Walled garden for on-boarding user devices to eduroam

Technical Deployment Guide

Contents

Background

One of the key barriers in successful deployment of eduroam, is around ensuring that users are adequately supported. 802.1x/WPA2 Enterprise configuration on the majority of devices is a little more complex than PSK-based Wireless solutions, which users are familiar with at home. As a result there is a need for on-boarding tools to be made available to users, such as eduroam CAT.

Organisations providing eduroam will need to provide access to their chosen on-boarding tool; typically they will be available via the organisations eduroam support web page. The challenge for many organisations is that devices need Internet access to visit to the organisations eduroam support web page, this usually isn't a problem for mobile phones which usually have access to the Internet via the mobile network.

However, there are other situations which require an Internet connection or local network access to gain access to the on-boarding tools.   This includes where organisations have poor mobile coverage, but also for tablets and laptop devices, which may not have access to the mobile network.

The solution deployed by many organisations is that of a 'Walled Garden', this is a network connection that enables sufficient access to download on-boarding tools, gain access to support webpage and any other relevant access, but it should fall short of providing full internet access.

Our work with the Further Education sector has highlighted the need for organisations deploying eduroam to also deploy a 'Walled Garden' to on-board large numbers of users onto eduroam, and to enable users to 'self-service'. The 'Walled Garden' is typically made available by broadcasting an open wireless SSID.

The following guide is aimed to help you in configuring a walled garden network. This uses the Open-source product pfSense, which is a Firewall solution based on FreeBSD. It's a viable solution, even for organisations which typically don't use Unix-based operating systems, since it is almost entirely configured through a web page, is comparable to appliance-based solutions, and is relatively easy to maintain and update.

pfSense can be configured to run in a Virtual Machine, this guide covers using VMware, but it can also be deployed in a Xen environment, or on physical hardware.

Since the completion of this guide, there has been an update to pfSense from 2.2 to 2.3, and has is now known as the pfSense Community Edition. Since the update the user interface has improved, but there is very little change to the menu options and pages. These instructions have been tested with version 2.2.4 and 2.3.2, we recommend using the latest stable version of the software.

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Document - Version 0.5

Date 9th August 2016

Changelog

Version	Modification	Author	Date
0.2	Initial version	Jon Agland	19th January 2016
0.3	Updating following feedback from eduroam (UK) team	Jon Agland	20th April 2016
0.4	Added eduroam CAT website list	Jon Agland	6th July 2016
0.5	Update Background related to new pfSense 2.3 release Added missing Network screenshot from Create New Virtual Machine Changelog added	Jon Agland	9th August 2016

Considerations

You should take some time to consider and even design the solution, security is one of the key areas to think about. Opening up an open wireless network is a significant risk. Whilst we have some confidence that pfSense can provide a secure solution, you may wish to consider additional safeguards. We would suggest the following

- LAN port of pfSense must be into a dedicated network (VLAN)

    o   VLAN should have no IP address on other Routers, Switches, Firewall

    o   DHCP/IP Helper/Directed-Broadcast is not required, DHCP will be provided by pfSense

    o   VLAN may need IP addressing (an SVI) on the Wireless controller

    ▪   We know this to be true for Wireless controllers from Cisco and Meru.

    o   If you need multiple controllers at different locations, which then use different VLANs, then you may need multiple pfSense units

    o   This VLAN will be your 'walled garden' where untrusted devices will be connected.

    o   The IP subnet used should be unique on your network

- WAN port of pfSense

    o   Should be into a dedicated network (VLAN)

    o   Could be a 'DMZ', restricted network, or the perimeter/Internet edge network

    o   Ensure that pfSense Web and SSH interfaces are secured appropriately.

    o   The corresponding IP interface e.g. on a Router, Layer 3 Switch or Firewall, should have an appropriate Access-List to offer further protection to your infrastructure

    o   Consider that a failure or misconfiguration of the pfSense could expose this network to untrusted devices.

    o   The IP subnet used must be unique on your network, and be routable out the Internet but can utilise NAT

- Further usage of pfSense;

    o   You could utilise to provide a Captive Portal for non-eduroam users

    ▪   Janet connected sites should consider our guidance on **guest and public access.**

    o   If using dynamic VLANs in your eduroam/RADIUS configuration, your 'walled-garden' could be elected as the default VLAN for the controller or for RADIUS in the event of a configuration issue.

    o   A separate network and interface could be used to provide the eduroam visitor network, this will need to be compliant with the **eduroam (UK) Technical Specification**.

Preparing

Start by downloading the latest ISO image from the pfSense website. Whilst a 32-bit version is available for most installations you should use the 64-bit version.

The pfSense ISO image is compressed using gzip, therefore you may need a package such as 7Zip or you could gunzip the file on a Linux/Unix system.

Download the Captive Portal PHP code from Gist/Github.

RAW PHP version for download (**RAW PHP version of file**)

Code version for info/comment/contribution (**Gist/Github of captiveportal.php**)

