 of your FireBrick to your LAN, and it will get an address.

2.2. Accessing the web-based user interface

If you used either Method 1 or Method 2, you should browse to the FireBrick's IP address as listed below:-

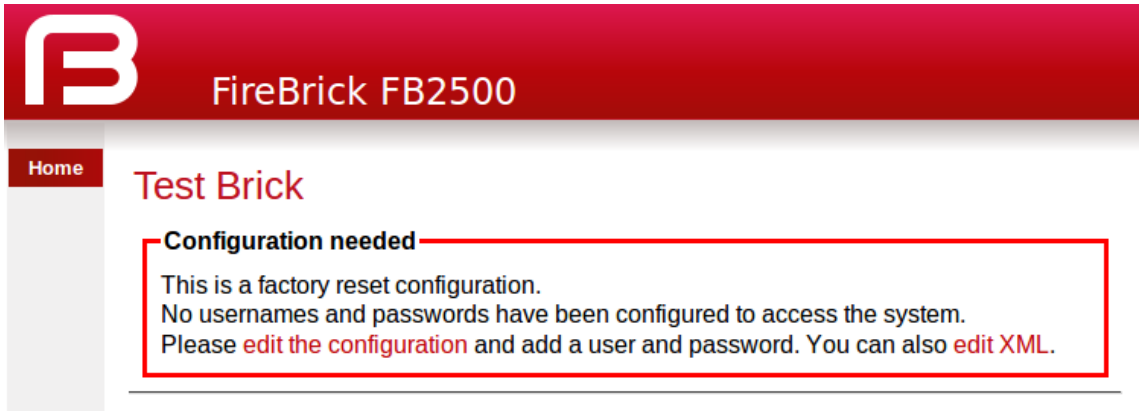
Table 2.2. IP addresses to access the FireBrick

IPv6	IPv4
`http://[2001:DB8::1]`	`http://10.0.0.1`

If you used Method 3, you will need to be able to access a list of allocations made by the DHCP server in order to identify which IP address has been allocated to the FB6000, and then browse this address from your computer. If your DHCP server shows the client name that was supplied in the DHCP request, then you will see FB6000 in the client name field (assuming a factory reset configuration) - if you only have one FB6000 in factory reset state on your network, then it will be immediately obvious via this client name. Otherwise, you will need to locate the allocation by cross-referring with the MAC address range used by the FB6000 you are interested in - if necessary, refer to Appendix C to see how to determine which MAC address you are looking for in the list of allocations.

Once you are connected to the FB6000, you should see a page with "Configuration needed" prominently displayed, as shown below :-

Figure 2.1. Initial web page in factory reset state



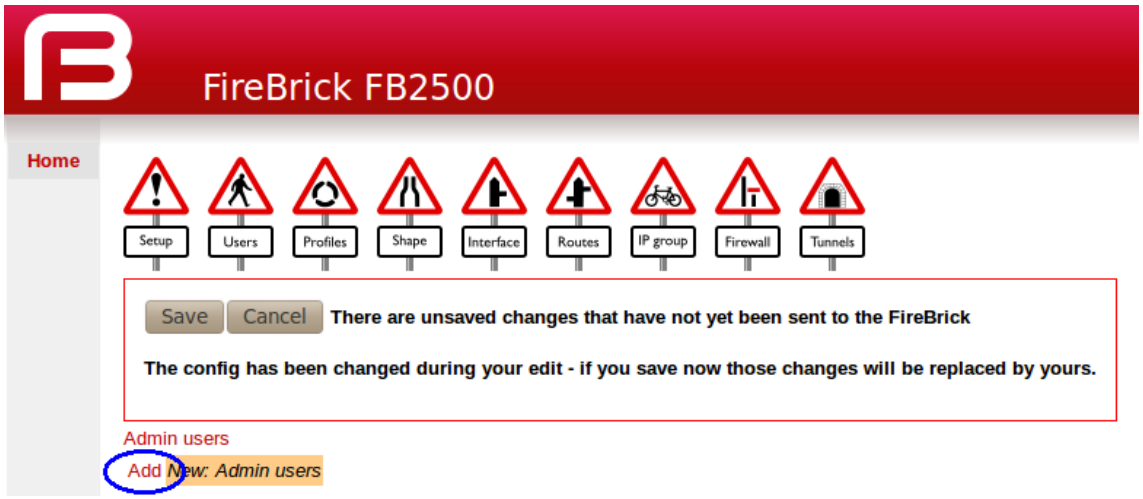
Click on the "edit the configuration" link (red text), which will take you to the main user interface page for managing the configuration.

2.2.1. Add a new user

You now need to add a new user with a password in order to gain full access to the FireBrick's user interface.

Click on the "Users" icon, then click on the "Add" link to add a user. The "Users" page is shown below, with the "Add" link highlighted:-

Figure 2.2. Initial "Users" page



Enter a suitable username in the "Name" box, and enter a password (passwords are mandatory), as shown below. Leave all other checkboxes un-ticked, but see the Tip below regarding the `timeout` setting.

Note

Take care to enter the password carefully, as the FB6000 does not prompt you for confirmation of the password.

Figure 2.3. Setting up a new user

Tip

You may also want to increase the login-session idle time-out from the default of 5 minutes, especially if you are unfamiliar with the user-interface. To do that, tick the checkbox next to `timeout`, and enter an appropriate value, which should start `PT`, be followed by a number, and end with units of either `M` for minutes, or `H` for hours.

Click on the Save button near the top of the screen which will save a new configuration that includes your new user definition.

You should now see a page showing the progress of storing the new configuration in Flash memory :-

Figure 2.4. Configuration being stored

```
Loading config
No errors found
Erasing flash page
Programming flash page
Flashed 1789 bytes
Config loaded. Please login to make any further changes.

Login
```

On this page there is a "Login" link (in red text)- click on this link and then log in using the username and password you chose.

We recommend you read Chapter 3 to understand the design of the FB6000's user interface, and then start working with your FB6000's factory reset configuration. Once you are familiar with how the user interface is structured, you can find more detail on setting up users in Section 4.1.

Chapter 3. Configuration

3.1. The Object Hierarchy

The FB6000 has, at its core, a configuration based on a *hierarchy of objects*, with each object having one or more *attributes*. An object has a *type*, which determines its role in the operation of the FB6000. The values of the attributes determine how that object affects operation. Attributes also have a *type* (or *datatype*), which defines the type of data that attribute specifies. This in turn defines what the valid syntax is for a value of that datatype - for example some are numeric, some are free-form strings, others are strings with a specific format, such as a dotted-quad IP address. Some examples of attribute values are :-

- IP addresses, and subnet definitions in CIDR format e.g. 192.168.10.0/24
- free-form descriptive text strings, e.g. a name for a firewall rule
- Layer 4 protocol port numbers e.g. TCP ports
- data rates used to control traffic shaping
- enumerated values used to control a feature e.g. defining Ethernet port LED functions

The object hierarchy can be likened to a family-tree, with relationships between objects referred to using terms such as Parent, Child, Sibling, Ancestor and Descendant. This tree-like structure is used to :-

- group a set of related objects, such as a set of firewall rules - the parent object acts as a container for a group of (child) objects, and may also contribute to defining the detailed behaviour of the group
- define a context for an object - for example, an object used to define a locally-attached subnet is a child of an object that defines an interface, and as such defines that the subnet is accessible on that specific interface. Since multiple interfaces can exist, other interface objects establish different contexts for subnet objects.

Additional inter-object associations are established via attribute values that reference other objects, typically by name, e.g. a firewall rule can specify one of several destinations for log information to be sent when the rule is processed.

3.2. The Object Model

The term 'object model' is used here to collectively refer to :-

- the constraints that define a valid object hiearchy - i.e. which object(s) are valid child objects for a given parent object, how many siblings of the same type can exist etc.
- for each object type, the allowable set of attributes, whether the attributes are mandatory or optional, their datatypes, and permissible values of those attributes

The bulk of this User Manual therefore serves to document the object model and how it controls operation of the FB6000.

Tip

This version of the User Manual may not yet be complete in its coverage of the full object model. Some more obscure attributes may not be covered at all - some of these may be attributes that are not used under any normal circumstances, and used only under guidance by support personnel. If you

encounter attribute(s) that are not documented in this manual, please refer in the first instance to the documentation described in Section 3.2.1 below. If that information doesn't help you, and you think the attribute(s) may be relevant to implementing your requirements, please consult the usual support channel(s) for advice.

3.2.1. Formal definition of the object model

The object model has a *formal* definition in the form of an XML Schema Document (XSD) file, which is itself an XML file, normally intended for machine-processing. A more readable version of this information is available by following the "Doc" link that is present against each software release on the FB6000 software downloads website [http://www.firebrick.co.uk/software.php?PRODUCT=6000].

Note, however, that this is *reference* material, containing only brief descriptions, and intended for users who are familiar with the product, and in particular, for users configuring their units primarily via XML.

The XSD file is also available on the software downloads website by following the "XSD" link that is present against each software release.

3.2.2. Common attributes

Most objects have a `comment` attribute which is free-form text that can be used for any purpose. Similarly, most objects have a `source` attribute that is intended for use by automated configuration management tools. Neither of these attributes have a direct effect on the operation of the FB6000.

3.3. Configuration Methods

The configuration objects are created and manipulated by the user via one of two configuration methods :

- web-based graphical User Interface accessed using a supported web-browser
- an XML (eXtensible Markup Language) file representing the entire object hierarchy, editable via the web interface or can be uploaded to the FB6000

The two methods operate on the same underlying object model, and so it is possible to readily move between the two methods - changes made via the User Interface will be visible as changes to the XML, and vice-versa. Users may choose to start out using the User Interface, and - as experience with the object model and the XML language develops - increasingly make changes in the XML environment. For information on using XML to configure the FB6000, please refer to Section 3.5.

3.4. Web User Interface Overview

This section provides an overview of how to use the web-based User Interface. We recommend that you read this section if you are unfamiliar with the FB6000, so that you feel comfortable with the design of the User Interface. Later chapters cover specific functionality topics, describing which objects are relevant, any underlying operational principles that are useful to understand, and what effect the attributes (and their values) have.

The web-based User Interface provides a method to create the objects that control operation of the FB6000. Internally, the User Interface uses a formal definition of the object model to determine where (in the hierarchy) objects may be created, and what attributes may exist on each object, so you can expect the User Interface to always generate valid XML. [1]

[1] If the User Interface does not generate valid XML - i.e. when saving changes to the configuration the FireBrick reports XML errors, then this may be a bug - please check this via the appropriate support channel(s).

Additionally, the web User Interface provides access to the following items :-

- status information, such as DHCP server allocations, FB105 tunnel information and system logs
- network diagnostic tools, such as Ping and Traceroute ; there are also tools to test how the FB6000 will process particular traffic, allowing you to verify your firewalling is as intended
- traffic graphs

By default, access to the web user interface is available to all users, from any IP address. If you don't require such open access, you may wish to restrict access using the settings described in Section 12.1.

3.4.1. User Interface layout

The User Interface has the following general layout :-

- a 'banner' area at the top of the page, containing the FireBrick logo, model number and system name
- a main-menu, with sub-menus that access various parts of the user interface ; the main-menu can be shown vertically or horizontally - sub-menu appearance depends on this display style : if the main-menu is vertical, sub-menus are shown by 'expanding' the menu vertically ; if the main-menu is horizontal, sub-menus are shown as pull-down menus
- a 'footer' area at the bottom of the page, containing layout-control icons and showing the current software version
- the remaining page area contains the content for the selected part of the user-interface

Figure 3.1 shows the main menu when it is set to display horizontally. Note that the main-menu items themselves have a specific function when clicked - clicking such items displays a general page related to that item - for example, clicking on Status shows some overall status information, whereas sub-menu items under Status display specific categories of status information.

Figure 3.1. Main menu

The user interface pages used to change the device configuration are referred to as the 'config pages' in this manual - these pages are accessed by clicking on the "Edit" item in the sub-menu under the "Config" main-menu item.

Note

The config pages utilise JavaScript for their main functionality ; you must therefore have JavaScript enabled in your web browser in order to configure your FB6000 using the web interface.

3.4.1.1. Customising the layout

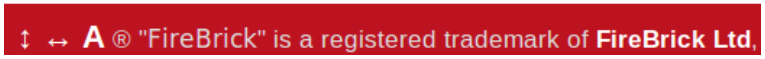
The following aspects of the user interface layout can be customised :-

- The banner area can be reduced in height, or removed all together
- The main menu strip can be positioned vertically at the left or right-hand sides, or horizontally at the top (under the banner, if present)

Additionally, you can choose to use the default fonts that are defined in your browser setup, or use the fonts specified by the user interface.

These customisations are controlled using three icons on the left-hand side of the page footer, as shown in Figure 3.2 below :-

Figure 3.2. Icons for layout controls



The first icon, an up/down arrow, controls the banner size/visibility and cycles through three settings : full size banner, reduced height banner, no banner. The next icon, a left/right arrow, controls the menu strip position and cycles through three settings : menu on the left, menu on the right, menu at the top. The last icon, the letter 'A', toggles between using browser-specified or user-interface-specified fonts.

Layout settings are stored in a cookie - since cookies are stored on your computer, and are associated with the DNS name or IP address used to browse to the FB6000, this means that settings that apply to a particular FB6000 will automatically be recalled next time you use the same computer/browser to connect to that FB6000.

3.4.2. Config pages and the object hierarchy

The structure of the config pages mirrors the object hierachy, and therefore they are themselves naturally hierachical. Your postition in the hierachy is illustrated in the 'breadcrumbs' trail at the top of the page, for example :-

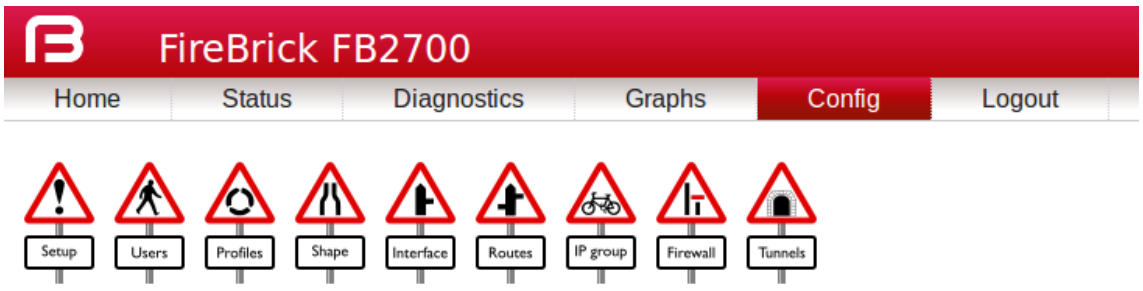
```
Firewall/mapping rules :: rule-set 1 of 3 (filters) :: rule 7 of 19 (ICMP)
```

This shows that the current page is showing a rule, which exists within a rule-set, which in turn is in the "Firewall/mapping rules" *category* (see below).

3.4.2.1. Configuration categories

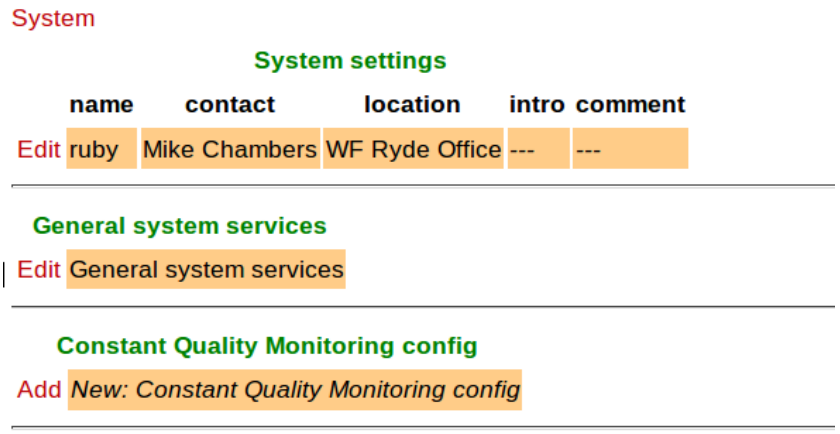
Configuration objects are grouped into a number of *categories*. At the top of the config pages is a set of icons, one for each category, as shown in Figure 3.3 :-

Figure 3.3. Icons for configuration categories



Within each category, there are one or more sections delimited by horizontal lines. Each of these sections has a heading, and corresponds to a particular type of *top-level* object, and relates to a major part of the configuration that comes under the selected category. See Figure 3.4 for an example showing part of the "Setup" category, which includes general system settings (the `system` object) and control of system services (network services provided by the FB6000, such as the web-interface web server, telnet server etc., controlled by the `services` object).

Figure 3.4. The "Setup" category



Each section is displayed as a tabulated list showing any existing objects of the associated type. Each row of the table corresponds with one object, and a subset (typically those of most interest at a glance) of the object's attributes are shown in the columns - the column heading shows the attribute name. If no objects of that type exist, there will be a single row with an "Add" link. Where the order of the objects matter, there will be an 'Add' link against each object - clicking an 'Add' link for a particular object will insert a new object *before* it. To add a new object after the last existing one, click on the 'Add' link on the bottom (or only) row of the table.

Tip

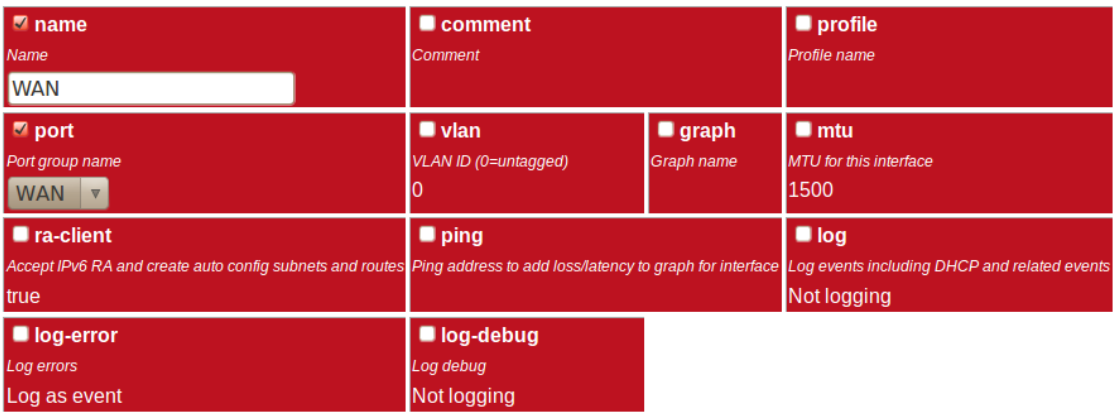
If there is no 'Add' link present, then this means there can only exist one object of that type, and such an object already exists. The existing object may have originated from the factory reset configuration.

You can 'push-down' into the hierarchy by clicking the 'Edit' link in a table row. This takes you to a page to edit that specific object. The page also shows any child objects of the object being edited, using the same horizontal-line delimited section style used in the top-level categories. You can navigate back up the hierarchy using various methods - see Section 3.4.3.

3.4.2.2. Object settings

The details of an object are displayed as a matrix of boxes, one for each attribute associated with that object type. Figure 3.5 shows an example for an `interface` object (covered in Chapter 6) :-

Figure 3.5. Editing an "Interface" object



By default, more advanced or less frequently used attributes are hidden - if this applies to the object being edited, you will see the text shown in Figure 3.6. The hidden attributes can be displayed by clicking on the link "Show all".