Creating a VMware Virtual Machine for pfSense

Open up your VMware vSphere Client, Right click on your Host/Cluster/Resource Pool and choose 'New Virtual Machine'
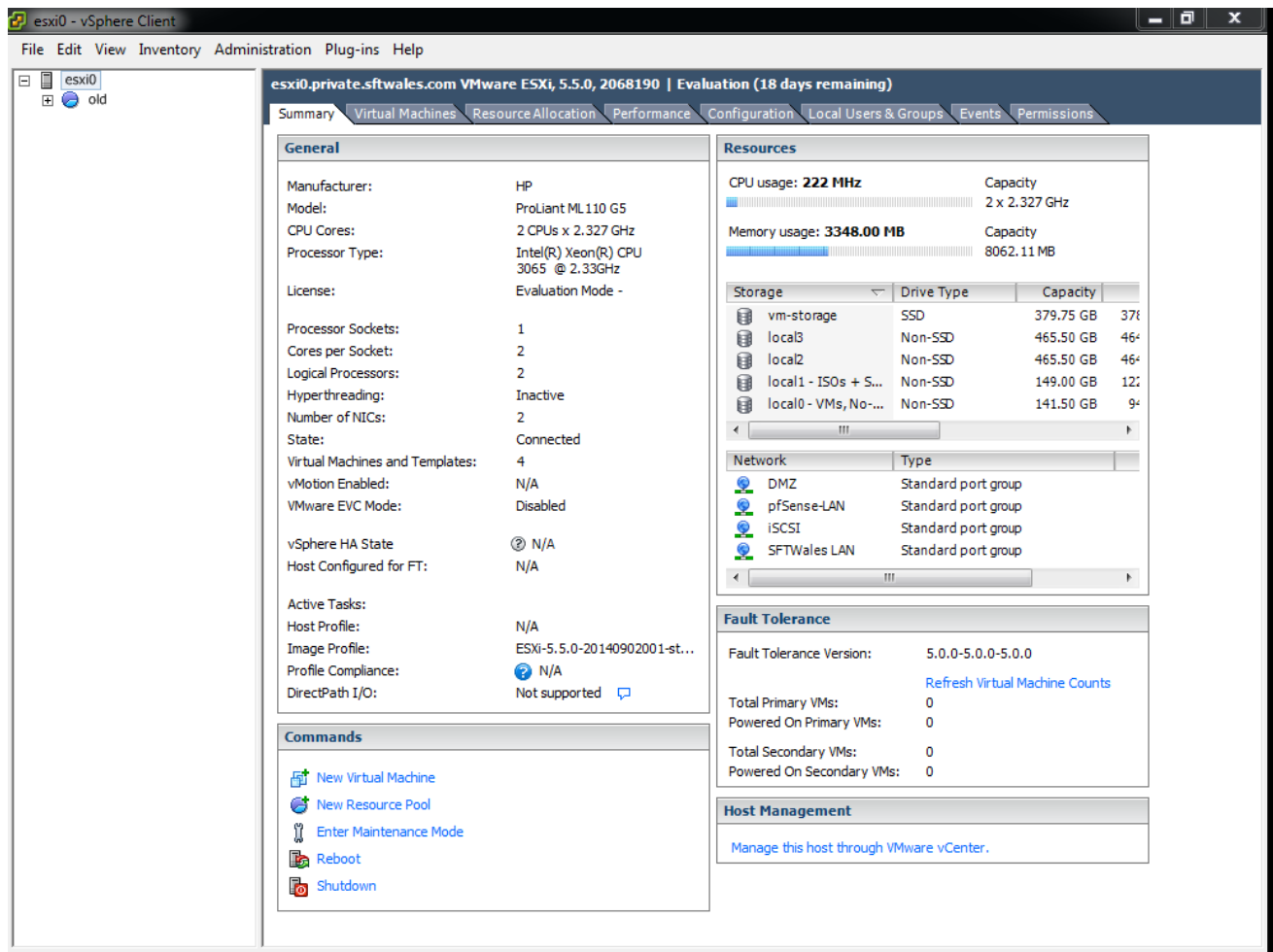
Choose Typical
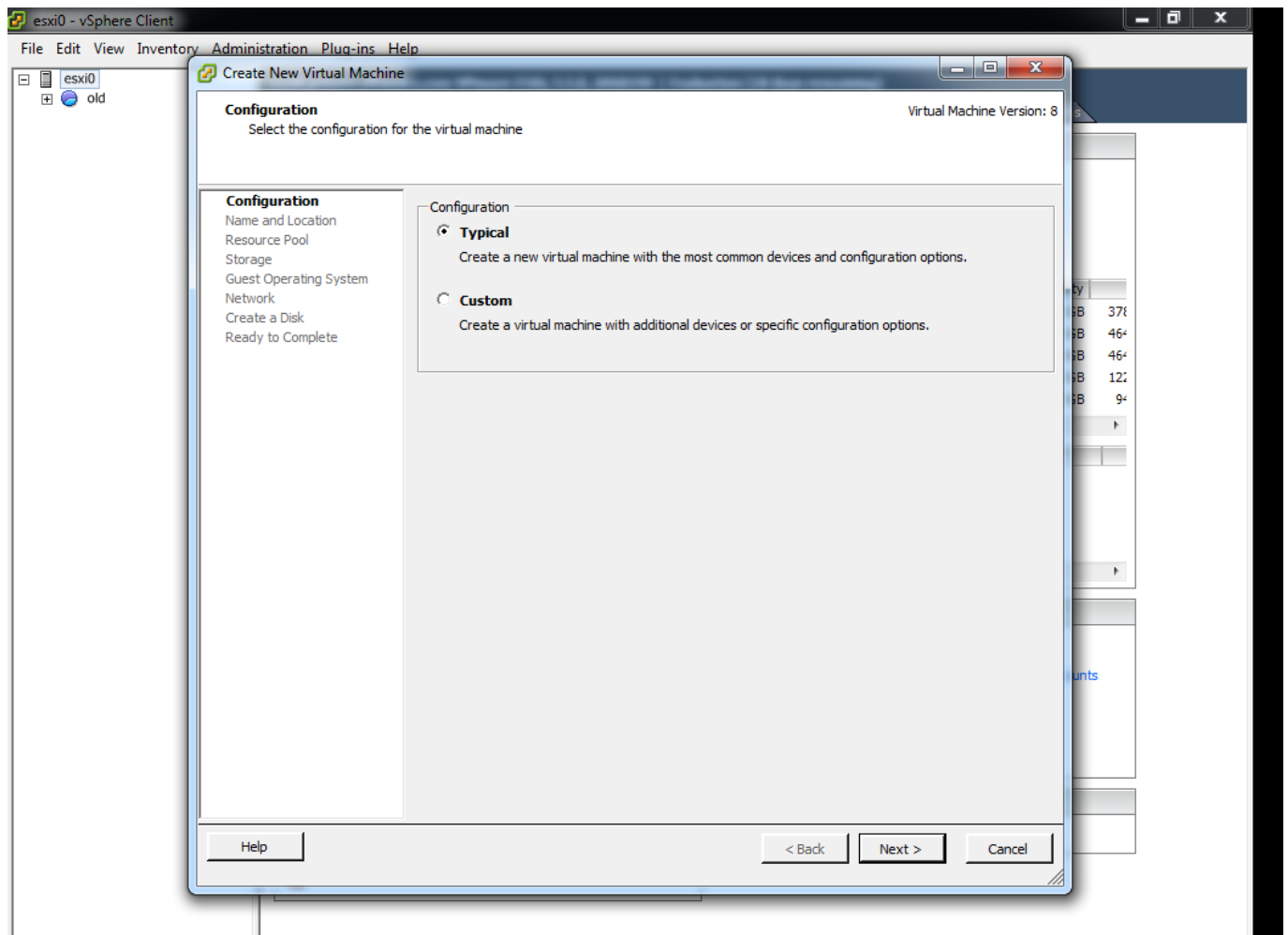
Enter a name for your virtual machine (in this instance we chose pfsense-wg)
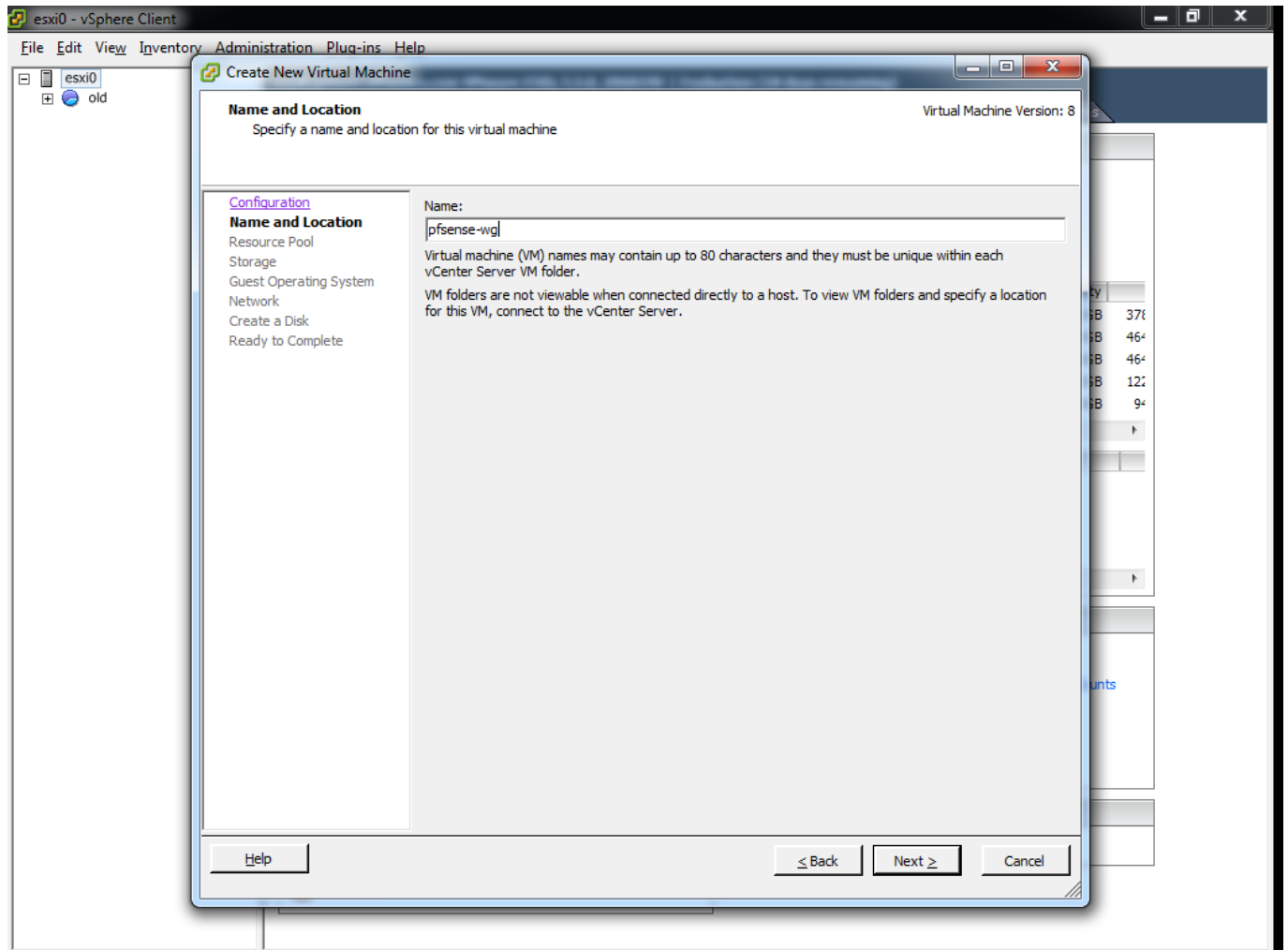
Choose the Resource Pool and click Next;
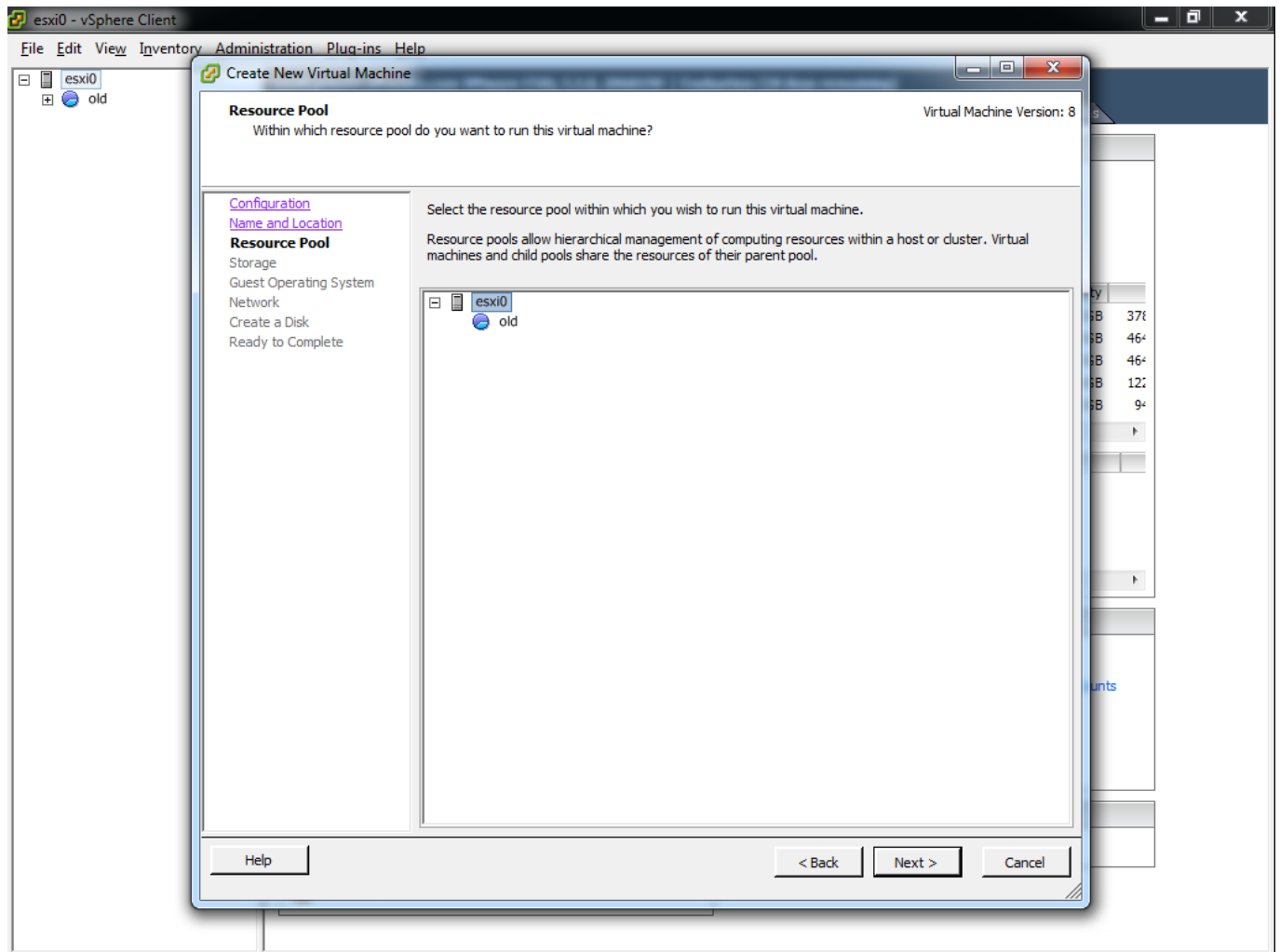