Figure 3.6. Show hidden attributes

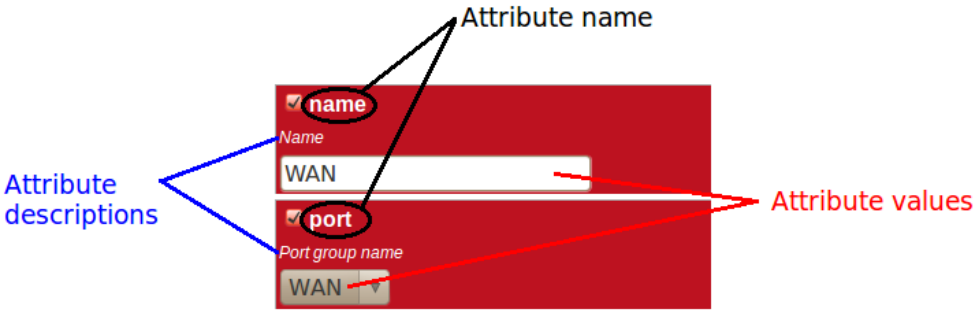
There are additional attributes which have not been shown. Show all

Each box in the matrix contains the following :-

- a checkbox - if the checkbox is checked, an appropriate value entry widget is displayed, otherwise, a *default* value is shown and applied for that setting.
- the attribute name - this is a compact string that exactly matches the underlying XML attribute name
- a short description of the attribute

These can be seen in Figure 3.7 :-

Figure 3.7. Attribute definitions



If the attribute value is shown in a 'strike-through' font (with a horizontal line through it mid-way vertically), this illustrates that the attribute can't be set - this will happen where the attribute value would reference an instance of particular type of object, but there are not currently any instances of objects of that type defined.

Tip

Since the attribute name is a compact, concise and un-ambiguous way of referring to an attribute, please quote attribute names when requesting technical support, and expect technical support staff to discuss your configuration primarily in terms of attribute (and object/element) names, rather than descriptive text, or physical location on your screen (both of which can vary between software releases).

Note

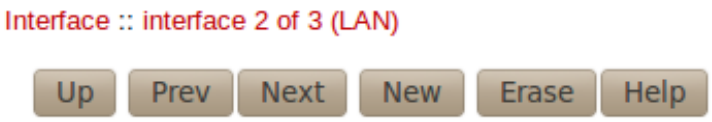
When the checkbox associated with an attribute is unchecked, this means the attribute value is *not (explicitly) specified*, and a *default* value is used. The default value is specified by the object model (see Section 3.2 via its associated formal definition (XSD file). When the checkbox is unchecked, the default value is shown under the attribute description text, and in the XML configuration (see Section 3.5), there will be no `name="value"` specification present for the attribute.

3.4.3. Navigating around the User Interface

You navigate around the hierarchy using one or more of the following :-

- configuration category icons
- the breadcrumbs - each part of the breadcrumbs (delimited by the :: symbol) is a clickable link
- the *in-page* navigation buttons, shown in Figure 3.8 : "Up" - move one level up in the object hierachy, "Prev" - Previous object in a list, and "Next" - Next object in a list.

Figure 3.8. Navigation controls



Caution

The configuration pages are generated on-the-fly using JavaScript within your web browser environment (i.e. client-side scripting). As such, the browser is essentially unaware of changes to page content, and cannot track these changes - *this means the browser's navigation buttons (Back, Forward), will not correctly navigate through a series of configuration pages.*

Please take care not to use the browser's Back button whilst working through configuration pages - navigation between such pages must be done via the buttons provided on the page - "Prev", "Next" and "Up".

Navigating away from an object *using the supported navigation controls* doesn't cause any modifications to that object to be lost, even if the configuration has not yet been saved back to the FB6000. All changes are initially held in-memory (in the web browser itself), and are committed back to the FireBrick only when you press the Save button.

The navigation button area, shown in Figure 3.8, also includes three other buttons :-

- New : creates a new instance of the object type being edited - the new object is inserted after the current one ; this is equivalent to using the "Add" link one level up in the hierarchy
- Erase : deletes the object being edited - note that the object will not actually be erased until the configuration is saved
- Help : browses to the online reference material (as desribed in Section 3.2.1) for the object type being edited

Caution

If you *Add* a new object, but don't fill in any parameter values, the object will remain in existence should you navigate away. You should be careful that you don't inadvertently add incompletely setup objects this way, as they may affect operation of the FireBrick, possibly with a detrimental effect.

If you have added an object, perhaps for the purposes of looking at what attributes can be set on it, remember to delete the object before you navigate away -- the "Erase" button (see Figure 3.8) is used to delete the object you are viewing.

3.4.4. Backing up / restoring the configuration

To back up / save or restore the configuration, start by clicking on the "Config" main-menu item. This will show a page with a form to upload a configuration file (in XML) to the FB6000 - also on the page is a link "Download/save config" that will download the current configuration in XML format.

3.5. Configuration using XML

3.5.1. Introduction to XML

An XML file is a text file (i.e. contains human-readable characters only) with formally defined structure and content. An XML file starts with the line :-

```
<?xml version="1.0" encoding="UTF-8"?>
```

This defines the version of XML that the file complies with and the character encoding in use. UTF-8 is used everywhere by the FireBrick.

The XML file contains one or more *elements*, which may be nested into a hiearchy.

Note

In XML, the configuration objects are represented by *elements*, so the terms object and element are used interchangeably in this manual.

Each element consists of some optional content, bounded by two *tags* - a *start tag* AND an *end tag*.

A start tag consists of the following sequence of characters:-

- a < character
- the element name
- optionally, a number of *attributes*
- a > character

An end tag consists of the following sequence of characters:-

- a < character
- a / character
- the element name
- a > character

If an element needs no content, it can be represented with a more compact *self closing tag*. A self closing tag is the same as a start tag but ends with /> and then has no content or end tag.

Since the <, > and " characters have special meaning, there are special ('escape') character sequences starting with the ampersand character that are used to represent these characters. They are :-

Table 3.1. Special character sequences

Sequence	Character represented
<	<
>	>
"	"
&	&

Note that since the ampersand character has special meaning, it too has an escape character sequence.

Attributes are written in the form : `name="value"` or `name='value'`. Multiple attributes are separated by white-space (spaces and line breaks).

Generally, the content of an element can be other *child* elements or text. However, the FB6000 doesn't use text content in elements - all configuration data is specified via attributes. Therefore you will see that elements only contain one or more child elements, or no content at all. Whilst there is generally not any text between the tags, white space is normally used to make the layout clear.

3.5.2. The root element - <config>

At the top level, an XML file normally only has one element (the *root* element), which contains the entire element hierarchy. In the FB6000 the root element is `<config>`, and it contains 'top-level' configuration elements that cover major areas of the configuration, such as overall system settings, interface definitions, firewall *rule sets* etc.

In addition to this User Manual, there is reference material is available that documents the XML elements - refer to Section 3.2.1.

3.5.3. Viewing or editing XML

The XML representation of the configuration can be viewed and edited (in text form) via the web interface by clicking on "XML View" and "XML Edit" respectively under the main-menu "Config" item. Viewing the configuration is, as you might expect, 'read-only', and so is 'safe' in as much as you can't accidentally change the configuration.

3.5.4. Example XML configuration

An example of a simple, but complete XML configuration is shown below, with annotations pointing out the main elements

```
<?xml version="1.0" encoding="UTF-8"?>
<config xmlns="http://firebrick.ltd.uk/xml/fb2700/"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:schemaLocation="http://firebrick.ltd.uk/xml/fb2700/  ...
        timestamp="2011-10-14T12:24:07Z"
        patch="8882">

 <system name="gateway"             ❶
         contact="Peter Smith"
         location="The Basement"
         log-panic="fb-support">
 </system>

 <user name="peter"                 ❷
       full-name="Peter Smith"
       password="FB105#4D42454D26F8BF5480F07DFA1E41AE47410154F6"
       timeout="PT3H20M"
       config="full"
       level="DEBUG"/>

 <log name="default"/>              ❸
 <log name="fb-support">
  <email to="crashlog@firebrick.ltd.uk"
         comment="Crash logs emailed to FireBrick Support"/>
 </log>

 <services>                         ❹
  <ntp timeserver="pool.ntp.org"/>
  <telnet log="default"/>
  <http />
  <dns domain="watchfront.co.uk"
       resolvers="81.187.42.42 81.187.96.96"/>
```

```
</services>

<port name="WAN"                    ❺
      ports="1"/>
<port name="LAN"
      ports="2"/>

<interface name="WAN"
           port="WAN">
 <subnet name="ADSL"
         ip="81.187.106.73/30"/>
</interface>

<interface name="LAN"               ❻
           port="LAN">
 <subnet name="LAN"
         ip="81.187.96.94/28"/>
 <dhcp name="LAN"
       ip="81.187.96.88-92"
       log="default"/>
</interface>

</config>
```

❶ sets some general system parameters (see Section 4.2)
❷ defines a single user with the highest level of access (DEBUG) (see Section 4.1)
❸ defines a log target (see Chapter 5)
❹ configures key system services (see Chapter 12)
❺ defines physical-port group (see Section 6.1)
❻ defines an interface, with one subnet and a DHCP allocation pool (see Chapter 6)

3.6. Downloading/Uploading the configuration

The XML file may be retrieved from the FireBrick, or uploaded to the FireBrick using HTTP transfers done via tools such as `curl`. Using these methods, configuration of the FB6000 can be integrated with existing administrative systems.

Note

Linebreaks are shown in the examples below for clarity only - they must not be entered on the command-line

3.6.1. Download

To download the configuration from the FB6000 you need to perform an HTTP `GET` of the following URL :-

`http://<FB6000 IP address or DNS name>/config/config`

An example of doing this using `curl`, run on a Linux box is shown below :-

```
curl http://<FB6000 IP address or DNS name>/config/config
```

```
   --user "username:password" --output "filename"
```

Replace *username* and *password* with appropriate credentials.

The XML configuration file will be stored in the file specified by *filename* - you can choose any file extension you wish (or none at all), but we suggest that you use `.xml` for consistency with the file extension used when saving a configuration via the User Interface (see Section 3.4.4).

3.6.2. Upload

To upload the configuration to the FB6000 you need to send the configuration XML file as if posted by a web form, using encoding MIME type `multi-part/form-data`.

An example of doing this using `curl`, run on a Linux box is shown below :-

```
curl http://<FB6000 IP address or DNS name>/config/config
   --user "username:password" --form config="@filename"
```

3.1. IP address groups

An IP address group is a named definition of a range of IP addresses, which can be referenced in many places where you would otherwise explicitly specify such ranges. This allows you to specify commonly occuring ranges (for example a trusted group of addresses) in one place, which aids maintainability, and then reference them by name, which speeds configuration and aids readability.

An IP address group is defined using an `ip-group` top-level object - in the web user interface, click on the "IP group" category icon to create and edit these objects.

Chapter 4. System Administration

4.1. User Management

You will have created your first user as part of the initial setup of your FB6000, as detailed in either the QuickStart Guide or in Chapter 2 in this manual.

To create, edit or delete users, browse to the config pages by clicking the "Edit" item in the sub-menu under the "Config" main-menu item, then click on the "Users" category icon. Click on the "Edit" link adjacent to the user you wish to edit, or click on the "Add" link to add a user.

To delete a user, click the appropriate "Edit" link, then click the "Erase" button in the navigation controls - see Figure 3.8. As with any such object erase operation, the object will not actually be erased until the configuration is saved.

Once you have added a new user, or are editing an existing user, the object editing page will appear, as shown in Figure 4.1 :-

Figure 4.1. Setting up a new user

The minimum attributes that must be specified are `name`, which is the username that you type in when logging in, and `password` - passwords are mandatory on the FB6000.

You can optionally provide a *full name* for the specified username, and a general comment field value.

4.1.1. Login level

A user's *login level* is set with the `level` attribute, and determines what CLI commands the user can run. The default, if the `level` attribute is not specified, is `ADMIN` - you may wish to downgrade the level for users who are not classed as 'system administrators'.

Table 4.1. User login levels

Level	Description
`NOBODY`	Unknown or not logged in user
`GUEST`	Guest user
`USER`	Normal unprivileged user
`ADMIN`	System administrator
`DEBUG`	System debugging user

4.1.2. Configuration access level

The *configuration access level* determines whether a user has read-only or read-write access to the configuration, as shown in Table 4.2 below. This mechanism can also be used to deny all access to the configuration using the `none` level, without actually deleting the user definition.

This setting is distinct from, and not connected with, the *login level* described above. You can use the access level to define, for example, whether a USER login-level user can modify the configuration. Typically an ADMIN (or DEBUG) login-level user would always be granted full access, so for ADMIN or DEBUG level user's, the default of `full` is suitable.

Table 4.2. Configuration access levels

Level	Description
`none`	No access unless explicitly listed
`view`	View only access (no passwords)
`read`	Read only access (with passwords)
`full`	Full view and edit access - DEFAULT

4.1.3. Login idle timeout

To improve security, login sessions to either the web user interface, or to the command-line interface (via telnet, see Chapter 15), will time-out after a period of inactivity. This idle time-out defaults to 5 minutes, and can be changed by setting the `timeout` attribute value.

The time-out value is specified using the syntax for the XML *Period* data type - this syntax consists of the prefix `PT`, followed by one or more components of a time value. Each component consists of a number followed by a unit - `H` (hours), `M` (minutes), `S` (seconds). As an example, the value `PT5M30S` represents 5 minutes and 30 seconds.

To set a user's time-out in the user interface, tick the checkbox next to `timeout`, and enter a value in the format described above.

4.1.4. Restricting user logins

4.1.4.1. Restrict by IP address

You can restrict logins by a given user to be allowed only from specific IP addresses, using the `allow` attribute. This restriction is per-user, and is distinct from, and applies in addition to, any restrictions specified on either the

web or telnet (for command line interface access) services (see Section 12.1 and Section 12.2), or any firewall rules that affect web or telnet access to the FB6000 itself.

4.1.4.2. Restrict by profile

By specifying a profile name using the `profile` attribute, you can allow logins by the user only when the profile is in the Active state (see Chapter 8). You can use this to, for example, restrict logins to be allowed only during certain times of the day, or you can effectively suspend a user account by specifying an always-Inactive profile.

4.2. General System settings

The `system` top-level object can specify attributes that control general, global system settings. The available attributes are described in the following sections, and can be configured in the User Interface by choosing the "Setup" category, then clicking the "Edit" link under the heading "System settings".

The software auto upgrade process is controlled by `system` objects attributes - these are described in Section 4.3.3.2.

4.2.1. System name (hostname)

The system name, also called the *hostname*, is used in various aspects of the FB6000's functions, and so we recommend you set the hostname to something appropriate for your network.

The hostname is set using the `name` attribute.

4.2.2. Administrative details

The attributes shown in Table 4.3 allow you to specify general administrative details about the unit :-

Table 4.3. General administrative details attributes

Attribute	Purpose
`comment`	General comment field
`contact`	Contact name
`intro`	Text that appears on the 'home' page - the home page is the first page you see after logging in to the FB6000. This text is also displayed immediately after you login to a command-line session.
`location`	Physical location description

4.2.3. System-level event logging control

The `log` and `log-...` attributes control logging of events related to the operation of the system itself. For details on event logging, please refer to Chapter 5, and for details on the logging control attributes on `system` object, please refer to Section 5.7.

4.2.4. Home page web links

The home page is the first page you see after logging in to the FB6000, or when you click the Home main-menu item. The home page displays the system name, and, if defined, the text specified by the `intro` attribute on the `system` object.

Additionally, you can define one or more web links to appear on the home page. These are defined using `link` objects, which are child objects of the `system` object.

To make a usable link, you must specify the following two attributes on the `link` object :-

- `text` : the text displayed as a hyperlink
- `url` : link destination URL

Additionally, you can name a link, specify a comment, and make the presence of the link on the home page conditional on a profile.

4.3. Software Upgrades

FB6000 users benefit from FireBrick's pro-active software development process, which delivers fast fixes of important bugs, and implementation of many customer enhancement requests and suggestions for improvement. As a matter of policy, FireBrick software upgrades are always free to download for all FireBrick customers.

To complement the responsive UK-based development process, the FB6000 is capable of downloading and installing new software *directly from Firebrick's servers*, providing the unit has Internet access.

This Internet-based upgrade process can be initiated manually (refer to Section 4.3.3.1), or the FB6000 can download and install new software automatically, without user intervention.

If the unit you want to upgrade does not have Internet access, then new software can be uploaded to the unit via a web browser instead - see Section 4.3.4.

Caution

Software upgrades are best done using the Internet-based upgrade process if possible - this ensures the changes introduced by *Breakpoint* releases are automatically accounted for (see Section 4.3.1.1)

Software upgrades will trigger an automatic reboot of your FB6000 - this will cause an outage in routing, and can cause connections that are using NAT to drop. However, the FB6000 reboots very quickly, and in many cases, users will be generally unaware of the event. You can also use a profile to restrict when software upgrades may occur - for example, you could ensure they are always done over night.

4.3.1. Software release types

There are three types of software release : factory, beta and alpha. For full details on the differences between these software releases, refer to the FB6000 software downloads website [http://www.firebrick.co.uk/software.php?PRODUCT=6000] - please follow the 'read the instructions' link that you will find just above the list of software versions.

Note

In order to be able to run alpha releases, your FB6000 must be enabled to run alpha software - this is done by changing the entry in the FireBrick capabilities database (hosted on FireBrick company servers) for your specific FB6000, as identified by the unit's Serial Number. Normally your FB6000 will be running factory or possibly beta software, with alpha software only used under advice and guidance of support personnel while investigating/fixing possible bugs or performance issues. You can see whether your FB6000 is able to run alpha releases by viewing the main Status page (click the Status main menu-item), and look for the row labelled "Allowed" - if the text shows "Alpha builds (for testing)" then your FB6000 can run alpha releases.

4.3.1.1. Breakpoint releases

Occasionally, a software release will introduce a change to the object model that means the way specific functionality is configured in XML also changes - for example an attribute may have been deprecated, and a replacement attribute should be used instead. A release where such an change has been made, and existing configurations will need modifying, are termed *Breakpoint* software releases.

Breakpoint releases are special as they are able to automatically update an existing configuration - used with the *previous* software release - so that it is compatible with the new release, and functionality is retained wherever possible.

When using the Internet-based upgrade process, the FB6000 will always upgrade to the next available breakpoint version first, so that the configuration is updated appropriately. If your current software version is several breakpoint releases behind the latest version, the upgrade process will be repeated for each breakpoint release, and then to the latest version if that is later than the latest breakpoint release.

On the FB6000 software downloads website, breakpoint releases are labelled `[Breakpoint]` immediately under the version number.

Note

If you have saved copies of configurations for back-up purposes, always re-save a copy after upgrading to a breakpoint issue. If you use automated methods to configure your FB6000, check documentation to see whether those methods need updating.

4.3.2. Identifying current software version

The current software version is displayed on the main Status page, shown when you click the Status main menu-item itself (i.e. not a submenu item). The main software application version is shown next to the word "Software", e.g. :-

```
Software      FB2700 Hermia (V1.07.001 2011-11-15T10:22:48)
```

The software version is also displayed in the right hand side of the 'footer' area of each web page, and is shown immediately after you login to a command-line session.

4.3.3. Internet-based upgrade process

Note

'Out of the box' the FB6000 is configured to automatically download and install new *factory* releases. This is a safe option, and we expect many users to be happy with this - however, if you would prefer, this process can be disabled - refer to Section 4.3.3.2.

If automatic installs are allowed, the FB6000 will check for new software on boot up and approximately every 24 hours thereafter - your FB6000 should therefore pick up new software at most ~ 24 hours after it is released. You can choose to allow this process to install only new factory-releases, factory or beta releases, or any release, which then includes *alpha* releases (if your FB6000 is enabled for alpha software - see Section 4.3.1) - refer to Section 4.3.3.2 for details on how to configure auto upgrades.