Choose an appropriate storage location. In most environments a SAN or NAS are used, rather than local disks, you will require ~8GB of storage to start. The storage needn't be your Highest Tier (e.g.. SSD/SAS), Lower Tier storage (e.g. SATA) will be more than sufficient for most usage.
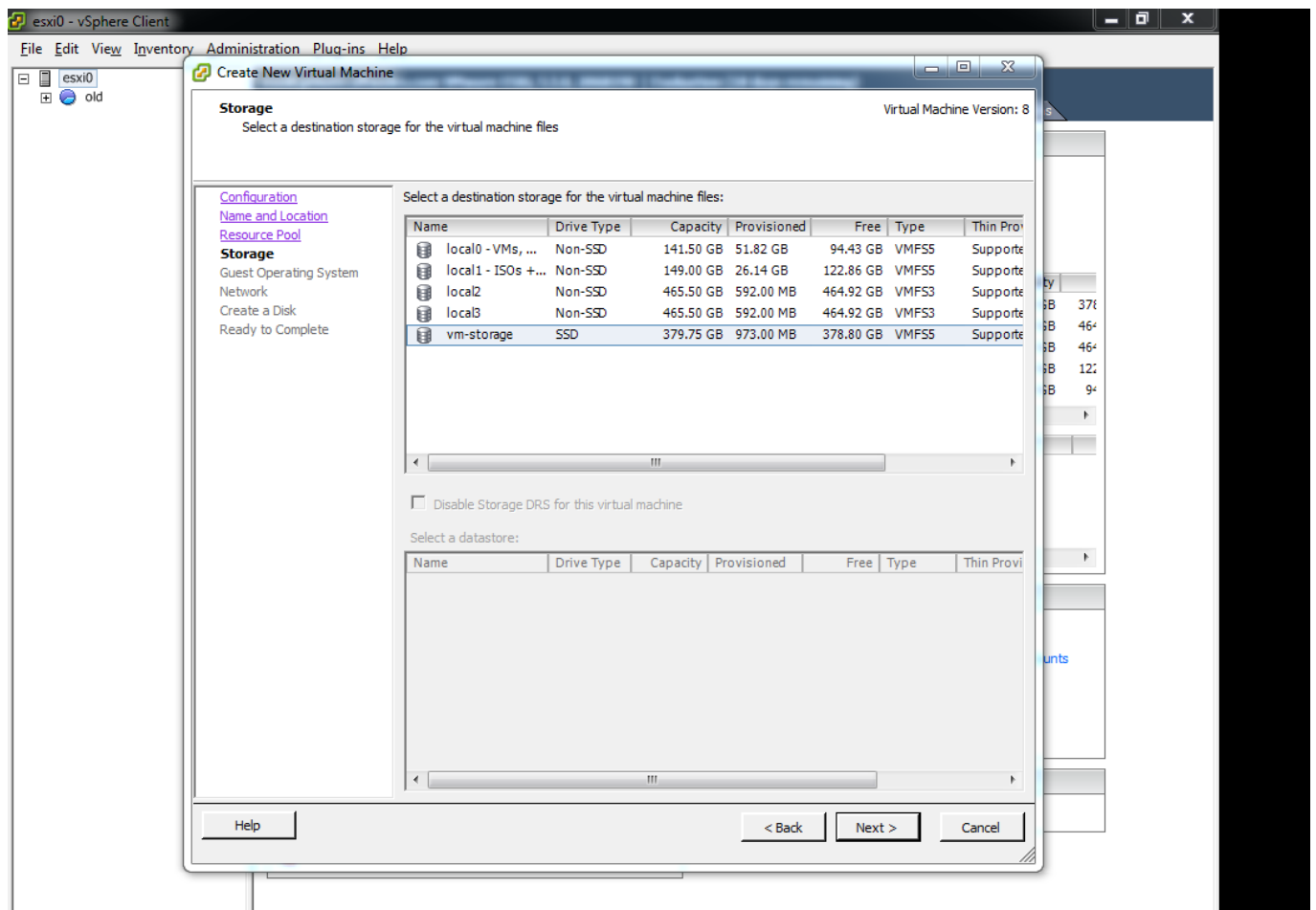
Choose the number of network interfaces and their connections, at this stage choose just one interface for example on a LAN or DMZ. At a later stage we will add an additional interface for the 'Walled Garden', do not add it now.