4.3.3.1. Manually initiating upgrades

Whenever you browse to the main Status page, the FB6000 checks whether there is newer software available, given the current software version in use, and whether alpha releases are allowed. If new software is available, you will be informed of this as shown in Figure 4.2 :-

Figure 4.2. Software upgrade available notification

To see what new software is available, click on the "Upgrade available" link. This will take you to a page that will show *Release notes* that are applicable given your current software version, and the latest version available. On that page there is an "Upgrade" button which will begin the software upgrade process.

4.3.3.2. Controlling automatic software updates

There are two attributes on the `system` object (see Section 4.2) that affect the automatic software upgrade process :-

Table 4.4. Attributes controlling auto-upgrades

Attribute	Description
`sw-update`	Controls what types of software releases the auto-upgrade process will download/install. This attribute can also be used to disable the auto-upgrade process - use the value of `false` to achieve this. • `false` : Disables auto upgrades • `factory` : Only download/install factory releases - this is the default if the attribute is not specified • `beta` : Download/install factory or beta releases • `alpha` : Download/install factory, beta or alpha releases
`sw-update-profile`	Specifies the name of a profile to use to control when software upgrades are attempted (see Chapter 8 for details on profiles).

The current setting of `sw-update` (in descriptive form) can be seen on the main Status page, adjacent to the word "Upgrade", as shown in Figure 4.2 (in that example, `sw-update` is set to, or is defaulting to, `factory`).

4.3.4. Manual upgrade

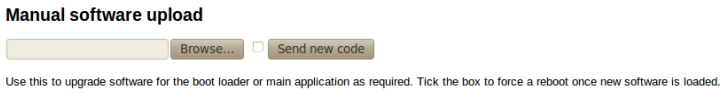
This method is entirely manual, in the sense that the brick itself does not download new software from the FireBrick servers, and responsibilty for loading breakpoint releases as required lies with the user.

In order to do this, you will first need to download the required software image file (which has the file extension `.img`) from the FB6000 software downloads website [http://www.firebrick.co.uk/software.php?PRODUCT=6000] onto your PC.

The next step is the same as you would perform when manually-initiating an Internet-based upgrade i.e. you should browse to the main Status page, where, if there is new software is available, you will be informed of this as shown in Figure 4.2.

This step is necessary since the manual upgrade feature currently shares the page used for Internet-based manual upgrades, which is reached by clicking "Upgrade available" link. After clicking this link, you will find the manual upgrade method at the bottom of the page, as shown in Figure 4.3 :-

Figure 4.3. Manual Software upload



4.4. Boot Process

The FB6000 contains internal Flash memory storage that holds two types of software :-

- main application software (generally referred to as the *app*)
- a bootloader - runs immediately on power-up, initialises system, and then loads the app

It is possible for only one of these types of software, or neither of them, to be present in the Flash, but when shipped from the factory the unit will contain a bootloader and the latest factory-release application software. The FB6000 can store multiple app software images in the Flash, and this is used with an automatic fall-back mechanism - if a new software image proves unreliable, it is 'demoted', and the unit falls back to running older software. The `show flash contents` CLI command can be used to see what is stored in the Flash - see Command Line Reference.

4.4.1. LED indications

4.4.1.1. Power LED status indications

The green power LED has three defined states, as shown in Table 4.5 below :-

Table 4.5. Power LED status indications

Indication	Status
Off	No AC power applied to unit (or possibly hardware fault)
Flashing with approximately 1 second period	Bootloader running / waiting for network connection
On	Main application software running

After power-up, the normal power LED indication sequence is therefore to go through the ~1 second period flashing phase, and then - if at least one Ethernet port is connected to an active device - change to solid once the app is running.

From power-up, a FB6000 will normally boot and be operational in *under five seconds*.

4.4.1.2. Port LEDs

Whilst the bootloader is waiting for an active Ethernet connection, the green and yellow LEDs built into the physical port connectors flash in a continual left-to-right then right-to-left sequence. The port LEDs on the panel on the opposite side to the physical ports also flash, in a clock-wise sequence.

Note

The same port LED flashing sequences are observed if the app is running and none of the Ethernet ports are connected to an active link-partner. Note that the app continues to run, and the power LED will still be on solid.

When connected to an active link-partner, these flashing sequences will stop and the port LEDs will start indicating physical port status, with various status indications possible, controllable via the configuration (see Section 6.4).

Chapter 5. Event Logging

5.1. Overview

Many *events* in the operation of the FireBrick create a log entry. These are a one-line string of text saying what happened. This could be normal events such as someone logging in to the web interface, or unusual events such as a wrong password used, or DHCP not being able to find any free addresses to allocate.

5.1.1. Log targets

A *log target* is a named destination (initially internal to the FB6000) for log entries - you can have multiple log targets set up which you can use to separate out log event messages according to some criteria - for example, you could log all firewalling related log events to a log target specifically for that purpose. This makes it easier to locate events you are looking for, and helps you keep each log target uncluttered with un-related log events - this is particularly important when when you are logging a lot of things very quickly.

A log target is defined using a `log` top-level object - when using the web User Interface, these objects are in the "Setup" category, under the heading "Log target controls".

Every log entry is put in a buffer in RAM, which only holds a certain number of log entries (typically around 1MB of text) - once the buffer is full, the oldest entries are lost as new ones arrive. Since the buffer is stored in volatile memory (RAM), buffer contents are lost on reboot or power failure.

This buffer can be viewed via the web interface or command line which can show the history in the buffer and then *follow the log* in real time (even when viewing via a web browser, with some exceptions - see Section 5.6.1).

In some cases it is essential to ensure logged events can be viewed even after a power failure. You can flag a log target to log to the non-volatile Flash memory within the FB6000, where it will remain stored even after a power failure. You should read Section 5.5 before deciding to log events to Flash memory.

Each log target has various attributes and child objects defining what happens to log entries to this target. However, in the simplest case, where you do not require non-volatile storage, or external logging (see Section 5.3), the log object will only need a `name` attribute, and will have no child objects. In XML this will look something like :-

```
<log name="my_log"/>
```

5.1.1.1. Logging to Flash memory

The internal Flash memory logging system is separate from the external logging. It applies if the log target object has `flash="true"`. It causes each log entry to be written to the internal non-volatile Flash log as it is created.

The flash log is intended for urgent permanent system information only, and is visible using the `show flash log` CLI command (see Command Line Reference for details on using this command. Chapter 15 covers the CLI in general.

> **Caution**
>
> Flash logging slows down the system considerably - only enable Flash logging where absolutely necessary.

The flash log does have a limit on how much it can hold, but it is many thousands of entries so this is rarely an issue. Oldest entries are automatically discarded when there is no space.

5.1.1.2. Logging to the Console

The *console* is the command line environment described in Chapter 15. You can cause log entries to be displayed as soon as possible on the console (assuming an active console session) by setting `console="true"` on the log target.

You can stop the console logging with `troff` command or restart it with `tron` command.

5.2. Enabling logging

Event logging is enabled by setting one of the attributes shown in Table 5.1 on the appropriate object(s) in the configuration, which depends on what event(s) you are interested in. The attribute value specifies the name of the log target to send the event message to. The events that cause a log entry will naturally depend on the object on which you enable logging. Some objects have additional attributes such as `log-error` for unusual events, and `log-debug` for extra detail.

Table 5.1. Logging attributes

Attribute	Event types
`log`	This is normal events. Note that if `log-error` is not set then this includes errors.
`log-errors`	This is when things happen that should not. It could be something as simple as bad login on telnet. Note that if `log-errors` is not set but `log` is set then errors are logged to the *log* target by default.
`log-debug`	This is extra detail and is normally only used when diagnosing a problem. Debug logging can be a lot of information, for example, in some cases whole packets are logged (e.g. PPP). It is generally best only to use debug logging when needed.

5.3. Logging to external destinations

Entries in the buffer can also be sent on to external destinations, such as via email or *syslog*. Support for triggering SNMP traps may be provided in a future software release.

You can set these differently for each log target. There is inevitably a slight lag between the event happening and the log message being sent on, and in some cases, such as email, you can deliberately delay the sending of logs to avoid getting an excessive number of emails.

If an external logging system cannot keep up with the rate logs are generated then log entries can be lost. The fastest type of external logging is using *syslog* which should manage to keep up in pretty much all cases.

5.3.1. Syslog

The FB6000 supports sending of log entries across a network to a *syslog server*. Syslog is described in RFC5424 [http://tools.ietf.org/html/rfc5424], and the FB6000 includes microsecond resolution time stamps, the hostname (from system settings) and a module name in entries sent via syslog. Syslog logging is very quick as there is no reply, and syslog servers can be easily setup on most operating systems, particularly Unix-like systems such as Linux.

Note

Older syslog servers will typically show time and hostname twice, and will need upgrading.

The module name refers to which part of the system caused the log entry, and is also shown in all other types of logging such as web and console.

To enable log messages to be sent to a syslog server, you need to create a `syslog` object that is a child of the log target (`log`) object. You must then specify the DNS name or IP address of your syslog server by setting the `server` attribute on the `syslog` object. You can also set the *facility* and/or *severity* values using these attributes :-

- `facility` : the 'facility' to be used in the syslog messages - when syslog entries are generated by subsystems or processes in a general-purpose operating system, the facility typically identifies the message source ; where the commonly used facility identifiers are not suitable, the "local0" thru "local7" identifiers can be used. If the `facility` attribute is not set, it defaults to `LOCAL0`

- `severity` : the severity value to be used in the syslog messages - if not set, the severity defaults to `NOTICE`

The FB6000 normally uses the 'standard' syslog port number of 514, but if necessary, you can change this by setting the `port` attribute value.

5.3.2. Email

You can cause logs to be sent by e-mail by creating an `email` object that is a child of the log target (`log`) object.

An important aspect of emailed logs is that they have a *delay* and a *hold-off*. The delay means that the email is not sent immediately because often a cluster of events happen over a short period and it is sensible to wait for several log lines for an event before e-mailing.

The hold-off period is the time that the FB6000 waits after sending an e-mail, before sending another. Having a hold-off period means you don't get an excessive number of e-mails ; since the logging system is initially storing event messages in RAM, the e-mail that is sent after the hold-off period will contain any messages that were generated during the hold-off period.

Both of these periods are specified as an XML Period value - refer to Section 4.1.3 for details on the required syntax.

The following aspects of the e-mail process can be configured :-

- subject : you can either specify the subject, by setting the `subject` attribute value, or you can allow the FB6000 to create a subject based on the first line of the log message

- e-mail addresses : as to be expected, you must specify a target e-mail address, using the `to` attribute. You can optionally specify a From: address, by setting the `from` atttribute, or you can allow the FB6000 to create an address based on the unit's serial number

- outgoing mail server : the FB6000 normally sends e-mail directly to the Mail eXchanger (MX) host for the domain, but you can optionally specify an outgoing mail server ('smart host') to use instead, by setting the `server` attribute

- SMTP port number : the FB6000 defaults to using TCP port 25 to perform the SMTP mail transfer, but if necessary you can set the `port` attribute to specify which port number to use

- retry delay : if an attempt to send the e-mail fails, the FB6000 will wait before re-trying ; the default wait period is 10 minutes, but you can change this by setting the `retry` attribute

An example of a simple log target with e-mailing is available in a factory reset configuration - the associated XML is shown below, from which you can see that in many cases, you only need to specify the `to` attribute (the `comment` attribute is an optional, general comment field) :-

```
<log name="fb-support"
     comment="Log target for sending logs to FireBrick support team">
 <email to="crashlog@firebrick.ltd.uk"
        comment="Crash logs emailed to FireBrick Support team"/>
</log>
```

A profile can be used to stop emails at certain times, and when the email logging is back on an active profile it tries to catch up any entries still in the RAM buffer if possible.

5.3.2.1. E-mail process logging

Since the process of e-mailing can itself encounter problems, it is possible to request that the process itself be logged via the usual log target mechanism. This is done by specifying one or more of the `log`, `log-debug` and `log-error` attributes.

> **Note**
>
> We recommend that you avoid setting these attributes such that specify the log-target containing the `email` object, otherwise you are likely to continually receive e-mails as each previous e-mail process log will trigger another e-mail - the hold-off will limit the rate of these mails though.

5.4. Factory reset configuration log targets

A factory reset configuration has a log target named `default`, which only logs to RAM. Provided this log target has not been deleted, you can therefore simply set `log="default"` on any appropriate object to immediately enable logging to this 'default' log target, which can then be viewed from the web User Interface or via the CLI.

A factory reset configuration also has a log target named `fb-support` which is referenced by the `log-panic` attribute of the `system` object (see Section 5.7). This allows the FireBrick to automatically email the support team if there is a panic (crash) - you can, of course, change or delete this if you prefer.

> **Caution**
>
> Please only set things to log to `fb-support` if requested by support staff.

5.5. Performance

The FireBrick can log a lot of information, and adding logs can causes things to slow down a little. The controls in the config allow you to say what you log in some detail. However, logging to flash will always slow things down a lot and should only be used where absolutely necessary.

5.6. Viewing logs

5.6.1. Viewing logs in the User Interface

To view a log in the web User Interface, select the "Log" item in the "Status" menu. Then select which log target to view by clicking the appropriate link. You can also view a 'pseudo' log target "All" which shows log event messages sent to any log target.

The web page then continues showing log events on the web page in *real time i.e. as they happen.*

Note

This is an "open ended" web page which has been known to upset some browsers, but this is rare. However it does not usually work with any sort of web proxy which expects the page to actually finish.

All log targets can be viewed via the web User Interface, regardless of whether they specify any external logging (or logging to Flash memory).

5.6.2. Viewing logs in the CLI environment

The command line allows logs to be viewed, and you can select which log target, or all targets. The logging continues on screen until you press a key such as RETURN.

In addition, anything set to log to console shows anyway (see Section 5.1.1.2), unless disabled with the `troff` command.

5.7. System-event logging

Some aspects of the operation of the overall system have associated events and messages that can be logged. Logging of such events is enabled via the `system` object attributes shown in Table 5.2 below :-

Table 5.2. System-Event Logging attributes

`system` object attribute	Event types
`log`	General system events.
`log-debug`	System debug messages.
`log-error`	System error messages.
`log-eth`	General Ethernet hardware messages.
`log-eth-debug`	Ethernet hardware debug messages.
`log-eth-error`	Ethernet hardware error messages.
`log-panic`	System Panic events.
`log-stats`	"One second stats" messages

Specifying system event logging attributes is usually only necessary when diagnosing problems with the FB6000, and will typically be done under guidance from support staff. For example, `log-stats` causes a log message to be generated *every second* containing some key system statistics and state information, which are useful for debugging.

Note that there are some system events, such as startup and shutdown, which are always logged to all log targets, and to the console and flash by default, regardless of these logging attributes.

5.8. Using Profiles

The log target itself does not have a profile, but each of the external logging entries can have a profile. Some types of logging will catch up when their profile comes back on (e.g. email) but most are immediate (such as syslog and SMS) and will drop any entries when disabled by an Inactive profile.

Chapter 6. Interfaces and Subnets

This chapter covers the setup of *Ethernet* interfaces and the definition of subnets that are present on those interfaces.

For information about other types of 'interfaces', refer to the following chapters :-

- Point-to-Point Protocol over Ethernet (PPPoE) - Chapter 10
- Tunnels, including FB105 tunnels - Chapter 11

6.1. Relationship between Interfaces and Physical Ports

The FB6000 features four Gigabit Ethernet (1Gb/s) ports that can also operate at 10Mb/s and 100Mb/s speeds. Auto-negotiation of link speed is enabled by default, so when connected to auto-negotation capable equipment, the ports operate at the highest speed that both ends of the link can run at. In some situations, auto-negotiation is not supported by connected equipment, and so the FB6000 provides control of port behaviour to allow the port to work with such equipment.

Each port features a green and amber LED, the functions of which can be chosen from a range of options indicating link speed and/or traffic activity.

The exact function of the ports is flexible, and controlled by the configuration of the FB6000.

6.1.1. Port groups

Up to four port groups can be defined, with each group comprising a set of one or more physical ports that doesn't overlap with any other group. The ports within the group work as a conventional Ethernet switch, directly transferring traffic at wire-speed that is destined for a MAC address that is present on one of the other ports in the group.

6.1.2. Interfaces

In the FB6000, an *interface* is a logical equivalent of a physical Ethernet interface adapter. Each interface normally exists in a distinct *broadcast domain*, and is associated with at most one port group. It is referred to as a logical interface, since Virtual LAN (VLAN) support allows multiple logical interfaces to be implemented on one physical port group. If you are unfamiliar with VLANs or the concept of broadcast domains, Appendix D contains a brief overview.

Table 6.1 shows the logical to physical associations that are possible :-

Table 6.1. Physical port usage options

Association	Notes
A single physical port[a] implements one interface	VLANs are not in use on the port, and so only untagged packets are present.
A user-defined group of physical ports implements one interface	The ports in the group work as a conventional Layer 2 Ethernet switch, directly transferring traffic at wire-speed that is destined for a MAC address that is present on one of the other ports in the group.

	The interface is associated with an internal (to the FB6000) port in this switch-port group, thus :- • packets arriving at any of the ports in the group and destined for a MAC address belonging to the FB6000 will be received by the associated interface • packets being sent out of the interface will be forwarded to the appropriate physical port based on normal MAC learning
A single physical port implements multiple interfaces	VLANs are in use on the port - each logical interface is specified with a different VLAN ID, the port receives (and sends) tagged packets, the tag is removed and the packet is processed as arriving on the interface with matching VLAN ID
A user-defined group of physical ports implements multiple interfaces	**TBC would this ever be done?**

[a]This is actually a port group, but with only a single member.

From Table 6.1 it will be apparent that, when not using VLANs, a maximum of four interfaces can be defined - one interface per physical port. When using VLANs, the number of interfaces is ultimately limited to the smaller of 4096 (as a result of the VLAN tag size of 12-bits) or the number of MAC addresses available for use by a specific FB6000 (see Appendix C).

By combining the FB6000 with a VLAN capable switch, using only a single physical connection between the switch and the FB6000, you can effectively expand the number of distinct physical interfaces, with the upper limit on number being determined by switch capabilities, or by inherent IEEE 802.1Q VLAN or FB6000 MAC address block size. An example of such a configuration is a multi-tenant serviced-office environment, where the FB6000 acts as an Internet access router for a number of tenants, firewalling between tenant networks, and maybe providing access to shared resources such as printers.

6.2. Defining port groups

Port groups come under the Interface category in the top-level icons. Under the section headed "Port grouping and naming", you will see the list of existing port groups - port group objects (`port`) are top-level objects. If there are less than four groups already defined, an Add link will be present.

Each group is given a user-defined name, which is used to refer to the group in any interface definitions.

To create a new group, click on the Add link to take you to a simple page where you specify the name of the group, and select one or more physical ports to belong to the group. To select more than one physical port, hold down the Ctrl key whilst clicking on a port number to toggle it between selected and unselected. An optional comment can also be specified for the group, which may be useful to act as a memory jogger for the purpose of the port group.

Editing an existing group works similarly - click the Edit link next to the group you want to modify.

The example XML below shows three port groups :-

```
<config ...>
...
 <port name="WAN"
       ports="1"/>
 <port name="ADMIN"
       ports="2"/>
```

```
 <port name="LAN"
       ports="3 4"/>
...
</config>
```

In this example, "WAN" and "ADMIN" groups consists of a single port each, physical ports 1 and 2 respectively. The "LAN" group consists of two physical ports, numbers 3 and 4. Ports 3 and 4 are members of a single layer 2 broadcast domain, and are equivalent in function in terms of communication between the FB6000 and another device.

6.3. Defining an interface

To create or edit interfaces, select the Interface category in the top-level icons - under the section headed "Ethernet interface (port-group/vlan) and subnets", you will see the list of existing `interface` top-level objects (if any), and an "Add" link.

The primary attributes that define an interface are the name of the physical port group it uses, an optional VLAN ID, and an optional name. If the VLAN ID is not specified, it defaults to "0" which means only *untagged* packets will be received by the interface.