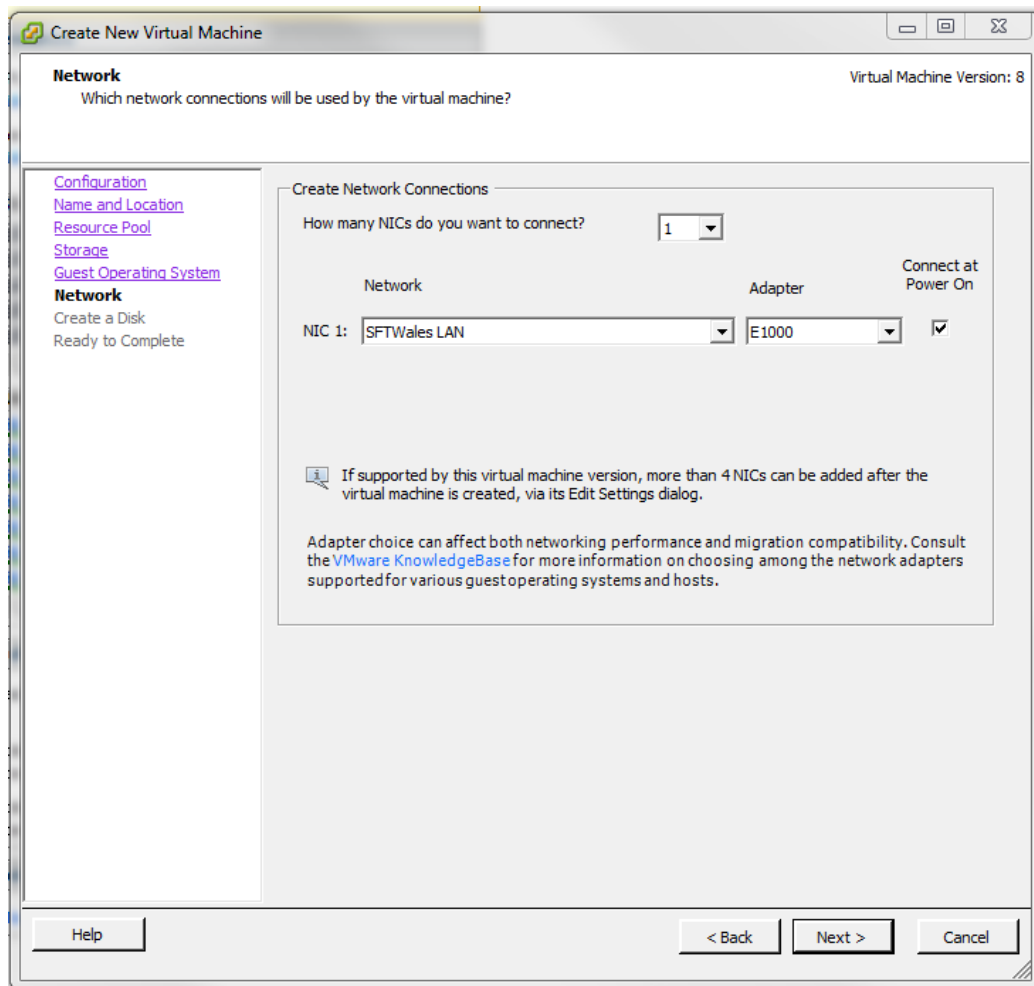
Choose the Guest Operating System version (FreeBSD 64-Bit)
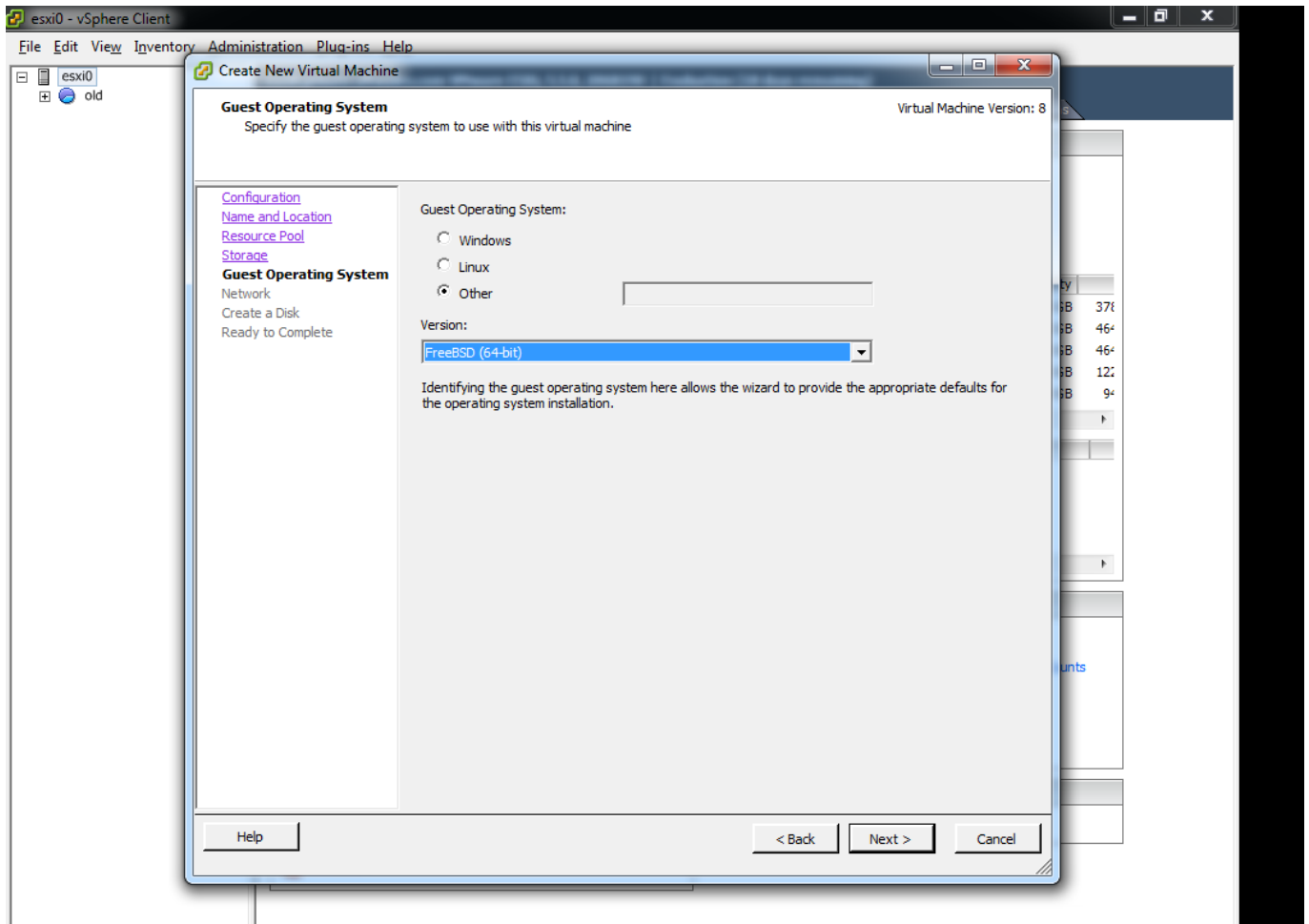
Select the size of the disk. This can remain at the default of 8GB. The type i.e. Thick Provision or Thin Provision will depend on your procedures;
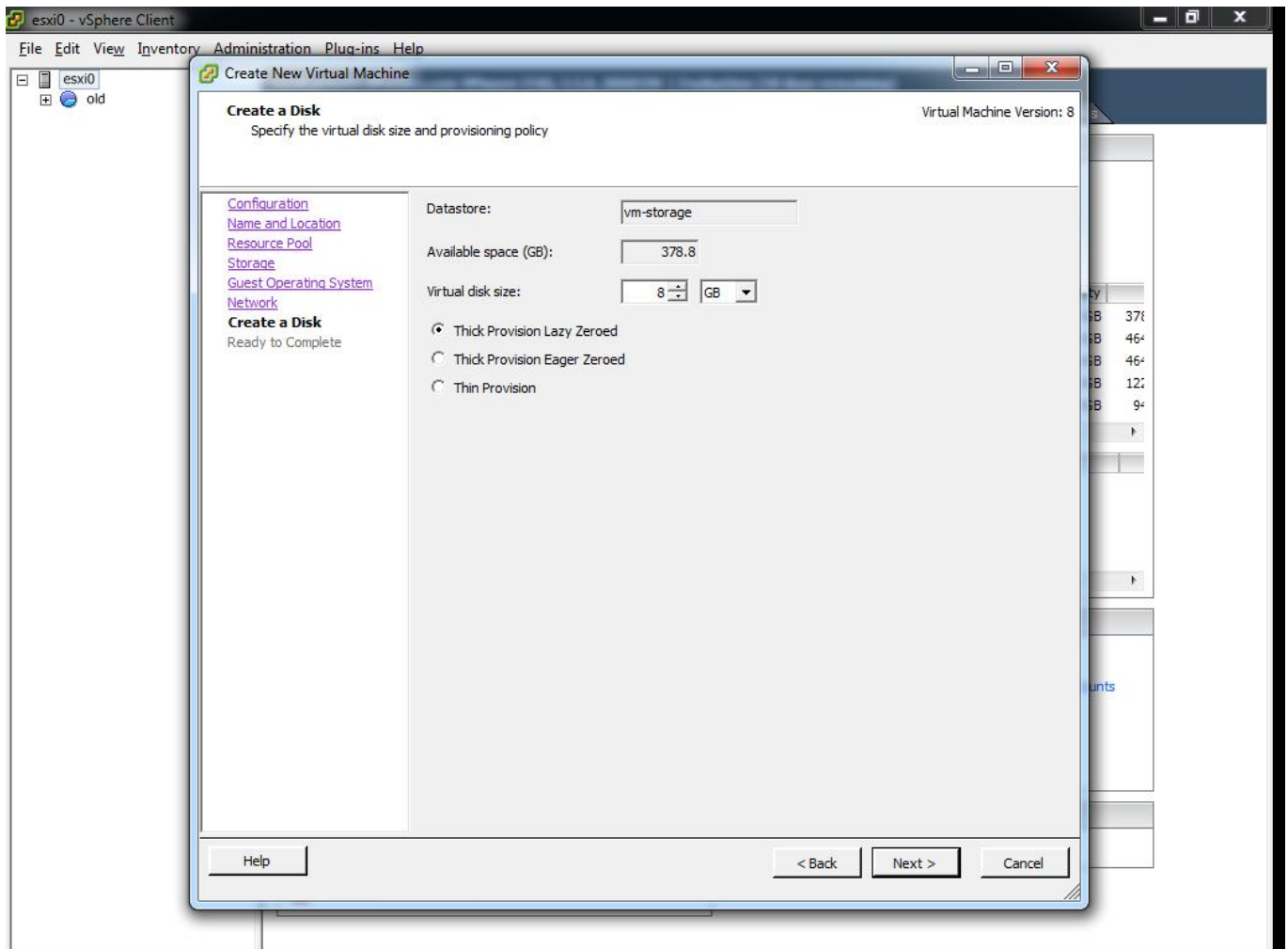
On this screen, remember to tick 'Edit the virtual machine settings before completion
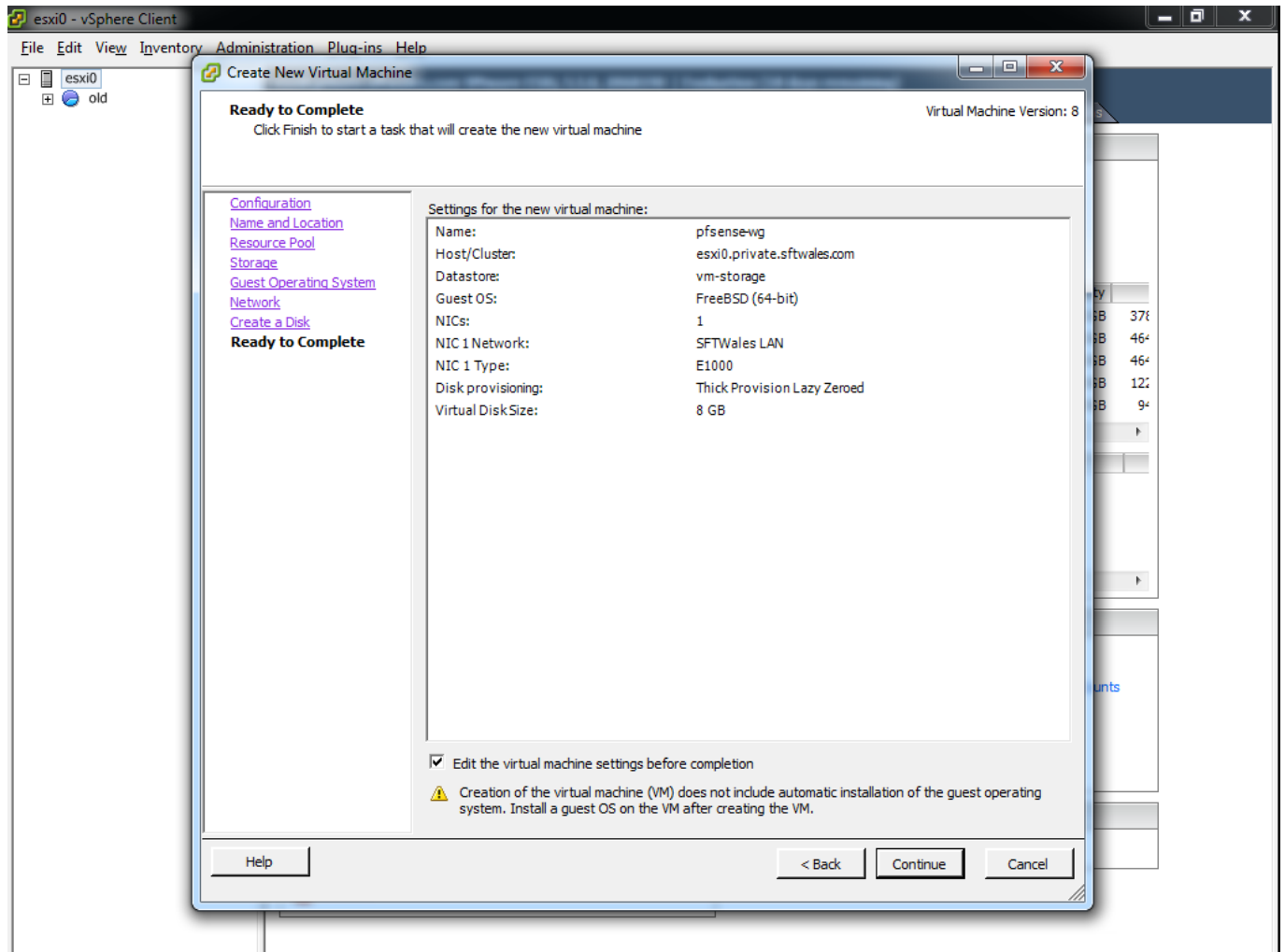
Complete the following changes

- Memory - adjust as required (for small installations 256MB may be suitable).

- CPUs – adjust as required (for most installations 1 CPU will be sufficient)

- Floppy – can be removed

- NIC – Check that the Interface is set correctly, this will become the 'WAN Interface' within pfSense.
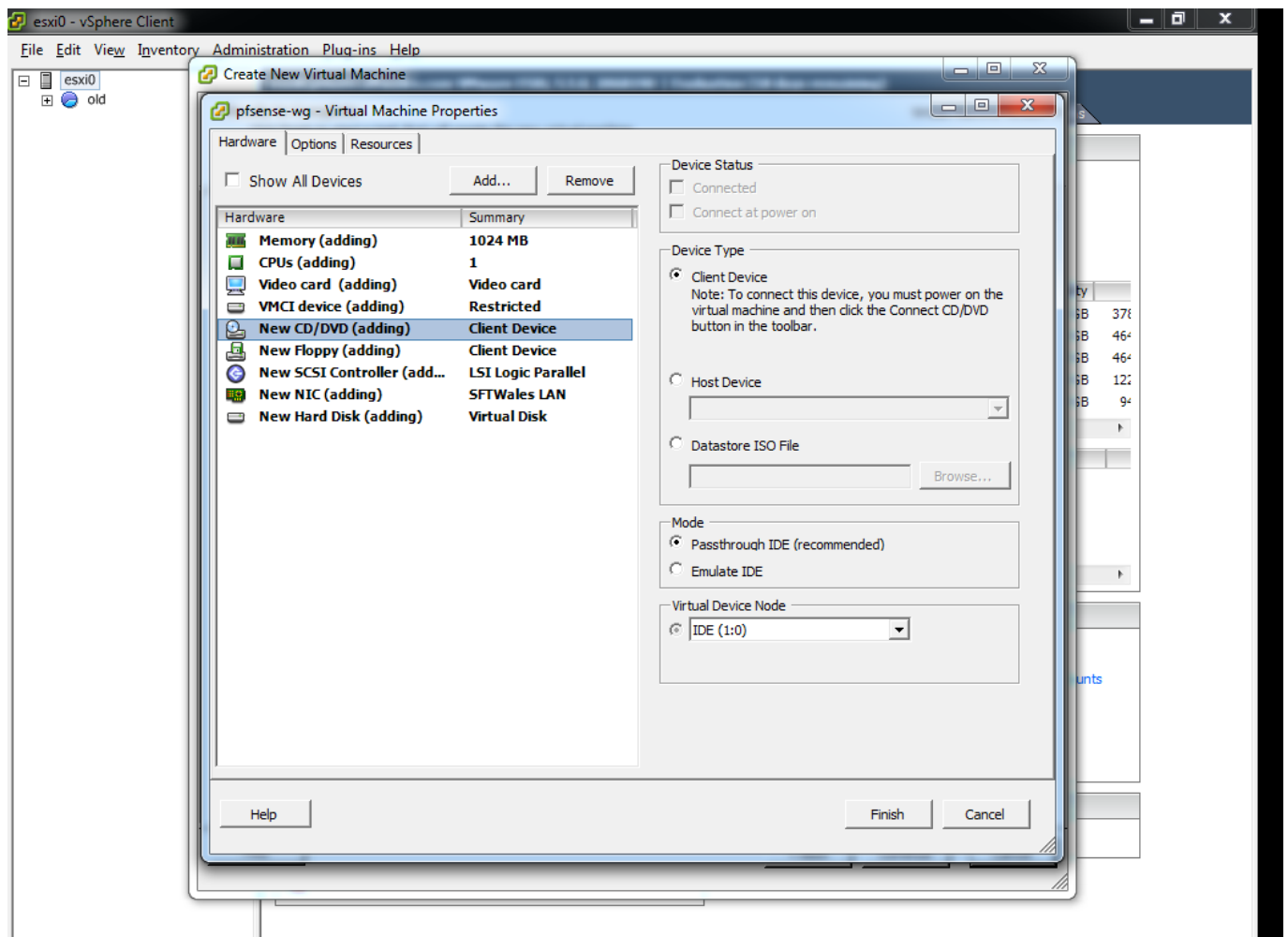
Uploading the ISO Image

Choose a Datastore under Storage, Right click and choose 'Browse Datastore'