To create a new interface, click on the Add link to take you to a new interface defintion. Tick the `port` checkbox and select one of the defined port groups. If the interface is to exist in a VLAN, tick the `vlan` checkbox and enter the VLAN ID in the text field.

Editing an existing interface works similarly - click the Edit link next to the interface you want to modify.

An `interface` object can have the following child objects :-

- One or more subnet definition objects
- Zero or more DHCP server settings objects
- Zero or more Virtual Router Redundancy Protocol (VRRP) settings objects (refer to Chapter 14)

6.3.1. Defining subnets

Each interface can have one *or more* subnets definitions associated with it. The ability to specify multiple subnets on an interface can be used where it is necessary to communicate with devices on two different subnets and it is acceptable that the subnets exist in the same broadcast domain. For example, it may not be possible to reassign machine addresses to form a single subnet, but the machines do not require firewalling from each other.

Note

As discussed in Section 6.1, an interface is associated with a broadcast domain ; therefore multiple subnets existing in a single broadcast domain are not 'isolated' (at layer 2) from each other. Effective firewalling (at layer 3) cannot be established between such subnets ; to achieve that, subnets need to exist in different broadcast domains, and thus be on different interfaces. An example of this is seen in the factory default configuration, which has two interfaces, "WAN" and "LAN", allowing firewalling of the LAN from the Internet.

You may also have both IPv4 and IPv6 subnets on an interface where you are also using IPv6 networking.

The primary attributes that define a subnet are the IP address range of the subnet, the IP address of the FB6000 itself on that subnet, and an optional name.

The IP address and address-range are expressed together using *CIDR notation* - if you are not familiar with this notation, please refer to Appendix B for an overview.

To create or edit subnets, select the Interface category in the top-level icons, then click Edit next to the appropriate interface - under the section headed "IP subnet on the interface", you will see the list of existing `subnet` child objects (if any), and an "Add" link.

Note

In a factory reset configuration, there are two temporary subnets defined on the "LAN" interface : `2001:DB8::1/64` and `10.0.0.1/24`. These subnet definitions provide a default IP address that the FB6000 can initially be accessed on, regardless of whether the FB6000 has been able to obtain an address from an existing DHCP server on the network. Once you have added new subnets to suit your requirements, and tested that they work as expected, these temporary definitions should be removed.

To create a new subnet, click on the Add link to take you to a new `subnet` object defintion. Tick the `ip` checkbox, and enter the appropriate CIDR notation.

Editing an existing subnet works similarly - click the Edit link next to the subnet you want to modify.

6.3.1.1. Using DHCP to configure a subnet

You can create a subnet that is configured via DHCP by clearing the `ip` checkbox - the absence of an IP address/prefix specification causes the FB6000 to attempt to obtain an address from a DHCP server (which must be in the same broadcast domain). It may help to use the Comment field to note that the subnet is configured via DHCP.

In its simplest form, a DHCP configured subnet is created by the following XML :- `<subnet />`

6.3.2. Setting up DHCP server parameters

The FB6000 can act as a DHCP server to dynamically allocate IP addresses to clients. Optionally, the allocation can be accompanied by information such as a list of DNS resolvers that the client should use.

Since the DHCP behaviour needs to be defined for each interface (specifically, each broadcast domain), the behaviour is controlled by one or more `dhcp` objects, which are children of an `interface` object.

Address allocations are made from a *pool* of addresses - the pool is either explicitly defined using the `ip` attribute, or if `ip` is not specified, it consists of all addresses on the interface i.e. from all subnets, but excluding network or broadcast addresses, or any addresses that the FB6000 has seen ARP responses for (i.e. addresses already in use, perhaps through a static address configuration on a machine).

The XML below shows an example of an explicitly-specified DHCP pool :-

```
<interface ...>
...
  <dhcp name="LAN"
        ip="172.30.16.50-80"
        log="default"/>
...
</interface>
```

Every allocation made by the DHCP server built-in to the FB6000 is stored in non-volatile memory, and as such will survive power-cycling and/or rebooting. The allocations can be seen using the "DHCP" item in the "Status" menu, or using the `show dhcp` CLI command.

If a client does not request renewal of the lease before it expires, the allocation entry will show "expired". Expired entries remain stored, and are used to lease the same IP address again if the same client (as identified

by its MAC address) requests an IP address. However, if a new MAC address requests an allocation, and there are no available IPs (excluding expired allocations) in the allocation pool, then the oldest expired allocation IP address is re-used for the new client.

6.3.2.1. Fixed/Static DHCP allocations

'Fixed' (or 'static') allocations can be achieved by creating a separate `dhcp` object for each such allocation, and specifying the client MAC address via the `mac` attribute on the `dhcp` object.

The XML below shows an example of a fixed allocation - note the MAC address is written without any colons, and is therefore a string of twelve hexadecimal digits (48-bits). This allocation also supplies DNS resolver information to the client.

```
<interface ...>
...
  <dhcp name="laptop"
        ip="81.187.96.81"
        mac="0090F59E4F12"
        dns="81.187.42.42 81.187.96.96"
        log="default"/>
...
</interface>
```

Tip

If you are setting up a static allocation, but your client has already obtained an address (from your FB6000) from a pool, you will need to clear the allocation and then force the client to issue another DHCP request (e.g. unplug ethernet cable, do a software 'repair connection' procedure or similar etc.). See the `show dhcp` and `clear dhcp` CLI commands in the Command Line Reference for details on how to clear the allocation. Chapter 15 covers the CLI in general.

6.3.2.2. Partial-MAC-address based allocations

In addition to specifying a full 48-bit (12 hexadecimal character) MAC address in a `dhcp` object, it is also possible to specify part of a MAC address, specifically some number of *leading* bytes. The `dhcp` object will then apply for any client whose MAC address has the same leading bytes.

For example, as discussed in Appendix C, the first three octets (bytes) of a MAC address identify the organization (often the end product manufacturer) that can allocate that MAC address to an Ethernet device. By specifying only these first three bytes (six hexadecimal characters, no colon delimiters), in the `mac` attribute, you could ensure that all devices from the associated manufacturer are allocated addresses from a particular address pool. This is helpful if you have some common firewalling requirements for such a group of devices - for example, if all your VoIP phones are from one manufacturer - as you can have appropriate firewall rule(s) that apply to addresses in that pool.

6.4. Physical port settings

The detailed operation of each physical port can be controlled by creating `ethernet` top-level objects, one for each port that you wish to define different behaviour for vs. default behaviour.

To create a new `ethernet` object, or edit an existing object, select the Interface category from the top-level icons. Under the section headed "Ethernet port settings", you will see the list of existing `ethernet` objects (if any), and an "Add" link.

In a factory reset configuration, there are no `ethernet` objects, and all ports assume the following defaults :-

- Link auto-negotiation is enabled - both speed and duplex mode are determined via auto-negotiation, which should configure the link for highest performance possible for the given link-partner (which will need to be capable of, and participating in, auto-negotiation for this to happen)
- Auto-crossover mode is enabled - the port will swap Receive and Transmit pairs if required to adapt to cable / link-partner configuration
- The green port LED is configured to show combined Link Status and Activity indication - the LED will be off if no link is established with a link-partner. When a link is established (at any speed), the LED will be on steady when there is no activity, and will blink when there is activity.
- The yellow port LED is configured to show Transmit activity.

When you first create an `ethernet` object you will see that none of the attribute checkboxes are ticked, and the defaults described above apply. Ensure that you set the `port` attribute value correctly to modify the port you intended to.

6.4.1. Disabling auto-negotiation

If you are connecting a port to a link-partner that does not support auto-negotiation (or has it disabled), it is advisable to disable auto-negotiation on the FB6000 port. To do this, tick the checkbox for the `autoneg` attribute and select `false` from the drop-down box. You will then need to set port speed and duplex mode manually (see below) to match the link-partner settings.

6.4.2. Setting port speed

If auto-negotiation is enabled, the FB6000 port will normally advertise that it is capable of link-speeds of 10Mb/s, 100Mb/s or 1Gb/s - if you have reason to restrict the possible link-speed to *one* of these values you can set the `speed` attribute to 10M, 100M or 1G. This will cause the port to only advertise the specified speed - if the (auto-negotiate capable) link-partner does not support that speed, the link will fail to establish.

If auto-negotiation is disabled, the `speed` attribute simply sets the port's speed.

6.4.3. Setting duplex mode

If auto-negotiation is enabled, the FB6000 port will normally advertise that it is capable of either half- or full-duplex operation modes - if you have reason to restrict the operation to either of these modes, you can set the `duplex` attribute to either `half` or `full`. This will cause the port to only advertise the specified mode - if the (auto-negotiate capable) link-partner does not support that mode, the link will fail to establish.

If auto-negotiation is disabled, the `duplex` attribute simply sets the port's duplex mode.

> **Note**
> If you do not set the `autoneg` attribute (checkbox is unticked), and you set *both* port speed and duplex mode to values other than `auto`, auto-negotiation will be disabled ; this behaviour is to reduce the potential for duplex mis-match problems that can occur when connecting the FB6000 to some vendors' (notably Cisco) equipment that has auto-negotation disabled by default.

6.4.4. Defining port LED functions

For each port, the green and yellow port LEDs can be set to indicate any of the conditions shown in Table 6.2, by setting the values of the `green` and/or `yellow` attributes.

Table 6.2. Port LED functions

Value	Indication

`Link/Activity`	On when link up (any speed); blink (off) when Tx or Rx activity *(Default for Green LED)*
`Link1000/Activity`	On when link up at 1Gbit/s; blink (off) when Tx or Rx activity
`Link100/Activity`	On when link up at 100Mbit/s; blink (off) when Tx or Rx activity
`Link10/Activity`	On when link up at 10Mbit/s; blink (off) when Tx or Rx activity
`Link100-1000/Activity`	On when link up at 100Mbit/s or 1Gbit/s; blink (off) when Tx or Rx activity
`Link10-1000/Activity`	On when link up at 10Mbit/s or 1Gbit/s; blink (off) when Tx or Rx activity
`Link10-100/Activity`	On when link up at 10Mbit/s or 100Mbit/s; blink (off) when Tx or Rx activity
`Duplex/Collision`	On when full-duplex; blink when half-duplex and collisions detected
`Collision`	Blink (on) when collisions detected
`Tx`	Blink (on) when Transmit activity *(Default for Yellow LED)*
`Rx`	Blink (on) when Receive activity
`Off`	Permanently off
`On`	Permanently on
`Link`	On when link up
`Link1000`	On when link up at 1Gbit/s
`Link100`	On when link up at 100Mbit/s
`Link10`	On when link up at 10Mbit/s
`Link100-1000`	On when link up at 100Mbit/s or 1Gbit/s
`Link10-1000`	On when link up at 10Mbit/s or 1Gbit/s
`Link10-100`	On when link up at 10Mbit/s or 100Mbit/s
`Duplex`	On when full-duplex

For example, to configure the port LEDs to show the port link speed via the pattern of the green and yellow LEDs, you could set the `green` attribute to `Link10-1000/Activity`, and the `yellow` attribute to `Link100-1000` so that the indication is :-

Table 6.3. Example modified Port LED functions

Green	Yellow	Indication
Off	Off	Link down
On/Blinking	Off	Link up at 10Mbit/s / Tx or Rx Activity
Off	On/Blinking	Link up at 100Mbit/s / Tx or Rx Activity
On/Blinking	On/Blinking	Link up at 1Gbit/s / Tx or Rx Activity

Chapter 7. Routing

7.1. Routing logic

The routing logic in the FB6000 operates primarily using a conventional routing system of *most specific prefix*, which is commonly found in many IP stacks in general purpose computers and routers.

Conventional routing determines where to send a packet based *only* on the packet's *destination* IP address, and is applied on a 'per packet' basis - i.e. each packet that arrives is processed independently from previous packets.

Note that with this routing system, it does not matter where the packet came *from*, either in terms of source IP address or which interface/tunnel etc. the packet arrived on.

The FB6000 also implements more specialised routing logic that can route traffic based on other characteristics, such as source address, that can be used when routing based on destination IP address alone is insufficient.

A *route* consists of :-

- a 'target' specifying where to send the packet to - this may be a specialised action, such as silently dropping the packet (a 'black-hole')
- an IP address range that this routing information applies to - the *routing destination*

A *routing table* consists of one or more routes. Unlike typical IP stacks, the FB6000 supports multiple independent routing tables.

Routing destinations are expressed using CIDR notation - if you are not familiar with this notation, please refer to Appendix B for an overview. Note that ip-groups cannot be used when defining subnets or routes. IP-groups allow arbitrary ranges and not just prefixes, but routes can only use prefixes.

There are two cases that deserve special attention :-

- A routing destination may be a single IP address, in which case it is a "/32" in CIDR notation (for IPv4).
- A routing destination may encompass the entire IPv4 (or IPv6) address space, written as `0.0.0.0/0` (for IPv4) or `::/0` (for IPv6) in CIDR notation. Since the prefix is zero-length, all destination IP addresses will match this route - however, it is always the shortest-prefix route present, and so will only match if there are no more specific routes. A `0.0.0.0/0` route therefore acts as a *default* route.

The decision of where to send the packet is based on matching the packet's destination IP address to one or more routing table entries. If more than one entry matches, then the longest (most specific) prefix entry is used. The longest prefix is assumed to be associated with the optimal route to the destination IP address, since it is the 'most specific', i.e. it covers a smaller IP address range than any shorter matching prefix.

For example, if you have two routes, one for 10.0.1.32/27 , and another for 10.0.0.0/8 (which encompasses 10.0.1.32/27), then a destination IP address of 10.0.1.17 will match the longest-prefix (smallest address range) "/27" route.

The order in which routes are created does not normally matter as you do not usually have two routes that have the same prefix. However, there is an attribute of every route called the `localpref` which decides between identical routes - the *higher* `localpref` being the one which applies. If you have identical routes with the same `localpref` then one will apply (you cannot rely on which one) but it can, in some cases, mean you are bonding multiple links.

Tip

You can show the route(s) that apply for a specific destination IP address or address range using the CLI command `show route`. You can also see a list of all routes in a routing table using the CLI command `show routes`.

7.2. Routing targets

A route can specify various targets for the packet :-

Table 7.1. Route targets

Target	Notes
an Ethernet interface (locally-atached subnet)	requires ARP or ND to find the device on the LAN to which the traffic is to be sent.
a specific IP address (a "gateway")	the packet is forwarded to another router (gateway) ; routing is then determined based on the gateway's IP address instead
tunnel interface such as L2TP, PPPoE or FB105 tunnels. **TBC is PPPoE really a 'tunnel'? it's a type of interface ... **	
special targets	e.g. the FB6000 itself, or to a *black hole* (causes all traffic to be dropped)

These are covered in more detail in the following sections.

7.2.1. Subnet routes

Whenever you define a subnet or one is created dynamically (e.g. by DHCP), an associated route is automatically created for the associated prefix. Packets being routed to a subnet are sent to the Ethernet `interface` that the subnet is associated with. Traffic routed to the subnet will use ARP or ND to find the final MAC address to send the packet to.

In addition, a subnet definition creates a very specific single IP (a "/32" for IPv4, or a "/128" for IPv6) route for the IP address of the FB6000 itself on that subnet. This is a separate *loop-back* route which effectively internally routes traffic back into the FB6000 itself - i.e. it never appears externally.

A subnet can also have a *gateway* specified, either in the config or by DHCP or RA. This gateway is just like creating a route to 0.0.0.0/0 or ::/0 as a specific route configuration. It is mainly associated with the subnet for convenience. If defined by DHCP or RA then, like the rest of the routes created by DHCP or RA, it is removed when the DHCP or RA times out.

Example: `<subnet ip="192.168.0.1/24"/>` creates a route for destination `192.168.0.0/24` to the `interface` associated with that subnet. A loop-back route to `192.168.0.1` (the FB6000's own IP address on that subnet) is also created.

7.2.2. Routing to an IP address (gateway route)

Routes can be defined to forward traffic to another IP address, which will typically be another router (often also called a *gateway*) For such a routing target, the gateway's IP address is then used to determine how to route the traffic, and another routing decision is made. This subsequent routing decision usually identifies an `interface` or other data link to send the packet via - in more unusual cases, the subsequent routing decision identifies another gateway, so it is possible for the process to be 'recursive' until a 'real' destination is found.

Example: `<route ip="0.0.0.0/0" gateway="192.168.0.100"/>` creates a default IPv4 route that forwards traffic to `192.168.0.100`. The routing for `192.168.0.100` then has to be looked up to find the final target, e.g. it may be to an Ethernet interface, in which case an ARP is done for `192.168.0.100` to find the MAC to send the traffic.

7.2.3. Special targets

It is possible to define two special targets :-

- 'black-hole' : packets routed to a black-hole are silently dropped. 'Silent' refers to the lack of any ICMP response back to the sender.
- 'no-where' (also called 'dead-end') : packets routed to 'no-where' are also dropped but the FB6000 generates ICMP error responses back to the sender.

The `blackhole` and `nowhere` top-level objects are used to specify prefixes which are routed to these special targets. In the User Interface, these objects can be found under the Routes category icon.

7.3. Dynamic route creation / deletion

For data links that have an Up/Down state, such as L2TP or FB105 tunnels, or PPP links, the ability to actually send traffic to the route target will depend on the state of the link. For such links, you can specify route(s) to automatically create each time the link comes up - when the link goes down these routes are removed automatically. Refer to Chapter 11 for details on how to achieve this via the `routes` attribute on the tunnel definition objects.

Note

Routes to subnets on Ethernet interfaces do not support this functionality.

This can be useful where a link such as PPPoE is defined with a given `localpref` value, and a separate route is defined with a *lower* `localpref` value (i.e. less preferred), and therefore acts as a fallback route if the PPPoE link drops.

7.4. Routing tables

The conventional routing logic described above operates using one of possibly many routing tables that the FB6000 can support simultaneously. Routing tables are numbered, with the default being routing table 0 (zero).

The various ways to add routes allow the routing table to be specified, and so allow completely independent routing for different routing tables. The default table (table zero) is used when optional routing-table specification attributes or CLI command parameters are omitted.

Each `interface` is logically in a routing table and traffic arriving on it is processed based on the routes in that routing table. Tunnels like FB105 and L2TP allow the wrapped tunnel packets to work on one routing table and the tunnel payload packets to be on another. In firewalling models, it is possible to *jump* between routing tables using a rule in a rule-set.

Chapter 8. Profiles

Profiles allow you to enable/disable various aspects of the FB6000's configuration (and thus functionality) based on things such as time-of-day or presence/absence of Ping responses from a specified device.

8.1. Overview

A profile is a two-state control entity - it is either Active or Inactive. Once a profile is defined, it can be referenced in various configuration objects where the profile state will control the behaviour of that object.

A profile's state is determined by one or more defined *tests*, which are performed periodically. If multiple tests are specified, then the overall test result will be pass only if all the individual test results are pass. Assuming the profile's state is Active, then when the overall test result has been 'fail' for a specified duration, the profile transitions to Inactive. Similary, once the overall test result has been 'pass' for a specified duration, the profile transitions to Active. These two durations are controlled by attributes and provide a means to 'filter' out short duration 'blips' that are of little interest.

An example of a test that can be performed is a Ping test - ICMP echo request packets are sent, and replies are expected. If replies are not being received, the test fails.

Profiles can be logically combined using familiar boolean terminology i.e. AND, OR and NOT, allowing for some complex profile logic to be defined that determines a final profile state from several conditions.

By combining profiles with the FB6000's event logging facilities, they can also be used for automated monitoring and reporting purposes, where profile state changes can be e-mailed direct from the FB6000. For example, a profile using a Ping test can be used to alert you via e-mail when a destination is unreachable.