Next click on the 'Upload files to Datastore' icon (It's the one with the green arrow point upwards)
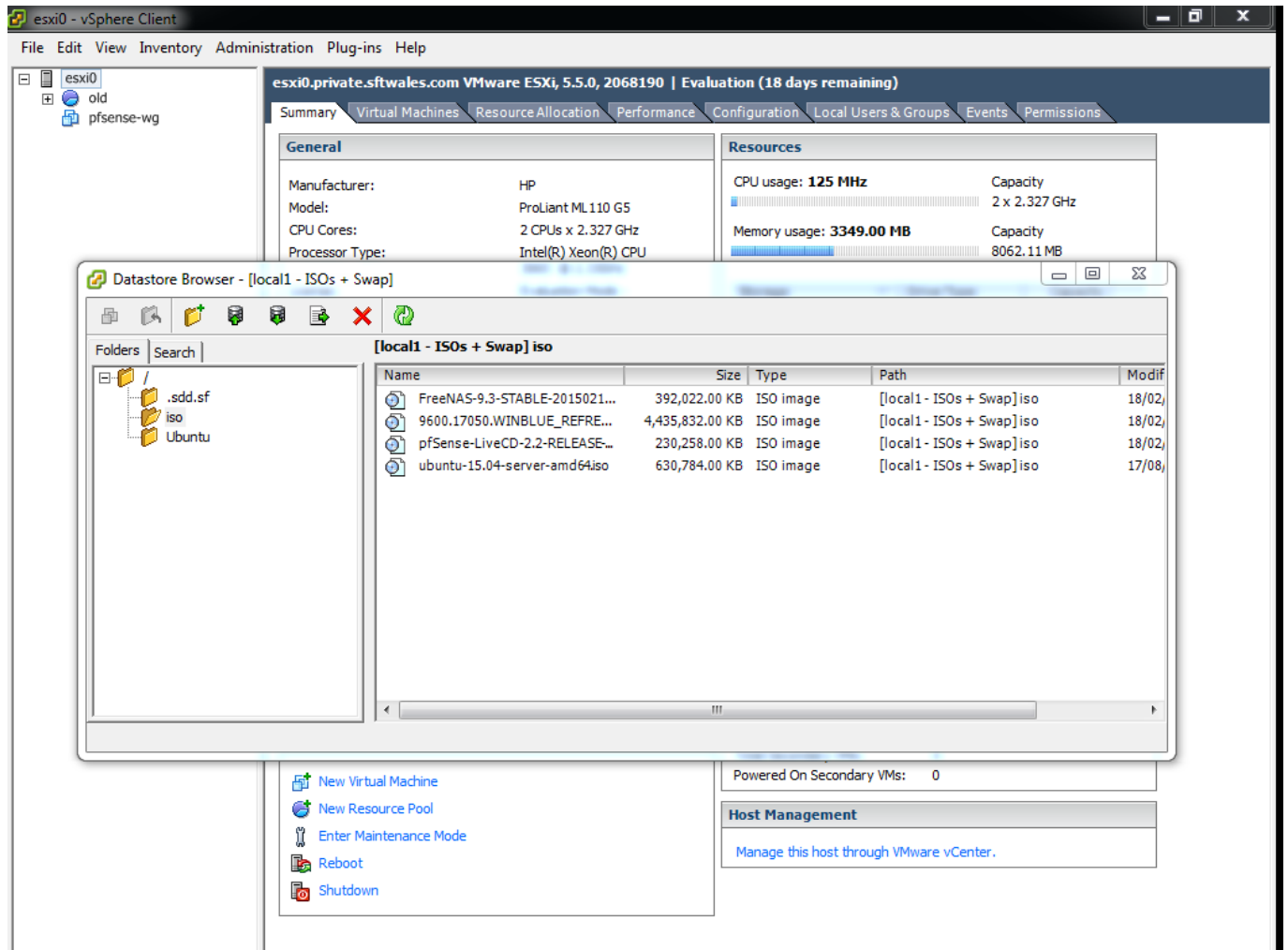
Next choose the ISO image you wish to upload (If you do not have an ISO image refer to the pre-requisites section)
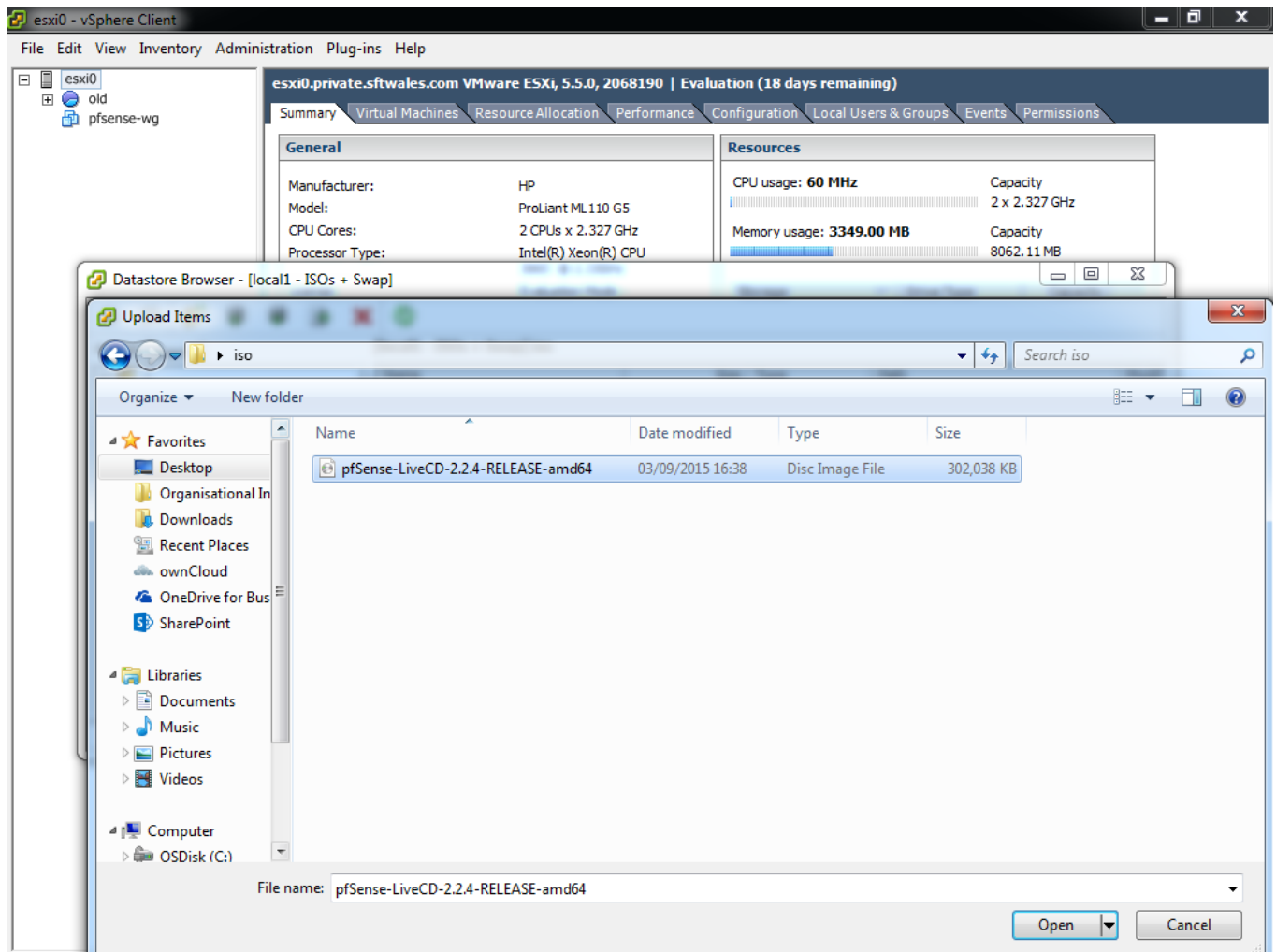
On the following dialogue you can select 'Yes'
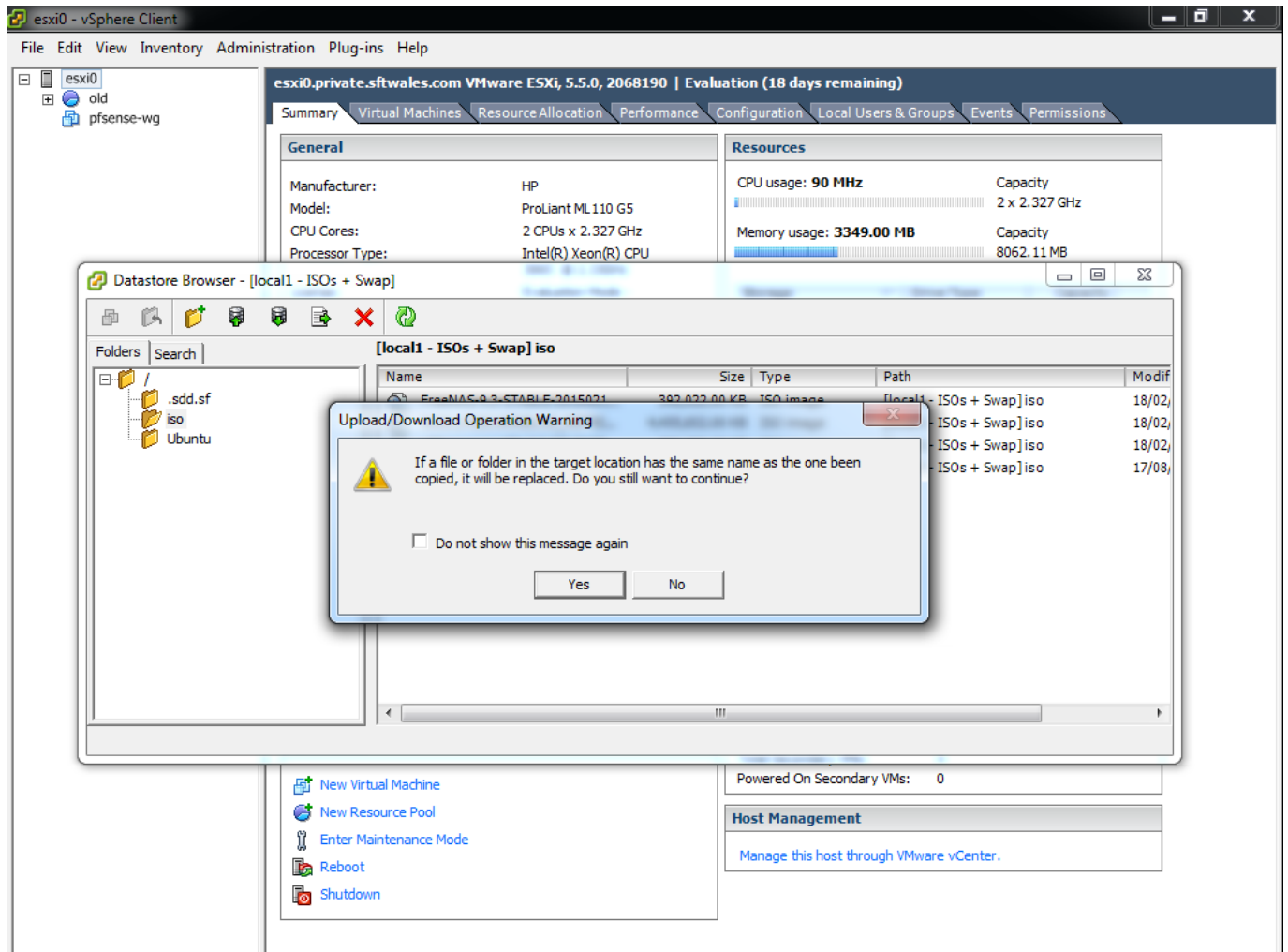
The file may take a few minutes to upload (depending on network and storage performance)
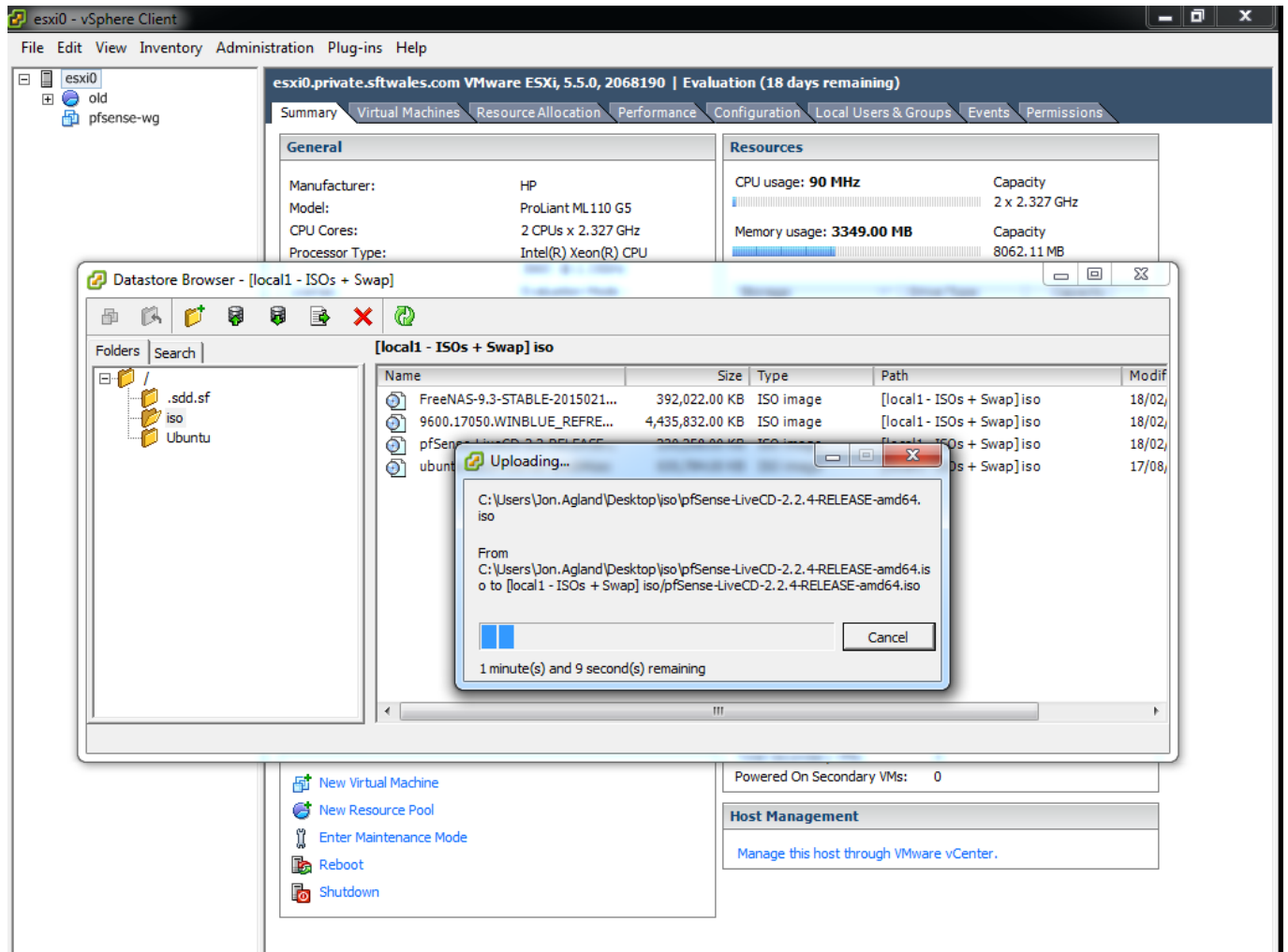
Attaching ISO Image to the VM

We now need to select the Virtual Machine ('pfsense-wg' in this case) and under Commands choose 'Edit Settings'
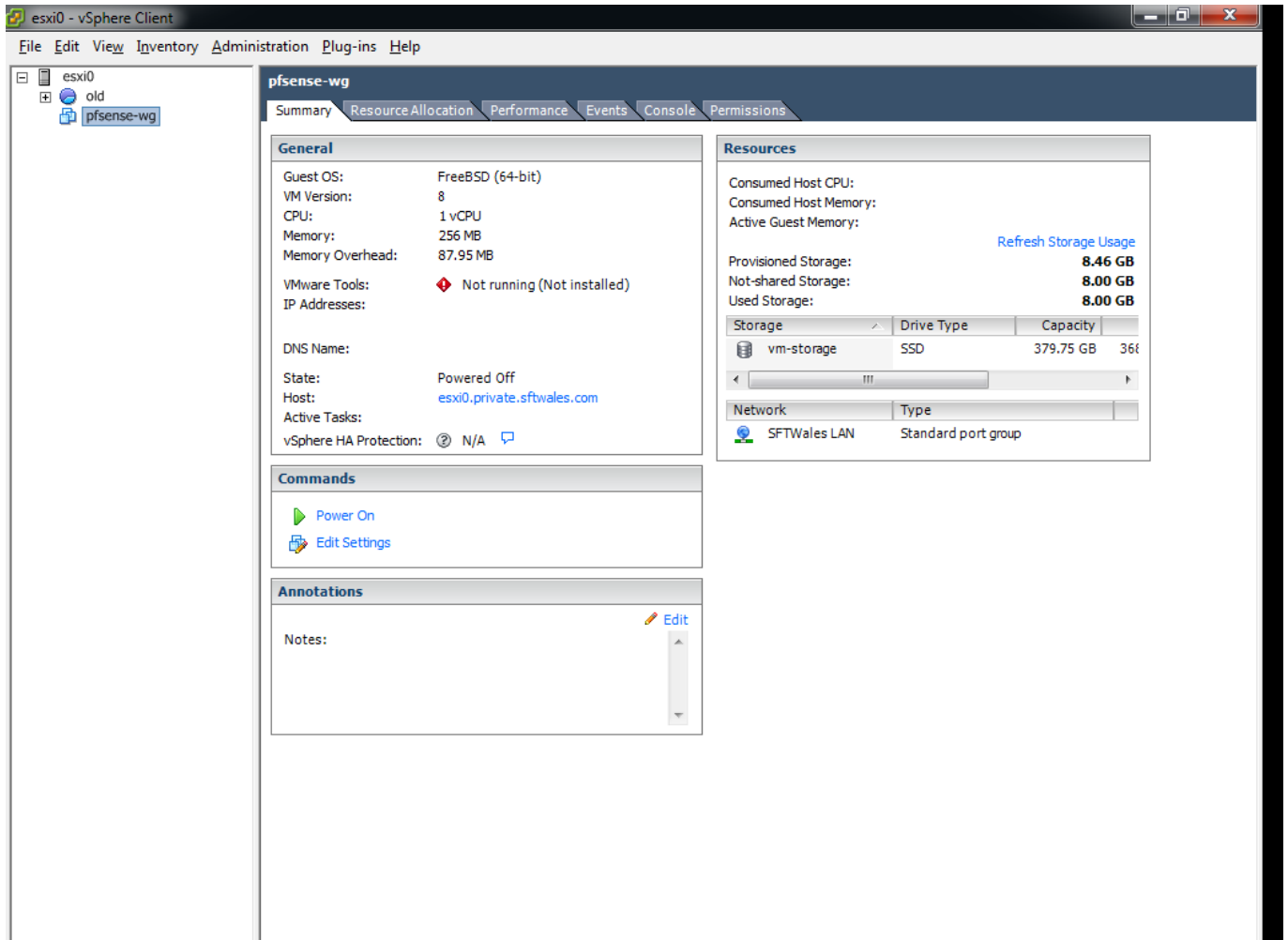
We now need to edit the CD/DVD Drive. Under device type choose 'Datastore ISO File' and Browse
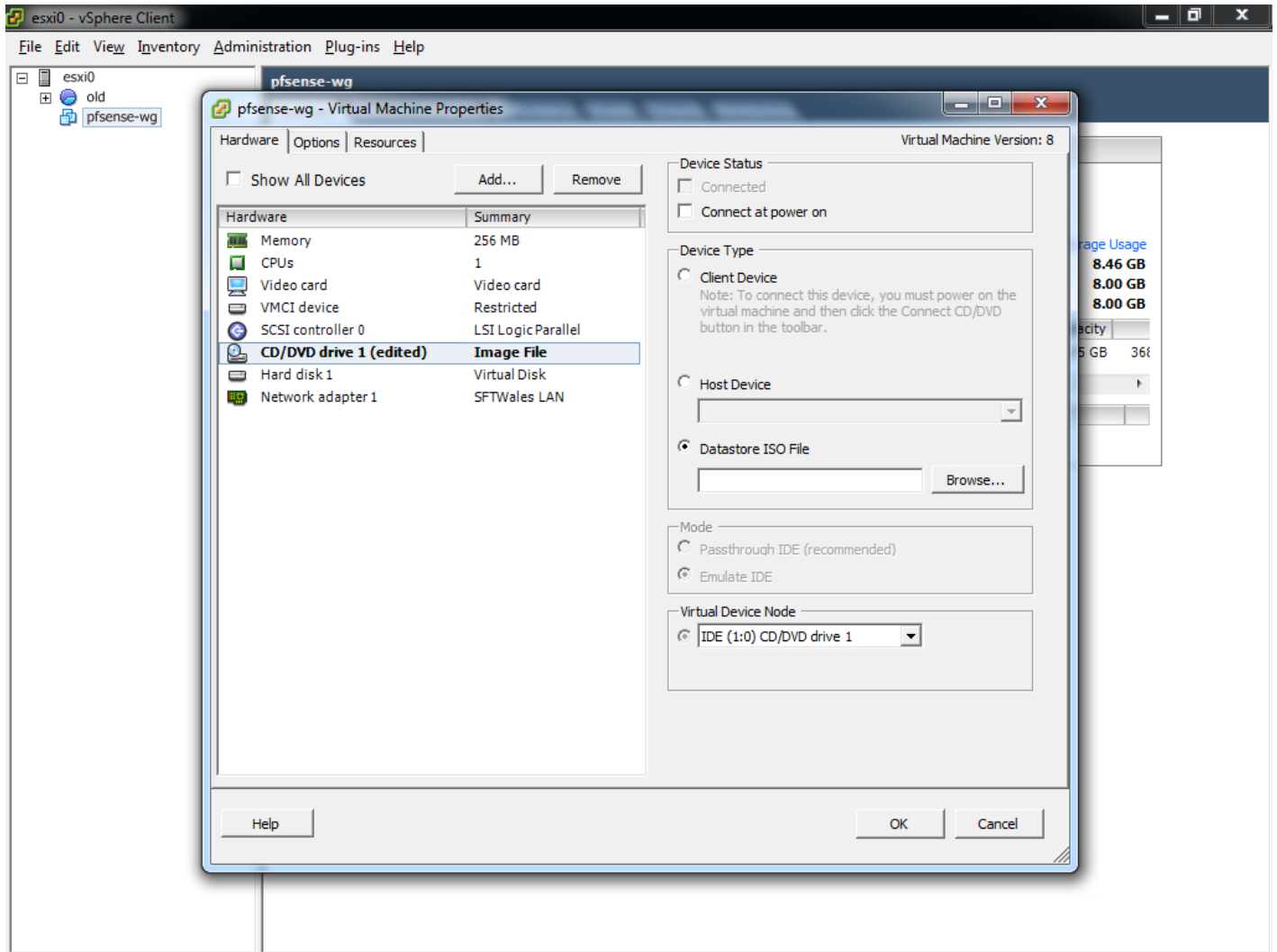
Ensure that the option for 'Connect at power on' is ticked
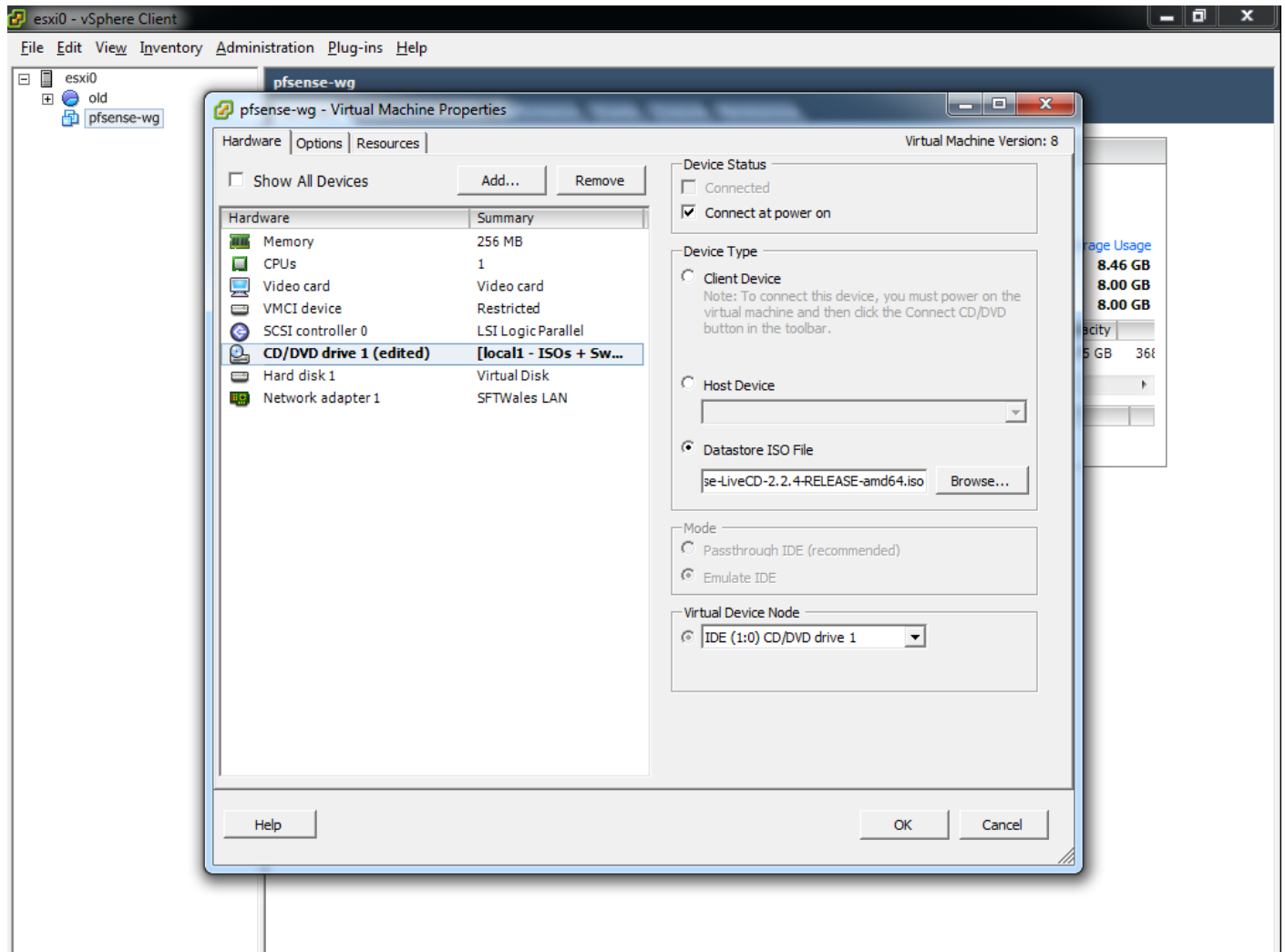
pfSense Installation