The current state of all the profiles configured on your FB6000 can be seen by choosing the "Profiles" item in the "Status" menu.

Tip

You can also define dummy profiles that are permanantly Active or Inactive, which can be useful if you wish to temporarily disable some functionality without deleting configuration object(s). For example, you can force an FB105 tunnel to be Down, preventing traffic from being routed through it. Refer to Section 8.2.4 for details.

8.2. Creating/editing profiles

In the web user interface, profiles are created and edited by clicking on the "Profiles" category icon. A profile is defined by a `profile` top-level object.

8.2.1. Timing control

The following timing control parameters apply :-

- `interval` : the interval between tests being performed
- `timeout` : the duration that the overall test must have been failing for before the profile state changes to Inactive
- `recover` : the duration that the overall test must have been passing for before the profile state changes to Active

The `timeout` and `recover` parameters do not apply to manually set profiles (see Section 8.2.4) and those based on time-of-day (see Section 8.2.2.2).

8.2.2. Tests

8.2.2.1. General tests

'General' tests are provided for the following :-

- FB105 tunnel state : the `fb105` attribute lists one or more FB105 tunnel names (see Section 11.1) - if *any* of the specified tunnels are in the Active state, this tunnel-state test will pass
- PPPoE connection state : the `ppp` attribute lists one or more PPPoE connection names (see Chapter 10) - if *any* of the specified connections are up, this pppoe-state test will pass
- Routable addresses : the `route` attributes lists one or more IP addresses (full addresses, not CIDR prefix ranges) - only if *all* the addresses are 'routable' - i.e. there is an entry in the routing table that will match that address - will this test pass. Refer to Chapter 7 for discussion of routing tables and the routing logic used by the FB6000
- VRRP state : the `vrrp` attribute lists one or more Virtual Router group membership definitions (see Chapter 14) by name - if the FB6000 is not the master device in any of these Virtual Routers, this test will fail

If more than one of these general tests is selected (corresponding attribute specified), then they must all pass (along with all other tests defined) for the overall result to be pass.

8.2.2.2. Time/date tests

Time and/or date tests are specified by `date` and/or `time` objects, which are child objects of the `profile` object.

You can define multiple date ranges via multiple `date` objects - the date test will pass if the current date is within *any* of the defined ranges. Similarly, you can define multiple time ranges via multiple `time` objects - the time test will pass if the current time is within *any* of the defined ranges.

8.2.2.3. Ping tests

Like time/date tests, a Ping test is specified by a `ping` object, as a child of the `profile` object. At most one Ping test can be defined per profile - logical combinations of profiles can be used to combine Ping tests if necessary.

8.2.3. Inverting overall test result

The tests described in the previous section are used to form an overall test result. Normally this overall result is used to determine the profile state using the mapping Pass > Active and Fail > Inactive. By setting the `invert` attribute to `true`, the overall result is inverted (Pass changed to Fail and vice-versa) first before applying the mapping.

8.2.4. Manual override

You can manually override all tests, and force the profile state using the `set` attribute - a value of `true` forces the state to Active, and `false` forces it to Inactive.

Note that the value of the `invert` attribute is ignored when manual override is requested.

These fixed-state profiles can be used as simple on/off controls for configuration objects. The following shows an example of two such profiles, expressed in XML :-

```
<profile name="Off" set="false"/>

<profile name="On" set="true"/>
```

Chapter 9. Traffic Shaping

The FB6000 includes traffic shaping functionality that allows you to control the speed of specific traffic flows through the FB6000. The FB6000 also provides *graphing* functionality, allowing specific traffic flows to be plotted on a graph image (PNG format) that the FB6000 generates. Within the FB6000, traffic shaping and graphing are closely associated, and this is reflected in how you configure traffic shaping - in order to be able to perform traffic shaping, you must first graph the traffic flow.

9.1. Graphs and Shapers

9.1.1. Graphs

Several objects in the FB6000's configuration allow you to specify the name of a *graph*, by setting the value of the `graph` attribute. This causes the traffic flow that is associated with that object (a firewall rule, an interface, or whatever the attribute is attached to) to be recorded on a graph with the specified name. For connections that have a defined state, such as a PPP link, the graph will also show the link state history. Other information, such as packet loss and latency may also be displayed, depending on whether it can be provided by the type of object you are graphing.

For example, the XML snippet below shows the `graph` attribute being set on an `interface`. As soon as you have set a `graph` attribute (and saved the configuration), a new graph with the specified name will be created.

```
<interface name="LAN"
           port="LAN"
           graph="LAN">
```

The graph is viewable directly (as a PNG image) from the FB6000 via the web User Interface - to view a graph, click the "PNG" item in the "Graphs" menu. This will display all the graphs that are currently configured - it is not currently possible to show a single graph within the web User Interface environment.

Note

You may find images shown for graph names that are no longer specified anywhere in the configuration. Over time, these graphs will disappear automatically.

Alternatively, the underlying graph data is available in XML format, again via the FB6000's built-in HTTP server. The XML version of the data can be viewed in the web User Interface by clicking the "XML" item in the "Graphs" menu, and then clicking on the name of the graph you're interested in.

Both directions of traffic flow are recorded, and are colour-coded on the PNG image generated by the FB6000. The directions are labelled "tx" and "rx", but the exact meaning of these will depend on what type of object the graph was referenced from - for example, on a graph for an `interface`, "tx" will be traffic leaving the FB6000, and "rx" will be traffic arriving at the FB6000.

Each data point on a graph corresponds to a 100 second interval ; where a data point is showing a traffic rate, the rate is an average over that interval. For each named graph, the FB6000 stores data for the last 24 hours.

Note

Specifying a graph does not itself cause any traffic shaping to occur, but is a pre-requisite to specifying how the associated traffic flow should be shaped.

9.1.2. Shapers

Once you have graphed a (possibly bi-directional) traffic flow, you can then also define speed restrictions on those flows. These can be simple "Tx" and "Rx" speed limits or more complex settings allowing maximum average speeds over time.

You define the speed controls associated with the graphed traffic flow(s) by creating a `shaper` top-level object. To create or edit a `shaper` object in the web User Interface, first click on the "Shape" category icon. To create a new object, click the "Add" link. To edit an existing object, click the appropriate "Edit" link instead.

The `shaper` object specifies the parameters (primarily traffic rates) to use in the traffic shaping process, and the `shaper` is *associated* with the appropriate existing graph by specifying the `name` attribute of the `shaper` object to be the *same* as the name of the graph.

Chapter 10. PPPoE

The FB6000 can operate as a PPPoE client. This is typically used to connect to an Internet service provider, either via a suitable PPPoE modem, bridging router, or direct connection.

The typical usage is to use one or more ports on the FB6000 each connected directly to a suitable PPPoE device such as a bridging router.

The PPPoE device is usually very dumb and may not need any configuration at all. The FireBrick is responsible for the login to the ISP using the PPPoE link, and the configuration for this is part of the FB6000's configuration and not the router. This makes it very easy to make use of spare routers, etc, without the complication of configuring additional devices.

It is possible to connect more than one PPP device to a single FB6000 port using an Ethernet switch. If you do this then you ideally need a switch that handles VLANs (see Appendix D if you are not familiar with VLANs) so that each router can be logically connected to a different interface on the FireBrick. It is also a good idea to have a switch that supports *jumbo frames* if using FTTC or FTTP services in this way.

Note

This section contains information relating to access network services (such as DSL and Fibre-To-The-Cabinet) available in the United Kingdom. Although this information will not be directly applicable to services available in other countries, the concepts are the same - with appropriate knowledge of your ISP service, and suitable equipment, the FB6000 should work equally well with services that are available in other countries.

10.1. Types of DSL line and router in the United Kingdom

In the UK there are various types of DSL line and router than can be used. Any device that supports PPPoE can work with the FireBrick, but some options are only available with some devices, as listed below :-

- BT 20CN or 21CN lines can support PPPoE and PPPoA *on the wire*. This means you can use them with a PPPoE/A modem (such as a *Vigor V-120*) *out of the box*, or with a bridging router such as the *Zyxel P660* configured in bridge mode.
- Be PPPoE lines only support PPPoE. This means you have to use a bridging router or other device that handles PPPoE *on the wire* and not a PPPoE/A modem.
- Be PPPoA lines only support PPPoA. This means you have to use a PPPoE/A modem, and not a bridging router.
- BT FTTC lines come with a VDSL modem which supports PPPoE directly so no extra equipment is needed to connect to the FireBrick.
- BT FTTP lines terminate on an active NTE which supports PPPoE directly so no extra equipment is needed to connect to the FireBrick.

For other types of lines in the UK, or those in other countries, you need to know what they can do *on the wire* (PPPoA or PPPoE) and have a suitable modem/router to talk that protocol and convert to PPPoE on the LAN link to the FB6000. It seems most DSL routers will bridge PPPoE on the wire to PPPoE on the LAN, but few will act as a PPPoE access concentrator. The Vigor V-120 is one of the few that handle PPPoA on the wire and PPPoE link to the FB6000.

A significant benefit of the Vigor V-120 is that it works with *no configuration* on BT 20CN and 21CN lines as well as Be PPPoA lines - you just plug it in to the line and the FB6000 and it just works.

For fibre to the cabinet (FTTC) and fibre to the premises (FTTP) service you connect the FB6000 directly to the service with no extra equipment.

10.2. Defining PPPoE links

A PPPoE link is defined by a `ppp` top-level object. To create or edit PPPoE links in the web user interface, select the "Interface" category icon - - under the section headed "PPPoE settings" you will see the list of existing `ppp` objects (if any), and an "Add" link.

For most situations, configuring a PPPoE link only requires that you specify the physical port number, or alternatively, a port group name (see Section 6.2), that the router/modem is connected to and the login credentials i.e. username and password. The port number or port group name is specified via the `port` attribute on the `ppp` object, and credentials are specified via the `username` and `password` attributes.

If you are connecting multiple routers/modems via a VLAN capable switch to a single FB6000 port, you will also need to specify the VLAN used for the FB6000 to router/modem layer 2 connection - this is done by setting the value of the `vlan` attribute too.

As an example, if you were to connect a single modem/router directly to port 4 on your FB6000 (i.e. not using VLANs), then the configuration needed, shown as an XML fragment, would be :-

```
<ppp port="4" username="..." password="..."/>
```

You may also want to give the PPPoE link a name, by setting the `name` attribute - you can then reference the link in, for example, a profile (see Section 8.2.2.1).

There are a number of additional options (see below), but for most configurations this is all you need. It causes the FB6000 to connect and set a default route for internet access via the PPP link.

10.2.1. IPv6

If your ISP negotiates IPv6 on the link, then a default route is set for IPv6 traffic down the line. You just need to configure your LAN subnet to have the IPv6 block your ISP has assigned to you.

10.2.2. Additional options

10.2.2.1. MTU and TCP fix

Normally PPPoE operates with a maximum packet size of 1492 bytes - this is due to the 8 byte PPPoE header that is used, and the normal 1500 byte payload limit of an Ethernet packet. The FB6000 includes an option to set the PPPoE MTU, so that when used with equipment capable of jumbo frames (such as BT FTTC and FTTP services) this allows use of slightly larger frames to provide a 1500 byte MTU. To achieve this, simply set the `mtu` attribute to a value of 1500. By default the `tcp-mss-fix` attribute is also set, which means when working with a smaller MTU such as 1492, any connections that try and establish 1500 byte links are adjusted on the fly to be the lower MTU. This avoids problems with a lot of corporate and bank web sites that do not handle MTU and ICMP correctly. Typically your ISP will be doing this TCP fix for you as well.

Testing has been done which confirms setting mtu="1500" works correctly on BT FTTC lines.

Note

Testing using a Zyxel P660R in bridge mode confirms that BT 21CN ADSL lines will negotiate 1500 byte MTU, but it seems the Zyxel will not bridge more than 1496 bytes of PPP payload. If you select more than 1492 MTU and have problems it could be that some device connecting you to the access

concentrator cannot handle the larger packets (such as a bridge or a switch). For this reason the default MTU is 1492.

10.2.2.2. Service and ac-name

The PPPoE protocol allows multiple services to be offered, and the service setting can be used to select which is available. This is rarely needed and should be ignored unless you know what you are doing. If specified, even as an empty string, then only matching services will be selected.

The name specified via the `ac-name` attribute is the name of the PPPoE endpoint (access controller). In some cases there may be a choice of endpoints and setting this causes one to be selected by name. Again, this is rarely needed, and if specified will only match the name you specify. On Be PPPoE lines, for example, you could select a specific LAC by name if you wanted to.

10.2.2.3. Logging

The PPP connection status, and PPP negotiation can be logged by setting the `log` attribute to a valid log target. This can be useful for debugging.

10.2.2.4. Speed and graphs

As discussed in Chapter 9, graphs allow you to visual connections, in terms of their state, traffic rates and patterns etc. By setting the `graph` attribute, you can cause the state of the line, data transferred each way, and current packet loss and latency to be recorded on a graph. This normally operates in slow mode (an LCP every 16 seconds) but by setting the `slow` attribute to `false` you can monitor a line every second. **TBC is this correct ; do we not use lcp-rate now?**

Once you are graphing the PPPoE connection, you can set traffic shaping to control speed (see Section 9.1.2). Alternatively, a PPPoE connection is something you can set a speed limit on directly - setting the `speed` attribute will control the speed of traffic *sent to* the Internet - this is mainly used when bonding PPP links.

Chapter 11. Tunnels

The FB6000 supports the following tunnelling protocols :-

- FB105 lightweight tunnelling protocol
- L2TP

Support for FB105 tunnels means the FB6000 can inter-work with existing FB105 hardware, and with FB2x00 devices.

11.1. FB105 tunnels

The FB105 tunnelling protocol is a FireBrick proprietary protocol that was first implemented in the FireBrick FB105 device, and is popular with FB105 users for setting up VPNs etc. It is 'lightweight' in as much as it is relatively simple, with low overhead and easy setup, but it does not currently offer encryption. Although encryption is not available, the protocol does digitally sign packets, so that tunnel end-points can be confident that the traffic originated from another 'trusted' end-point. Where it matters, encryption can be utilised via secure protocols such as HTTPS or SSH over the tunnel.

The protocol supports multiple simultaneous tunnels to/from an end-point device, and Local Tunnel ID values are used on an end-point device to identify each tunnel. The 'scope' of the Local ID is restricted to a single end-point device - as such, the tunnel *itself* does not possess a (single) ID value, and is instead identified by the Local IDs in use at both ends, *which may well differ*.

11.1.1. Tunnel wrapper packets

The protocol works by wrapping a complete IP packet in a UDP packet, with the destination port number of the UDP packet defaulting to 1, but which can be set to any other port number if required. These UDP packets are referred to as the 'tunnel wrappers', and include the digital signature. As with any other UDP traffic *originating* at the FB6000, the tunnel wrappers are then encapsulated in an IP packet and sent to the IP address of the *far-end* tunnel end-point. The IP packet that is contained in a tunnel wrapper packet is referred to as the 'tunnel payload', and IP addresses in the payload packet are not involved in any routing decisions until the payload is 'unwrapped' at the far-end.

Payload packet traffic is sent down a tunnel if the FB6000's routing logic determines that tunnel is the *routing target* for the traffic. Refer to Chapter 7 for discussion of the routing processes used in the FB6000. Often, a dynamic route is specified in the tunnel definition, such that traffic to a certain range of IP addresses (or possibly all IP addresses, for a default route) is routed down the tunnel when it is in the Up state - see Section 11.1.4 for details.

Tip

Payload IP addressing is not restricted to RFC1918 private IP address space, and so FB105 tunnels can be used to transport public IP address traffic too. This is ideal where you want to provide public IP addresses to a network, but it is either impossible to route the addresses directly to the network - e.g. it is behind a NAT'ing router, or is connected via networks (e.g. a 3rd party ISP) that you have no control over - or you wish to benefit from having 'portable' public IP addresses e.g. you can physically relocate a tunnel end-point FB6000 such that it is using different WAN connectivity, yet still have the same public IP address block routed to an attached network.

11.1.2. Setting up a tunnel

You define a tunnel by creating an `fb105` top-level object. In the web User Interface, these objects are created and managed under the "Tunnels" category, in the section headed "FB105 tunnel settings".

The basic parameters for a tunnel are :-

- `name` : name of the tunnel (OPTIONAL)
- `local-id` : the Local ID to use for the tunnel (REQUIRED)
- `remote-id` : the ID used at the far-end for this tunnel (this will be the Local ID used on the far-end for this tunnel) (REQUIRED)
- `secret` : this is a pre-shared secret string that must be set to the same value in the tunnel definitions on both end-point devices
- `ip` : the IP address of the far-end end-point device (OPTIONAL)

The far-end IP address is optional, and if omitted, tunnel wrapper packets will be sent to the IP address from which wrapper packets are being received (if any). As such, at least one of the two end-points involved must have a far-end IP address specified, but it is not necessary for *both* ends to specify the other. This allows you to setup a tunnel on an end-point without knowing (or caring) what the far-end IP address is ; this means you can handle cases such as *one* of end-points being behind a NAT router that has a dynamic WAN IP address, or can be used to simplify administration of end-points that are used to terminate a large number of tunnels, by omitting the far-end IP address in tunnel definitions on such 'shared' end-points. The latter case is typical where an ISP deploys a FireBrick device to provide a 'head-end' device for tunnel bonding.

If you wish to use a different UDP port number than the default of 1, specify the port number using the `port` attribute.

11.1.3. Viewing tunnel status

The status of all configured FB105 tunnels can be seen in the web User Interface by selecting "FB105" from the "Status" menu. The tunnels are listed in ascending Local ID order, showing the far-end IP in use, the tunnel name, and the state. The table row background colour is also used to indicate tunnel state, with green for Up and red for Down.

Note that there is a third state that a tunnel can be in, that is "Up/Down" **TBC confirm** - this indicates that tunnel wrapper packets are being received, but that they are informing this end-point that the far-end is *not* receiving tunnel wrapper packets. This means the tunnel is essentially only established unidirectionally, typically because of a firewalling, routing, NAT or similar issue that is prevent the correct bidirectional flow of tunnels wrapper packets between the tunnel end-points.

Tunnel status can also be seen using the `show fb105` CLI command - see Command Line Reference.

11.1.4. Dynamic routes

Since a tunnel can only carry traffic properly when in the Up state, any traffic routed down a tunnel that is not Up will be discarded. The ability to *dynamically create* a route when the tunnel enters the Up state (and automatically delete the route when the tunnel leaves the Up state) allows the route to be present only when traffic can actually be routed down the tunnel. In combination with the use of route preference values, you can use this to implement fall-back to a less-preferred route if the tunnel goes down. Alternatively, you may want to intentionally use a different tunnel to carry traffic, and use profiles to enable/disable tunnel(s) - the dynamic route creation means that you do not need to manually change routing information to suit.

A dynamic route is defined by setting the `routes` attribute on the tunnel definition, specifying one or more routing destinations in CIDR format, as discussed in Section 7.1.

11.1.5. Tunnel bonding

Multiple FB105 tunnels can be *bonded* together to form a *set*, such that traffic routed down the bonded tunnel set is distributed across all the tunnels in the set. This distribution is done on a *round-robin per-packet* basis

i.e. the first packet to be sent is routed down the first tunnel in the set, each subsequent packet is routed down the subsequent tunnel in the set, and the (N+1)'th packet (where N is the number of tunnels in the set) is again routed down the first tunnel. This provides the ability to obtain aggregated bandwidths when each tunnel is carried over a different physical link, for example, such as using multiple ADSL or VDSL (FTTC) connections.

Note

Using tunnel bonding to aggregate access-network connections such as ADSL or VDSL to provide a single 'fat pipe' to the Internet requires there to be another FB105 tunnel end-point device to terminate the tunnels. Ideally this 'head-end' device is owned and operated by your ISP, but it is also possible to use a head-end device hosted by a third party, or in a datacentre in which you already have equipment. ISPs that can offer tunnel-bonding for Internet access include Andrews & Arnold [http://aa.net.uk] and Watchfront [http://www.watchfront.co.uk].

To form a bonded tunnel set, simply specify the `set` attribute of each tunnel in the set to be a value unique to that set. Although not required, you would typically use a `set` value of 1 for the first set you have defined. You can defined multiple bonded sets by using different values of the `set` attribute in each set.

11.1.6. Tunnels and NAT

If you are using NAT in your network, it may have implications for how to successfully use FB105 tunnelling. The issues depend on where (on what device) in your network NAT is being performed.

11.1.6.1. FB6000 doing NAT

If you have a bonded tunnel set implementing a single logical WAN connection, then the FB6000 will typically have multiple WAN-side IP addresses, one per physical WAN connection. If you are using the FB6000 to NAT traffic to the WAN, the real source IP address of the traffic will be translated by the NAT process to one of the IP addresses used by the FB6000.

When this NAT'd traffic is carried via a tunnel, it will be the source address of the tunnel *payload* packet that is modified.

Whatever address is used, reply traffic will come back to that address. In order to ensure this reply traffic is distributed across the tunnel set by the far-end tunnelling device, the address used needs to be an address that is routed down the tunnel set, rather than one associated with any particular WAN connection.

In order to handle this scenario, the `internal-ip` attribute can be used to define which IP address is used as the source IP address of the tunnel payload packets.

TBC do you therefore need at least a /32 public IP that is used by the brick, and is not associated with any specific WAN connection? So far I have seen NAT used only where there is also a block of public IPs routed down the tunnel set.

11.1.6.2. Another device doing NAT

If you are using another device that is performing NAT (for example, a NAT'ing ADSL router) and that device is on the route that tunnel wrapper packets will take , you may have to set up what is generally called *port forwarding* on your NAT'ing router.

If the FB6000 is behind a NAT router, it will not have a public IP address of its own which you can reference as the far-end IP address on the *other* end-point device. Instead, you will need to specify the WAN address of the NAT router for this far-end address. Whether you need to setup a port forwarding rule on your NAT router depends on whether the FB6000 behind the router has a far-end IP address specified in tunnel definition(s), as follows :-

- If it does, then it will be sending tunnel wrapper packets via the NAT router such that a session will have been created in the NAT router by the session tracking functionality that is used to implement NAT (this

assumes there is no *outgoing* 'firewall' rule on the NAT router that would prevent the wrapper packets from being forwarded). The established session will mean that UDP packets that arrive from the WAN side will be passed to the UDP port number that was the source port used in the outgoing wrapper packets.

- If it does not, then you will have to manually setup a port-forwarding rule, since there will have been no outbound packets to initiate a session. The forwarding rule should specify the UDP port number that is being used by the tunnel wrapper packets (the `port` attribute value in the tunnel definintion, or the default of 1 if the port is not specified)

Chapter 12. System Services

A *system service* provides general functionality, and runs as a separate concurrent process alongside normal traffic handling.

Table 12.1 lists the services that the FB6000 can provide :-

Table 12.1. List of system services

Service	Function
SNMP server	provides clients with access to management information using the Simple Network Management Protocol
NTP client	automatically synchronises the FB6000's clock with an NTP time server (usually using an Internet public NTP server)
HTTP server	serves the web user-interface files to a user's browser on a client machine
Telnet server	provides an administration command-line interface accessed over a network connection
DNS	relays DNS requests from either the FB6000 itself, or client machines to one or more DNS *resolvers*
Platform RADIUS server/proxy	**TBC**

Services are configured under the "Setup" category, under the heading "General system services", where there is a single services object (XML element : `<services>`). The services object doesn't have any attributes itself, all configuration is done via child objects, one per service. If a service object is not present, the service is disabled. Clicking on the Edit link next to the services object will take you to the lists of child objects. Where a service object is not present, the table in that section will contain an "Add" link. A maximum of one instance of each service object type can be present.

12.1. HTTP Server configuration

The HTTP server's purpose is to serve the HTML and supporting files that implement the web-based user-interface for the FB6000. It is not a general-purpose web server that can be used to serve user documents, and so there is little to configure.

12.1.1. Access control

By default, the FB6000 will allow access to the user interface from any machine, although obviously access to the user interface normally requires the correct login credentials to be provided. However, if you have no need for your FB6000 to be accessed from arbitrary machines, then you may wish to 'lock-down' access to the user interface to one or more client machines, thus removing an 'attack vector'.

Access can be restricted to :-

- specific client IP addresses, or
- clients connecting from locally-attached Ethernet subnets[1]

Additionally, access to the HTTP server can be completely restricted (to all clients) under the control of a *profile*. This can be used, for example, to allow access only during certain time periods.

[1] A *locally-attached* subnet is one which can be directly reached via one of the defined interfaces, i.e. is not accessed via a gateway.

To restrict to specific client IP addresses, using the user interface, check the checkbox next to the `allow` attribute, and enter one or more IP addresses, or IP address ranges into the text entry box - use the Enter key to separate your list items.

Tip

Address ranges can be entered using either <first address>-<last_address> syntax, or using CIDR notation : <start address>/<prefix length>. If a range entered using the first syntax can be expressed using CIDR notation, it will be automatically converted to that format when the configuration is saved. You can also use name(s) of defined IP address group(s) - see Section 3.1 for discussion of address groups.

To restrict access to clients connecting from locally-attached subnets, check the checkbox next to the `local-only` attribute and select `true` from the drop-down box.

Tip

You can verify whether the access control performs as intended using the diagnostic facility described in Section 13.1

12.1.1.1. Trusted addresses

Trusted addresses are those from which additional access to certain functions is available. They are specified by setting the `trusted` attribute using address ranges or IP address group names.

12.2. Telnet Server configuration

The Telnet server allows standard telnet-protocol clients (available for most client platforms) to connect to the FB6000 and access a command-line interface (CLI). The CLI is documented in Chapter 15 and in the Command Line Reference.

12.2.1. Access control

As with the HTTP server, access can be restricted to :-

- specific client IP addresses, and/or
- clients connecting from locally-attached Ethernet subnets only.

Access can also be completely restricted under the control of a profile.

Note

By default, the FB6000 will only allow telnet access from machines that are on one of the locally-attached Ethernet subnets[1]. This default is used since the CLI offers a degree of system control that is not available via the web interface - for example, software images stored in the on-board Flash memory can be deleted via the CLI.

To restrict access by client IP address instead, using the user interface, check the checkbox next to the `local-only` attribute and select `false` from the drop-down box. Then check the checkbox next to the `allow` attribute, and enter one or more IP addresses, or IP address ranges into the text entry box - use the Enter key to separate your list items. See the Tip above for recognised range specification formats.

The example XML below shows the telnet service configured this way :-

```
<telnet allow="10.0.0.0/24 10.1.0.3-98 10.100.100.88 10.99.99.0/24"
          comment="telnet service access restricted by IP address"
          local-only="false"/>
```

Tip

You can verify whether the access control performs as intended using the diagnostic facility described in Section 13.1

12.3. DNS configuration

The DNS service provides name resolution service to other tasks within the app software, and can act as a relay for requests received from client machines.

Configuring the DNS service only requires the specification of one or more *resolver* DNS servers - resolvers are typically provided by your Internet Service Provider, and accept requests to resolve DNS names, performing the *recursive* process necessary to query all the necessary authoratative DNS servers.

The DNS service in the FB6000 is not itself a full recursive resolver - it merely sends the request to one of the listed resolver servers.

12.4. NTP configuration

The NTP service automatically sets the FB6000's real-time-clock using time information provided by a Network Time Protocol (NTP) server. There are public NTP servers available for use on the Internet, and a factory reset configuration uses `pool.ntp.org` (see http://support.ntp.org/bin/view/Servers/NTPPoolServers for details on `pool.ntp.org`).

The NTP service is currently only an NTP client. A future software version is likely to add NTP server functionality, allowing other NTP clients (typically those in your network) to use the FB6000 as an NTP server.

Configuration of the NTP (client) service typically only requires setting the `timeserver` attribute to specify one or more NTP servers, using either DNS name or IP address.

12.5. SNMP configuration

The SNMP service allows other devices to query the FB6000 for management related information, using the Simple Network Management Protocol (SNMP).

As with the HTTP server, access can be restricted to :-

- specific client IP addresses, and/or
- clients connecting from locally-attached Ethernet subnets only.

See Section 12.1.1 for details. The SNMP service defaults to allowing access from anywhere.

The remaining SNMP service configuration attributes are :-

- `community` : specifies the SNMP *community* name, with a default of `public`
- `port` : specifies the port number that the SNMP service listens on - this typically does not need setting, as the default is the standard SNMP port (161).

Chapter 13. Network Diagnostic Tools

Various network diagnostic tools are provided by the FB6000, accessible through either the web user interface or the CLI :-

- Packet dump : low level diagnostics to for detailed examination of network traffic passing through the FB6000
- Ping : standard ICMP echo request/reply ping mechanism
- Traceroute : classical traceroute procedure - ICMP echo request packets with increasing TTL values, soliciting "TTL expired" responses from routers along the path
- Access check : check whether a specific IP address is allowed to access the various network services described in Chapter 12

Each tool produces a textual result, and can be accessed via the CLI, where the *same* result text will be shown.

Caution

The diagnostic tools provided are *not* a substitute for external penetration testing - they are intended to aid understanding of FB6000 configuration, assist in development of your configuration, and for diagnosing problems with the behaviour of the FB6000 itself.

13.1. Access check

For each network service implemented by the FB6000 (see Chapter 12), this command shows whether a specific IP address will be able to access or utilise the service, based on any access restrictions configured on the service.

For example, the following shows some service configurations (expressed in XML), and the access check result when checking access for an external address, `1.2.3.4` :-

```
  <http local-only="false"/>
```

```
Web control page access via http:-
This address is allowed access to web control pages subject to
username/password being allowed.
```

```
  <telnet allow="admin-ips"
          local-only="false"/>
```

```
Telnet access:-
This address is not allowed access due to the allow list on telnet
service.
```

(in this example, `admin-ips` is the name of an IP address group that does not include `1.2.3.4`)

```
  <dns local-only="true"/>
```

```
DNS resolver access:-
This address is not on a local Ethernet subnet and so not allowed access.
```

13.2. Packet Dumping

The FireBrick includes the ability to capture packet dumps for diagnostic purposes. This might typically be used where the behaviour of the FB6000 is not as expected, and can help identify whether other devices are correctly implementing network protocols - if they are, then you should be able to determine whether the FB6000 is responding appropriately. The packet dumping facility may also be of use to you to debug traffic (and thus specific network protocols) between two hosts that the brick is routing traffic between.

This feature is provided via the FB6000's HTTP server and provides a download of a *pcap* format file (old format) suitable for use with `tcpdump` or *Wireshark*.

A packet dump can be performed by either of these methods :-

- via the user interface, using a web-page form to setup the dump - once the capture data has been downloaded it can be analysed using `tcpdump` or *Wireshark*
- using an HTTP client on another machine (typically a command-line client utility such as `curl`)

The output is streamed so that, when used with `curl` and `tcpdump`, you can monitor traffic in real time.

Limited filtering is provided by the FB6000, so you will normally apply any additional filtering you need via `tcpdump`.

13.2.1. Dump parameters

Table 13.1 lists the parameters you can specify to control what gets dumped. The "Parameter name" column shows the exact parameter name to specify when constructing a URL to use with an HTTP client. The "Web-form field" column shows the label of the equivalent field on the user interface form.

Table 13.1. Packet dump parameters

Parameter name	Web-form field	Function
interface	Interface	One or more interfaces, as the name of the interface. e.g. interface=WAN, also applies for name of PPPoE on an interface
l2tp	L2TP session	Where L2TP is available, one or more sessions, using the full hex accounting ID, can be specified, e.g. l2tp=002132D94AE297DFF51E01 or you can use l2tp=* followed by a calling line ID - this sets up logging for a session based on calling line id when it next connects.
fb105	FB105 tunnel	Where FB105 tunnels are available, this is the local tunnel ID (1-255)
dongle	Dongle	Where USB Dongles are available, this is the name of the dongle from the config or the socket (e.g. "direct") of the dongle

snaplen	Snaplen	The maximum capture length for a packet can be specified, in bytes. Default 0 (auto). See notes below.
timeout	Timeout	The maximum capture time can be specified in seconds. Default 10.
ip	IP address *(2-off)*	Up to two IPs can be specified to filter packets
self	Include my IP	By default any traffic to or from the IP which is connecting to the web interface to access pcap is excluded. This option allows such traffic. Use with care else you dump your own dump traffic.

13.2.2. Security settings required

The following criteria must be met in order to use the packet dump facility :-

- You must be accessing from an IP listed as *trusted* in the HTTP service configuration (see Section 12.1).
- You must use a user and password for a "DEBUG level" user - the user level is set with the `level` attribute on the `user` object.

> **Note**
> These security requirements are the most likely thing to cause your attempts to packet dump to fail. If you are getting a simple "404" error response, and think you have specified the correct URL (if using an HTTP client), please check security settings are as described here.

13.2.3. IP address matching

You may optionally specify upto two IP address to be checked for a match in packets on the interface(s) and/or L2TP session(s) specified. If you do not specify any IP addresses, then all packets are returned. If you specify one IP address then all packets containing that IP address (as source or destination) are returned. If you specify two IP addresses then only those packets containing both addresses (each address being either as source or destination) are returned.

IP matching is only performed against ARP, IPv4 or IPv6 headers and not in encapsulated packets or ICMP payloads.

If capturing too much, some packets may be lost.

13.2.4. Packet types

The capture can collect different types of packets depending on where the capture is performed. All of these are presented as Ethernet frames, with faked Ethernet headers where the packet type is not Ethernet.

Table 13.2. Packet types that can be captured

Type	Notes
Ethernet	Interface based capture contains the full Ethernet frame with any VLAN tag removed.
IP	IP only, currently not possible to capture at this level. An Ethernet header is faked.

PPP	PPP from the protocol word (HDLC header is ignored if present). An Ethernet header is faked and also a PPPoE header. The PPPoE header has the session PPPoE ID that is the local end L2TP session ID.

The faked protocol header has target MAC of 00:00:00:00:00:00 and source MAC of 00:00:00:00:00:01 for received packets, and these reversed for sent packets.

13.2.5. Snaplen specification

The `snaplen` argument specifies the maximum length captured, but this applies at the protocol level. As such PPP packets will have up to the `snaplen` from the PPP protocol bytes and then have fake PPPoE and Ethernet headers added.

A `snaplen` value of 0 has special meaning - it causes logging of just IP, TCP, UDP and ICMP headers as well as headers in ICMP error payloads. This is primarily to avoid logging data carried by these protocols.

13.2.6. Using the web interface

The web form is accessed by selecting the "Packet dump" item under the "Diagnostics" main-menu item. Setup the dump parameters with reference to Table 13.1 and click the "Dump" button. Your browser will ask you to save a file, which will take time to save as per the timeout requested.

13.2.7. Using an HTTP client

To perform a packet dump using an HTTP client, you first construct an appropriate URL that contains standard HTTP URL form-style parameters from the list shown in Table 13.1. Then you retreive the dump from the FB6000 using a tool such as `curl`.

The URL is `http://<FB6000 IP address or DNS name>/pcap?parameter_name=value[&parameter_name=value ...]`

The URL may include as many *parameter name* and *value* pairs as you need to completely specify the dump parameters.

Packet capturing stops if the output stream (HTTP transfer) fails. This is useful if you are unable to determine a suitable timeout period, and would like to run an ongoing capture which you stop manually. This is achieved by specifying a very long duration, and then interrupting execution of the HTTP client using Ctrl+C or similar.

Only one capture can operate at a time. The HTTP access fails if no valid interfaces or sessions etc. are specified or if a capturing is currently running.

13.2.7.1. Example using curl and tcpdump

An example of a simple real-time dump and analysis run on a Linux box is shown below :-

```
curl --silent --no-buffer --user name:pass
   'http://1.2.3.4/pcap?interface=LAN&amp;timeout=300&amp;snaplen=1500'
   | /usr/sbin/tcpdump -r - -n -v
```

Note

Linebreaks are shown in the example for clarity only - they must not be entered on the command-line

In this example we have used username *name* and password *pass* to log-in to a FireBrick on address 1.2.3.4 - obviously you would change the IP address (or host name) and credentials to something suitable for your FB6000.

We have asked for a dump of the interface named `LAN`, with a 5 minute timeout and capturing 1500 byte packets. We have then fed the output in real time (hence specifying `--no-buffer` on the `curl` command) to `tcpdump`, and asked it to take capture data from the standard input stream (via the `-r -` options). We have additionally asked for no DNS resolution (`-n`) and verbose output (`-v`).

Consult the documentation provided with the client (e.g. Linux box) system for details on the extensive range of `tcpdump` options - these can be used to filter the dump to better locate the packets you are interested in.

Chapter 14. VRRP

The FB6000 supports VRRP (Virtual Router Redundancy Protocol), which is a system that provides routing redundancy, by enabling more than one hardware device on a network to act as a gateway for routing traffic. Hardware redundancy means VRRP can provide resilience in the event of device failure, by allowing a backup device to *automatically* assume the role of actively routing traffic.

14.1. Virtual Routers

VRRP abstracts a group of routers using the concept of a *virtual router*, which has a *virtual IP address*. The IP address is virtual in the sense that it is associated with more than one hardware device, and can 'move' between devices automatically.

The virtual IP address normally differs from the real IP address of any of the group members, but it can be the real address of the master router if you prefer (e.g. if short of IP addresses).

You can have multiple virtual routers on the same LAN at the same time, so there is a Virtual Router Identifier (VRID) that is used to distinguish them. The default VRID used by the FB6000 is `42`. You must set all devices that are part of the same group (virtual router) to the same VRID, and this VRID must differ from that used by any other virtual routers *on the same LAN*. Typically you would only have one virtual router on any given LAN, so the default of `42` does not normally need changing.

At any one time, one physical device is the *master* and is handling all the traffic sent to the virtual IP address. If the master fails, a backup takes over, and this process is transparent to other devices, which do not need to be aware of the change.

The members of the group communicate with each other using multicast IP packets.

The transparency to device failure is implemented by having group members all capable of receiving traffic addressed to the *same* single MAC address. By default a special MAC address is used, `00-00-5E-00-01-XX`, where `XX` is the VRID.

The master device will reply with this MAC address when an ARP request is sent for the virtual router's IP address.

Since the MAC address associated with the virtual IP address does not change, ARP cache entries in other devices remain valid throughout the master / backup switch-over, and other devices are not even aware that the switch has happened, apart from a short 'black-hole' period until the backup starts routing.

When there is a switch-over, the VRRP packets that are multicast are sent from this special MAC, so network switches will automatically modify internal MAC forwarding tables, and start switching traffic to the appropriate physical ports for the physical router that is taking up the active routing role.

Note

You can disable the use of the special MAC if you wish, and use a normal FireBrick MAC. However, this can lead to problems in some cases.

14.2. Configuring VRRP

VRRP operates within a layer 2 broadcast domain, so VRRP configuration on the FB6000 comes under the scope of an `interface` definition. As such, to set-up your FB6000 to participate in a Virtual Router group, you need to create a `vrrp` object, as a child object of the `interface` that is in the layer 2 domain where the VRRP operates.

14.2.1. Advertisement Interval

A master indicates that it still 'alive' by periodically sending an advertisement multicast packet to the group members. A failure to receive a multicast packet from the master router for a period longer than three times the advertisement interval timer causes the backup routers to assume that the master router is down.

The interval is specified in multiples of 10ms, so a value of 100 represents one second. The default value, if not specified, is one second. If you set lower than one second then VRRP3 is used by default (see below). VRRP2 only does whole seconds, and must have the same interval for all devices. VRRP3 can have different intervals on different devices, but typically you would set them all the same.

The shorter the advertisement interval, the shorter the 'black hole' period, but there will be more (multicast) traffic in the network.

Note

For IPv6 VRRP3 is used by default, whereas for IPv4 VRRP2 is used by default. Devices have to be using the same version. IPv4 and IPv6 can co-exist with one using VRRP2 and the other VRRP3. Setting the same config (apart from priority) on all devices ensures they have the same version.

14.2.2. Priority

Each device is assigned a priority, which determines which device becomes the master, and which devices remain as backups. The (working) device with the highest priority becomes the master.

If using the real IP of the master, then the master should have priority 255. Otherwise pick priorities from 1 to 254. It is usually sensible to space these out, e.g. using 100 and 200. We suggest not setting priority 1 (see profiles and test, below).

14.3. Using a virtual router

A virtual router is used by another device simply by specifying the virtual-router's virtual IP address as the gateway in a route, rather than using a router's real IP address. From an IP point-of-view, the upstream device is completely unaware that the IP address is associated with a group of physical devices, and will forward traffic to the virtual IP address as required, exactly as it would with a single physical gateway.

14.4. VRRP versions

14.4.1. VRRP version 2

VRRP version 2 works with IPv4 addresses only (i.e. does not support IPv6) and whole second advertisement intervals only. The normal interval is one second - since the timeout is three times that, this means the fastest a backup can take over is just over 3 seconds. You should configure all devices in a VRRP group with the same settings (apart from their priority).

14.4.2. VRRP version 3

VRRP version 3 works in much the same way, but allows the advertisement interval to be any multiple of 10ms (1/100th of a second). The default interval is still 1 second, but it can now be set much faster - so although the timeout is still 3 times the interval, this means the backup could take over in as little as 30ms.

VRRP3 also works with IPv6. Whilst IPv4 and IPv6 VRRP are completely independent, you can configure both at once in a single `vrrp` object by listing one or more IPv4 addresses *and* one or more IPv6 addresses.

VRRP3 is used by default for any IPv6 addresses or where an interval of below one second is selected. It can also be specifically set in the config by setting the attribute `version3` to the value `"true"`.

Caution

If you have devices that are meant to work together as VRRP but one is version 2 and one is version 3 then they will typically not see each other and both become master. The FB6000's VRRP Status page shows if VRRP2 or VRRP3 is in use, and whether the FireBrick is master or not.

14.5. Compatibility

VRRP2 and VRRP3 are standard protocols and so the FB6000 can work alongside other devices that support VRRP2 or VRRP3.

Note that the FB6000 has non-standard support for some specific packets sent to the VRRP virtual addresses. This includes answering pings (configurable) and handling DNS traffic. Other VRRP devices may not operate in the same way and so may not work in the same way if they take over from the FireBrick.

Chapter 15. Command Line Interface

The FB6000 provides a traditional command-line interface (CLI) environment that can be used to check status information, and control some aspects of the unit's operation.

The CLI is accessed via the 'telnet' protocol - the FB6000 implements a telnet server, which you can connect to using any common telnet client program. To learn how to enable the telnet server, and to set-up access restrictions, please refer to Section 12.2.

Note

The CLI cannot be used to change the *configuration* of the unit - that must be done via the web interface. However, there are typically a few operations that can *only* be performed via the CLI.

The CLI has the following features :-

- full line-editing capabilities - that cursor-keys, backspace key and delete key function as expected allowing you to go back and insert/delete characters. You can press Enter at any point in the command-line text, and the full command text will be processed.
- command history memory - the CLI remembers a number of previously typed commands, and these can be recalled using the Up and Down cursor keys. Once you've located the required command, you can edit it if needed, and then press Enter.
- supports entering abbreviated commands - you only need to type sufficient characters to make the command un-ambiguous ; for example, 'show dhcp' and 'show dns' can be abbreviated to 'sh dh' and 'sh dn' respectively - 'show' is the only command word that begins "sh", and two characters of the second command word are sufficient to make it un-ambiguous.
- built-in command help - you can list all the available commands, and the CLI will also show the synopsis for each command. Typing the ? character at the command-prompt immediately displays this list (you do not have to press Enter). Alternatively, you can list all the possible completions of a part-typed command - in this case, typing the ? character after typing part of a command will list only commands that begin with the already-typed characters, for example, typing `tr ?` causes the CLI to respond as shown below :-

```
marty> tr

traceroute <IPNameAddr> [table=<routetable>] [source=<IPAddr>] ...
troff
tron

marty> tr
```

After listing the possible commands, the CLI re-displays the command line typed so far, which you can then complete.

The CLI is documented with reference style material - please refer to Command Line Reference.

Command Line Reference

Name

check access — Check whether an IP address can access/utilise network services provided by the FB6000

SYNOPSIS

```
check access <IPAddr> [table=<routetable>]
```

DESCRIPTION

For each network service implemented by the FB6000, this command shows whether a specific IP address will be able to access or utilise the service, based on any access restrictions configured on the service.

This command provides the same functionality as that provided via the web user interface - see Section 13.1 for details.

Name

clear bgp — ** TBC ? **

SYNOPSIS

```
clear bgp <IPNameAddr>
```

DESCRIPTION

** TBC ? **

Name

clear dhcp — Clears one or all of the stored allocations made by the FB6000's DHCP server.

SYNOPSIS

```
clear dhcp [<IP4Addr>] [table=<routetable>]
```

DESCRIPTION

Every allocation made by the DHCP server built-in to the FB6000 is stored in non-volatile memory, and as such will survive power-cycling and/or rebooting. The allocations can be seen using the **show dhcp** command.

The **clear dhcp** can be used to remove stored allocation information, by specifying the IP address of the allocation. Alternatively, if you do not specify an address, all allocations are deleted.

Name

clear l2tp all — ** TBC ? **

SYNOPSIS

```
clear l2tp all
```

DESCRIPTION

** TBC ? **

Name

clear l2tp session — ** TBC ? **

SYNOPSIS

```
clear l2tp session <string>
```

DESCRIPTION

** TBC ? **

Name

clear l2tp tunnel — ** TBC ? **

SYNOPSIS

```
clear l2tp tunnel <IPNameAddr>|<tun-id>
```

DESCRIPTION

** TBC ? **

Name

clear pppoe — ** TBC ? **

SYNOPSIS

```
clear pppoe <integer>
```

DESCRIPTION

** TBC ? **

Name

delete config — Delete a configuration from the Flash memory

SYNOPSIS

```
delete config <unsignedInt> [confirm=<string>]
```

DESCRIPTION

This command is used to permanently delete a configuration from the Flash memory.

Specify the starting block number of the configuration as the <unsignedInt> argument, which can be obtained using the **show flash contents** command.

To reduce the chance of accidental deletion, this command requires that *confirm=yes* is also specified.

Name

delete data — Delete a data item from the Flash memory

SYNOPSIS

```
delete data <unsignedInt> [confirm=<string>]
```

DESCRIPTION

This command is used to permanently delete a data item from the Flash memory.

Specify the starting block number of the data item as the <unsignedInt> argument, which can be obtained using the **show flash contents** command.

To reduce the chance of accidental deletion, this command requires that *`confirm=yes`* is also specified.

Name

delete image — Delete a software image from the Flash memory

SYNOPSIS

```
delete image <unsignedInt> [confirm=<string>]
```

DESCRIPTION

This command is used to permanently delete a software image from the Flash memory.

Specify the *starting block number* of the image as the <unsignedInt> argument, which can be obtained using the **show flash contents** command.

To reduce the chance of accidental deletion, this command requires that `confirm=yes` is also specified.

Name

ethernet reset — ** TBC ? **

SYNOPSIS

```
ethernet reset <port>
```

DESCRIPTION

** TBC ? **

Name

ethernet stall — ** TBC ? **

SYNOPSIS

```
ethernet stall <port>
```

DESCRIPTION

** TBC ? **

Name

exit — Logout and end a command-line session.

SYNOPSIS

```
exit
```

DESCRIPTION

Logs out and ends a command-line telnet session.

Note

The **exit** command is synonymous with the **quit**.

Name

kill command session — ** TBC ? **

SYNOPSIS

```
kill command session <IPAddr>
```

DESCRIPTION

** TBC ? ** Forcibly terminates another command-line session, identified by source IP address.

Name

kill session — Kills an active session in the session-table.

SYNOPSIS

```
kill session source-ip=<IPAddr> target-ip=<IPAddr>
    protocol=<unsignedByte> [source-port=<unsignedShort>]
    [target-port=<unsignedShort>] [table=<routetable>]
```

DESCRIPTION

Kills the active session that matches the specified parameters.

Name

login — Login to a command-line session.

SYNOPSIS

```
login [<string>]
```

DESCRIPTION

Changes a command-line session to the logged-in state, subject to the correct credentials being supplied. The login process occurs automatically at the start of a new telnet connection, but if no username is entered (i.e. the user just presses Enter), or the login fails, the command-line session stays active but in the logged-out state.

In the logged-out state, only the following four commands are available :-

```
exit
login [<string>]
logout
quit
```

Thus, the **login** command can be used to login when in this logged-out (but connected) state. If the optional argument is supplied, it specifies the username, and no username prompt is printed. The **login** command can also be used to log-in as a different user without logging out first.

Name

logout — Log-out from a command-line session.

SYNOPSIS

```
logout
```

DESCRIPTION

Changes a command-line session to the logged-out state, but doesn't disconnect the telnet connection. Refer to the **login** command for details on what is possible in the logged-out state.

Tip

To log-out and automatically close the telnet connection, use the **exit** command instead.

Name

panic — Force a system panic.

SYNOPSIS

```
panic [<string>] [confirm=<string>]
```

DESCRIPTION

Forces a system panic which causes an immediate reboot of the FB6000. The optional <string> argument specifies text that will be present in the panic message, which is typically visible in the system flash log.

To reduce the chance of accidental forced panic, this command requires that you specify *`confirm=yes`* - if this is omitted, the CLI responds with :-

```
Please use confirm=yes to run this command
```

Name

ping — Ping an IP address.

SYNOPSIS

```
ping <IPNameAddr> [table=<routetable>] [source=<IPAddr>]
    [gateway=<IPAddr>] [flow=<unsignedShort>] [count=<positiveInteger>]
    [ttl=<unsignedByte>]
```

DESCRIPTION

Pings the IP address specified by the first argument. The argument may also be a DNS name, which will be resolved if DNS resolver(s) are correctly configured.

EXAMPLE

```
marty> ping mozilla.org count=4
Pinging 63.245.209.11 from 81.187.96.94
  1: Reply    170.022ms from 63.245.209.11   moz.org01. ...
  2: Reply    167.907ms from 63.245.209.11   moz.org01. ...
  3: Reply    169.947ms from 63.245.209.11   moz.org01. ...
  4: Reply    169.782ms from 63.245.209.11   moz.org01. ...
```

Name

quit — Logout and end a command-line session.

SYNOPSIS

```
quit
```

DESCRIPTION

Logs out and ends a command-line telnet session.

Note

The **quit** command is synonymous with the **exit**.

Name

reboot — Reboots the FB6000.

SYNOPSIS

```
reboot [<unsignedInt>] [confirm=<string>]
```

DESCRIPTION

Initiates a reboot of the FB6000 - this is a controlled, clean shutdown and reboot.

To reduce the chance of accidental reboots, this command requires that you specify *`confirm=yes`* - if this is omitted, the CLI responds with :-

```
Please use confirm=yes to run this command
```

Name

set boot block — ** TBC ? **

SYNOPSIS

```
set boot block <unsignedInt> priority <unsignedInt>
```

DESCRIPTION

** TBC ? **

Name

set command screen width — ** TBC ? **

SYNOPSIS

```
set command screen width <unsignedInt>
```

DESCRIPTION

** TBC ? **

Name

show arp — Prints the ARP table.

SYNOPSIS

```
show arp [<IPAddr>]
```

DESCRIPTION

Prints the current contents of the ARP table i.e. the MAC addresses that have been discovered via ARP for IP addresses on local subnets.

TO see more detail about a particular ARP table entry, specify the IP address of the entry you are interested in as the argument to this command.

EXAMPLE

```
marty> show arp
ARP/ND
------
SN Interface                MAC                       IP address
 4 HOME       00:30:48:58:3c:b6                       10.90.10.2 linked
 4 HOME       78:e4:00:13:c8:74                     10.90.10.251 linked
```

Name

show bgp — ** TBC ? **

SYNOPSIS

```
show bgp
```

DESCRIPTION

** TBC ? **

Name

show bgp nexthop — ** TBC ? **

SYNOPSIS

```
show bgp nexthop
```

DESCRIPTION

** TBC ? **

Name

show bgp peer — ** TBC ? **

SYNOPSIS

```
show bgp peer <IPNameAddr>
```

DESCRIPTION

Name

show bgp routes — ** TBC ? **

SYNOPSIS

```
show bgp routes [<IPFilter>] [table=<routetable>]
    [imported=<IPNameAddr>] [exported=<IPNameAddr>
```

DESCRIPTION

** TBC ? **

Name

show bgp summary — ** TBC ? **

SYNOPSIS

```
show bgp summary
```

DESCRIPTION

** TBC ? **

Name

show boot log — ** TBC ? **

SYNOPSIS

```
show boot log [<unsignedInt>]
```

DESCRIPTION

** TBC ? **

Name

show command sessions — Print a list of command-line sessions.

SYNOPSIS

```
show command sessions
```

DESCRIPTION

Prints a list of all command-line (i.e. telnet) sessions - this includes those where no user is logged in, which display as `<logged out>` and user level `NOBODY` (see the **login** command for discussion of logged-in / logged-out states).

EXAMPLE

```
marty> sh c s
reginald level DEBUG from 10.1.2.3
<logged out> level NOBODY from 10.1.2.4
```

Name

show dhcp — Print list of IP address allocations made by the FB6000's DHCP server.

SYNOPSIS

```
show dhcp [<IP4Addr>] [table=<routetable>]
```

DESCRIPTION

Every allocation made by the DHCP server built-in to the FB6000 is stored in non-volatile memory, and as such will survive power-cycling and/or rebooting. The allocations can be seen using this command. If an IP address is specified, then details of the allocation for that address will be shown, otherwise all allocation information will be shown.

If a client does not request renewal of the lease before it expires, the allocation entry will show "expired". Expired entries remain stored, and are used to lease the same IP address again if the same client requests an address. However, if a new MAC address requests an allocation, there are no available IPs (excluding expired allocations) in an allocation pool, then the oldest expired allocation IP address is re-used for the new client.

You can clear expired, or any other entries, using the **clear dhcp** command - you may need to do this if you setup a static MAC-address-based DHCP allocation for a client, but it has already obtained an address from a pool ; by clearing the allocation, then getting the client to issue another DHCP request, it should pick up the new static allocation. If you do not clear the allocation, then the client will obtain the same address it did before you set up the MAC-based static allocation.

EXAMPLE

```
marty> sh dhcp
DHCP
----
T Interface                MAC      IP address Client name
0 LAN        00:90:f5:9e:4f:12    81.187.96.81 enceladus
0 LAN        7c:2f:80:17:0a:5c    81.187.96.83 N300-IP
```

The "Interface" column shows which `interface` (i.e. broadcast domain) was involved in the DHCP request/reply process.

The "Client name" column will typically show the client host-name, or perhaps a product name (as in the example above, where "N300-IP" is a VoIP DECT basestation).

Name

show dns — Displays the DNS resolvers that are currently configured for use.

SYNOPSIS

```
show dns
```

DESCRIPTION

Displays the DNS resolvers that are currently configured for use by the DNS service (see Section 12.3). The configured servers will include any setup in the DNS service configuration, plus any that have been informed to the FB6000 if it has obtained an IP address itself by DHCP (see Section 6.3.1.1).

Name

show ethernet counters — Print values of counters maintained by the Ethernet hardware.

SYNOPSIS

```
show ethernet counters
```

DESCRIPTION

The Ethernet hardware in the FB6000 maintains various byte and packet counters which can be displayed using this command. This information is likely to only be useful when diagnosing specific problems with the FB6000 hardware or software, under guidance of technical support personnel.

Name

show ethernet status — Print current status of the Ethernet ports

SYNOPSIS

```
show ethernet status
```

DESCRIPTION

This command prints the current status of the four Ethernet ports on the FB6000.

The following information is shown :-

- Link status (Up / Down)
- Speed (10M / 100M / 1G)
- Duplex mode
- Auto-MDI(X) (auto-crossover) mode

EXAMPLE

```
marty> show ethernet status
Port 1: Up 100M Full duplex MDI MASTER
Port 2: Up 100M Full duplex MDI MASTER
Port 3: Up 1G MDI
Port 4: Down
```

Name

show fb105 — Print information about FB105 tunnels.

SYNOPSIS

```
show fb105 [<string>]
```

DESCRIPTION

Prints information about tunnels using the FB105 lightweight tunnelling protocol. For each FB105 tunnel that is defined by the current configuration, this command lists the following information :-

Table 18. Information provided by show fb105 command

Column	Information
`ID`	*Local* tunnel ID
`T`	Routing table
`Far`	*Far-end* tunnel ID
`IP`	IP address of *far-end* tunnel end-point
`Name`	Tunnel name
`Status`	Tunnel status - Up or Down

To see more information about a particular tunnel, specify the local tunnel ID as the argument to this command. This will show you routing table entries that are associated with the tunnel.

EXAMPLE

```
marty> sh fb
FB105 tunnels
-------------
 ID T Far              IP Name      Status
  1 0   3        10.5.5.5 USOffice  Up
```

Name

show flash contents — Print a list of what is currently stored in the internal Flash memory.

SYNOPSIS

```
show flash contents
```

DESCRIPTION

The FB6000 uses internal Flash memory to store various items of data and software program code. A Flash memory is divided into *blocks*, with a typical block size of 128KiB. Each item that the FB6000 stores in the Flash memory occupies a distinct set of one or more blocks, depending on the size of the item.

This command lists what is stored in the Flash, in order of ascending block numbers.

For each item, the following information is printed :-

- "Blocks" : the block number(s) occupied by the item.
- "Type" : the type of information in this item
- "Seq/Flashtime" : sequence-number or timestamp of when the item was written to the Flash memory.
- "Prio/Pen" : cost metric **TBC?**
- "Name" : for software, this is the name of the image, which will include the version number

EXAMPLE

This shows *part* of a listing, showing a Bootloader, the Flash log space, and two software application images :-

```
marty> sh f c
  Blocks       Type  Seq/Flashtime  Prio/Pen Name
     0-1      Image 12/09/11 12:54       0/0 BOOTLOAD Dimity (V1.03.001
      20   BootInfo              1           (unnamed)
      21     SysLog              1           System Flash Log page
      22     SysLog              2           System Flash Log page
   23-27  SignedExe 01/06/11 11:06    1000/0 FB2700 Marmaduke (V0.06.001
   28-32  SignedExe 20/06/11 13:36    1000/0 FB2700 Randolph (V0.08.001
```

Name

show flash log — Print log text stored in the 'Flash log'.

SYNOPSIS

```
show flash log [<unsignedInt>]
```

DESCRIPTION

The *Flash Log* is a non-volatile (i.e. it is not lost when the FB6000 is powered-off) log information storage area. It is typically used to log information for significant events, where it is necessary for the information to be retained after power-loss or device reboot.

The optional argument specifies how many bytes (characters) of log information are displayed ; the default is 5000 bytes, and to see earlier logged information, you need to specify a sufficient number of bytes that is greater than this default.

Name

show l2tp — Print overview of L2TP status.

SYNOPSIS

```
show l2tp
```

DESCRIPTION

Name

show l2tp session — ** TBC ? **

SYNOPSIS

```
show l2tp session <string>
```

DESCRIPTION

** TBC ? **

Name

show l2tp sessions — ** TBC ? **

SYNOPSIS

```
show l2tp sessions
```

DESCRIPTION

** TBC ? **

Name

show l2tp tunnel — ** TBC ? **

SYNOPSIS

```
show l2tp tunnel <tun-id>
```

DESCRIPTION

** TBC ? **

Name

show l2tp tunnels — ** TBC ? **

SYNOPSIS

```
show l2tp tunnels
```

DESCRIPTION

** TBC ? **

Name

show log — Prints the stored log text for a specified log target.

SYNOPSIS

```
show log [<string>]
```

DESCRIPTION

Prints the stored log text for the log-target specified by the argument. If the argument is omitted , text logged to any target is shown. Once the stored text is displayed, the command continues to 'follow' the log, printing new text as it is logged. This continues until you press a key, such as Enter, to to exit this following mode and return to the command prompt.

Name

show memory — Print information about memory usage by the FB6000 application software.

SYNOPSIS

```
show memory
```

DESCRIPTION

This command prints details of memory usage in terms of virtual and physical address spaces - it is only likely to be helpful when diagnosing specific problems with the FB6000 hardware or software, under guidance of technical support personnel.

Name

show pppoe — Print information about PPPoE sessions.

SYNOPSIS

```
show pppoe [integer>]
```

DESCRIPTION

Prints information about PPPoE sessions established by the FB6000's built-in PPPoE client.

Name

show profiles — Print the current state of all the profiles that are defined.

SYNOPSIS

```
show profiles
```

DESCRIPTION

Shows the state of each profile that is defined by the current configuration - profile states are either Active or Inactive. The command also shows the reason that the profile is in that state.

Name

show radius — **TBC ? **

SYNOPSIS

```
show radius
```

DESCRIPTION

**TBC ? **

Name

show route — Print information about a specific route.

SYNOPSIS

```
show route <IPPrefix> [table=<routetable>]
```

DESCRIPTION

Prints information about a specific route - the one that matches (most-specific / longest-prefix match) a specified destination prefix, or an IP address (when specifying a /32 prefix). The full list of all routes can be obtained using the **show routes** command. When used with a /32 prefix (i.e. a full IP address) this command can be used to show which route is used to reach that destination IP address.

EXAMPLE

With a subnet defined as `<subnet ip="10.90.10.10/24"/>`, a route will have been automatically created, as described in Section 7.2.1.

```
ruby> sh route 10.90.10.0/24
Route 10.90.10.0/24
 ETHERNET: Source=SUBNET Metric=MAX Subnet=4
```

The route type is shown as `ETHERNET` - a direct route to a locally-attached subnet - the 'source' of the route (how it was created) is `SUBNET`, meaning it has been automatically created as a result of a subnet definition. (See the **show routes** for other route types).

Name

show routes — Print the list of route destinations from a routing table.

SYNOPSIS

```
show routes [<IPFilter>] [table=<routetable>]
```

DESCRIPTION

Prints a list of route destinations, and brief information about the route.

The information provided shows the type of the route :

- ETHERNET : direct route to locally-attached subnet (see Section 7.2.1)
- GATEWAY4 : route via a gateway (IPv4) e.g. default route obtained via DHCP, or a static route (see Section 7.2.2)
- SELF : a route back into the FB6000 itself, e.g. the /32 route automatically created for the FB6000's own IP adress on a subnet (see Section 7.2.1)
- NOWHERE : a 'dead end' route - see Section 7.2.3
- BLACKHOLE : a 'black-hole' route - see Section 7.2.3

Name

show sessions — Displays the session table.

SYNOPSIS

```
show sessions [protocol=<unsignedByte>]
```

DESCRIPTION

Prints the current contents of the session table.

Name

show status — Print general FB6000 status information.

SYNOPSIS

```
show status
```

DESCRIPTION

Prints a list of general FB6000 information items, including :-

- System name, serial number, build/ship dates
- Bootloader and Software versions
- System uptime
- Software options (e.g. Fully Loaded) and allowed software build types
- Amount of free RAM (in units of MebiBytes - if you are not familiar with these relatively new (1998) standard units for binary multiples, refer to the following page on the US NIST website :- http://physics.nist.gov/cuu/Units/binary.html.
- Software upgrade policy (automatic/manual)

The information is the same as that shown when you click the "Status" main-menu item in the web user interface.

Name

show subnet — Print information about a specific locally-attached subnet.

SYNOPSIS

```
show subnet <integer>
```

DESCRIPTION

Print information about a specific locally-attached subnet - the subnet is specified using its subnet number. The **show subnets** can be used to see subnet numbers.

Name

show subnets — Print list of locally-attached subnets.

SYNOPSIS

```
show subnets
```

DESCRIPTION

Prints a list of *locally-attached* subnets i.e. those directly accessible via an interface.

Name

show uptime — Print up-time since last bootup.

SYNOPSIS

```
show uptime
```

DESCRIPTION

This command is synonymous with the **uptime** command.

Name

show tasks — Prints the list of software tasks running on the FB6000.

SYNOPSIS

```
show tasks
```

DESCRIPTION

The FB6000's operating system software provides a multi-tasking environment for the application software. The app is implemented as a set of distinct tasks, running concurrently - **show tasks** may be helpful in some support situations as it shows some statistics about the tasks (such as CPU usage percentage) that may assist in diagnosing problems.

Name

show vrrp — Prints VRRP status information.

SYNOPSIS

```
show vrrp
```

DESCRIPTION

When this FB6000 is part of a Virtual Router, this command shows the current VRRP status of this device.

Name

start command session — ** TBC ? **

SYNOPSIS

```
start command session <IPAddr> [port=<unsignedShort>]
   [table=<routetable>]
```

DESCRIPTION

** TBC ? **

Name

traceroute — Runs a classical traceroute procedure.

SYNOPSIS

```
traceroute <IPNameAddr> [table=<routetable>] [source=<IPAddr>]
   [gateway=<IPAddr>] [flow=<unsignedShort>]
   [count=<positiveInteger>] [ttl=<unsignedByte>]
```

DESCRIPTION

This command performs the classical traceroute procedure to investigate the route taken to reach the IP address specified by the first argument.

Multiple ICMP Echo Request packets are sent to the destination IP address, with increasing Time-To-Live values starting at 1, thus obtaining "TTL expired" responses from successive routers along the path.

Although this command always does reverse DNS lookups on each router's IP address, the command does not wait for DNS responses before sending the next packet. DNS resolution runs concurrently with other tasks, so continues whilst the **traceroute** procedes. For this reason, you may not see many DNS names when you first perform a **traceroute**, and repeating the **traceroute** will likely show more names, given that time has been allowed for DNS resolutions to complete.

Name

troff — Prevents log messages sent to the console from being displayed.

SYNOPSIS

```
troff
```

DESCRIPTION

See the **tron** command for information about using **tron** and **troff**.

Name

tron — Enables log messages sent to the console to be displayed.

SYNOPSIS

```
tron
```

DESCRIPTION

Certain system events normally cause log messages to be sent to the console. If you find that these are interfering with your use of the console, you can disable printing of these messages via the `troff` command. To re-enable the messages, use the `tron` command.

EXAMPLE

Ethernet port link status changes are normally logged to the console. For example, removing and re-connecting an active link-partner from/to port 4 might show :-

```
link-monitor port 4 down
link-monitor port 4 up: auto speed 100Mbit; full-duplex; flow none; MDI-X
marty>
```

Use `troff` to disable these messages :-

```
marty> troff
Console logging stopped
```

Any changes to port link status will not be logged to the console until the `tron` command is used :-

```
marty> tron
Console logging started
```

Name

uptime — Print up-time since last bootup.

SYNOPSIS

```
uptime
```

DESCRIPTION

Prints the up-time since the last bootup of the FB6000

EXAMPLE

```
marty> uptime
Version: FB6202 Gemini (V1.06.001 2011-11-02T17:41:12)
Uptime 8 days 01:28:07
Current time: 10th Nov 2011 22:10:17
```

Appendix A. Factory Reset Procedure

The FireBrick has a simple factory reset process to erase the configuration allowing you to reconnect using the default IP addresses described in Chapter 2. This process can be very useful if you ever make an error in the configuration that stops you having access to the FireBrick for any reason, or any other situation where it is appropriate to start from scratch.

- Disconnect all network and power leads :-

- Connect lead between far left and far right ports (ports 1 and 4) :-

- Connect power and wait a few seconds for all port LEDs to be on steadily. Power LED blinks :-

- Disconnect loop, leave power connected. LEDs cycle and power LED blinks :-

Note

There is a timeout of 20 seconds in this process - if the loop is present for longer than 20 seconds, the power LED will stop flashing and the factory reset will be aborted

- Connect network to left hand port. Power LED comes on solidly.

This process will start the FireBrick in a factory reset mode *temporarily* - the configuration stored in flash memory has not yet been altered or deleted at this stage.

If you do not save a new configuration at this stage, then the FB6000 will revert to the existing saved configuration when next powered up or restarted.

It is also possible to recover the configuration stored in flash memory, if you know an administrative username and password for it - this gives you an opportunity to correct a configuration, such as where you had made a change that prevented you from accessing the FB6000.

To factory reset permanently follow the same process but with ports 1 and 2 looped - this *will* overwrite the configuration stored in flash memory, so use this reset method with caution.

Appendix B. CIDR and CIDR Notation

Classless Inter-Domain Routing (CIDR) is a strategy for IP address assignment originally specified in 1993 that had the aims of "conserving the address space and limiting the growth rate of global routing state". The current specification for CIDR is in RFC4632 [http://tools.ietf.org/html/rfc4632].

The pre-CIDR era

CIDR replaced the original class-based organisation of the IP address space, which had become wasteful of address space, and did not permit *aggregation* of routing information.

In the original scheme, only three sizes of network were possible :

- Class A : 128 possible networks each with 16,777,216 addresses
- Class B : 16384 possible networks each with 65,536 addresses
- Class C : 2097152 possible networks each with 256 addresses

Every network, including any of the large number of possible Class C networks, required an entry in global routing tables - those used by core Internet routers - since it was not possible to aggregate entries that had the same routing information. The inability to aggregate routes meant global routing table size was growing fast, which meant performance issues at core routers.

The position and size of the network ID and host ID bitfields were implied by the bit pattern of some of the most significant address bits, which segmented the 32-bit IPv4 address space into three main blocks, one for each class of network.

CIDR

The prefix notation introduced by CIDR was, in the simplest sense, "to make explicit which bits in a 32-bit IPv4 address are interpreted as the network number (or prefix) associated with a site and which are the used to number individual end systems within the site". In this sense, the 'prefix' is the N most significant bits that comprise the network ID bitfield.

CIDR notation is written as :-

IPv4 : Traditional IPv4 'dotted-quad' number, followed by the "/" (slash) character, followed by a decimal prefix-length value between 0 and 32 (inclusive)

IPv6 : IPv6 address, followed by the "/" (slash) character, followed by a decimal prefix-length value between 0 and 128 (inclusive)

Where formerly only three network sizes were available, CIDR prefixes may be defined to describe *any* power of two-sized block of between one and 2^32 end system addresses, that begins at an address that is a multiple of the block size. This provides for far less wasteful allocation of IP address space. The size of the range is given by 2^M, where *M = 32 - prefix_length*

Routing destinations

As well as being used to define a network (subnet), the CIDR notation is used to define the *destination* in a routing table entry, which may encompass multiple networks (with longer prefixes) that are reachable by using the associated routing information. This, therefore, provides the ability to create aggregated routing table entries.

For example, a routing table entry with a destination of `10.1.2.0/23` specifies the address range `10.1.2.0` to `10.1.3.255` inclusive. As an example, it might be that in practice two /24 subnets are reachable via this

routing table entry - 10.1.2.0/24 and 10.1.3.0/24 - routing table entries for these subnets would appear in a downstream router.

Note that in either a network/subnet or routing destination specification, the address will be the starting address of the IP address range being expressed, such that there will be M least significant bits of the address set to zero, where *M = 32 - prefix_length*

Combined interface IP address and subnet definitions

Another common use of the CIDR notation is to combine the definition of a network with the specification of the IP address of an end system on that network - this form is used in subnet definitions on the FB6000, and in many popular operating systems.

For example, the default IPv4 subnet on the `LAN` interface after factory reset is `10.0.0.1/24` - the address of the FB6000 on this subnet is therefore `10.0.0.1`, and the prefix length is 24 bits, leaving 8 bits for host addresses on the subnet. The subnet address range is therefore `10.0.0.0` to `10.0.0.255`

A prefix-length of 32 is possible, and specifies a block size of just one address, equivalent to a plain IP address specification with no prefix notation. This is not the same as a combined subnet and interface-IP-address definition, as it only specifies a single IP address.

General IP address range specifications

CIDR notation can also be used in the FB6000 to express general IP address ranges, such as in session-rules, trusted IP lists, access control lists etc. In these cases, the notation is the same as for routing destinations or subnets, i.e. the address specified is the starting address of the range, and the prefix-length determines the size of the range.

Appendix C. MAC Addresses usage

Ethernet networks use 48 bit MAC addresses. These are globally unique and allocated by the equipment manufacturer from a pool of addresses that is defined by the first three octets (bytes), which identify the organization, and are known as the Organizationally Unique Identifier (OUI). OUIs are issued by the IEEE - more information, and a searchable database of existing OUIs are available at http://standards.ieee.org/develop/regauth/oui/

MAC addresses are commonly written as six groups of two hexadecimal digits, separated by colons or hyphens.

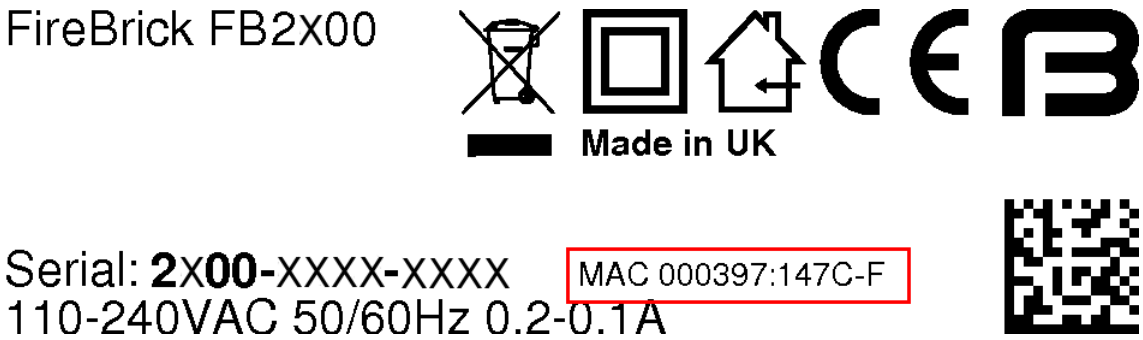
FB6000s currently ship with an OUI value of 00:03:97.

In principle the FireBrick could have a single MAC address for all operations. However, practical experience has led to the use of multiple MAC addresses on the FireBrick. A unique block of addresses is assigned to each FireBrick, with the size of the block dependent on the model.

Most of the time, FB6000 users do not need to know what MAC addresses the product uses. However, there are occasions where this information is useful, such as when trying to identify what IP address a DHCP server has allocated to a specific FB6000. For information on how MAC addresses are used by the FB6000, please refer to this article on the FireBrick website [http://www.firebrick.co.uk/fb2700/mac.php]

The label attached to the bottom of the FB6000 shows what MAC address range that unit uses, using a compact notation, as highlighted in Figure C.1 :-

Figure C.1. Product label showing MAC address range



In this example, the range is specified as :-

```
000397:147C-F
```

this is interpreted as :-

- All addresses in the range start with `00:03:97:14:7`
- the next digit then ranges from "C" through to "F"
  - the first address in the range has zero for the remaining digits (`C:00`)
  - the last address in the range has F for the remaining digits (`F:FF`)

Therefore this range spans `00:03:97:14:7C:00` to `00:03:97:14:7F:FF` inclusive (1024 addresses). If you trying to identify an IP address allocation, note that the exact address used within this range depends on a number of factors ; generally you should look for an IP address allocation against *any* of the addresses in the range.

Alternatively, if the range specification doesn't include a hyphen, it specifies that all addresses in the range start with this 'prefix' - the first address in the range will have zero for all the remaining digits, and the last address in the range will have F for all the remaining digits. For example :-

`000397:147C`

is interpreted as :

- All addresses in the range start with `00:03:97:14:7C`
  - the first address in the range has zero for the remaining digits (00)
  - the last address in the range has F for the remaining digits (FF)

Therefore this range spans `00:03:97:14:7C:00` to `00:03:97:14:7F:FF` inclusive (256 addresses).

If your DHCP server shows the name of the client (FB6000) that issued the DHCP request, then you will see a value that depends on whether the *system name* is set on the FB6000, as shown in Table C.1. Refer to Section 4.2.1 for details on setting the system name.

Table C.1. DHCP client names used

System name	Client name used
not set (e.g. factory reset configuration)	FB6000
set	Main application software running

If the FB6000's system name is set, and your DHCP server shows client names, then this is likely to be the preferred way to locate the relevant DHCP allocation in a list, rather than trying to locate it by MAC address. If the FB6000 is in a factory-reset state, then the system name will not be set, and you will have to locate it by MAC address.

Appendix D. VLANs : A primer

An Ethernet (Layer 2) broadcast domain consists of a group of Ethernet devices that are interconnected, typically via switches, such that an Ethernet broadcast packet (which specifies a reserved broadcast address as the destination Ethernet address of the packet) sent by one of the devices is always received by all the other devices in the group. A broadcast domain defines the boundaries of a single 'Local Area Network'.

When Virtual LANs (VLANs) are not in use, a broadcast domain consist of devices (such as PCs and routers), physical cables, switches (or hubs) and possibly bridges. In this case, creating a distinct Layer 2 broadcast domain requires a distinct set of switch/hub/bridge hardware, not physically interconnected with switch/hub/bridge hardware in any other domain.

A network using Virtual LANs is capable of implementing multiple distinct Layer 2 broadcast domains with *shared* physical switch hardware. The switch(es) used must support VLANs, and this is now common in cost-effective commodity Ethernet switches. Inter-working of VLAN switch hardware requires that all hardware support the same VLAN standard, the dominant standard being IEEE 802.1Q.

Such switches can seggregate physical switch ports into user-defined groups - with one VLAN associated with each group. Switching of traffic only occurs between the physical ports in a group, thus isolating each group from the others. Where more than one switch is used, with an 'uplink' connection between switches, VLAN *tagging* is used to multiplex packets from different VLANs across these single physical connections.

A IEEE 802.1Q VLAN tag is a small header prefixed to the normal Ethernet packet payload, includes a 12-bit number (range 1-4095) that identifies the tagged packet as belonging to a specific VLAN.

When a tagged packet arrives at another switch, the tag specifies which VLAN it is in, and switching to the appropriate physical port(s) occurs.

In addition to VLAN support in switches, some end devices incorporate VLAN support, allowing them to send and receive tagged packets from VLAN switch infrastructure, and use the VLAN ID to map packets to multiple logical interfaces, whilst only using a single physical interface. Such VLAN support is typically present in devices that are able to be multi-homed (have more than one IP interface), such as routers and firewalls, and general purpose network-capable operating systems such as Linux.

The FB6000 supports IEEE 802.1Q VLANs, and will accept (and send) packets with 802.1Q VLAN tags. It can therefore work with any Ethernet switch (or other) equipment that also supports 802.1Q VLANs, and therefore allows multiple logical interfaces to be implemented on a single physical port.

VLAN tagged switching is now also used in Wide-Area Layer 2 Ethernet networks, where a Layer 2 'circuit' is provided by a carrier over shared physical infrastructure. The conventional concept of a LAN occupying a small geographic area is thus no longer necessarily true.

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