- Within a VM installation you are unlikely to want to setup VLANs, these can be handled within the Hypervisor i.e. VMWare, in this case choose 'n'

- Within a Physical server you may need to setup VLANs, In this case choose 'y'
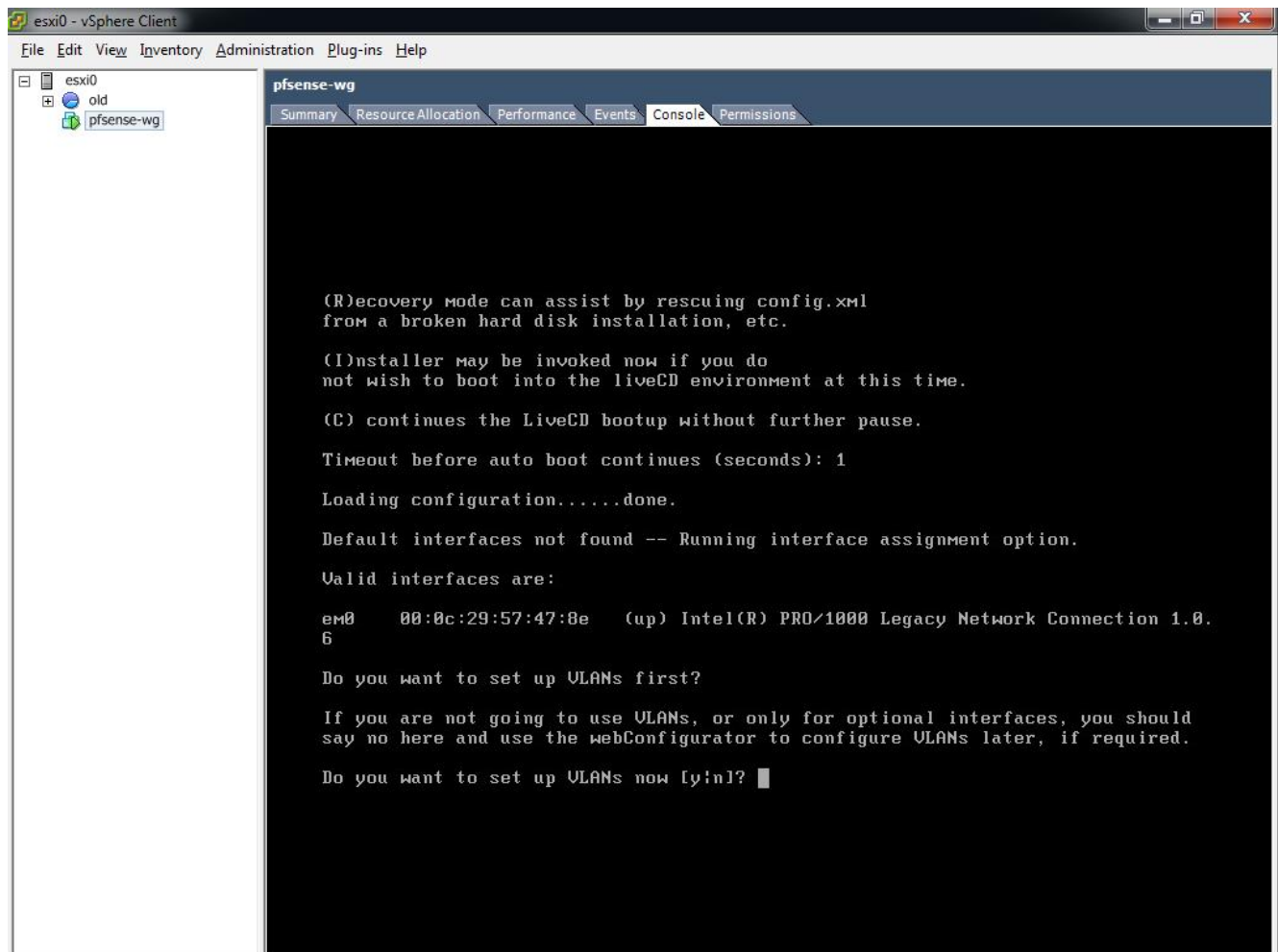
When prompted for the WAN interface enter the valid interface lists above i.e. 'emo'
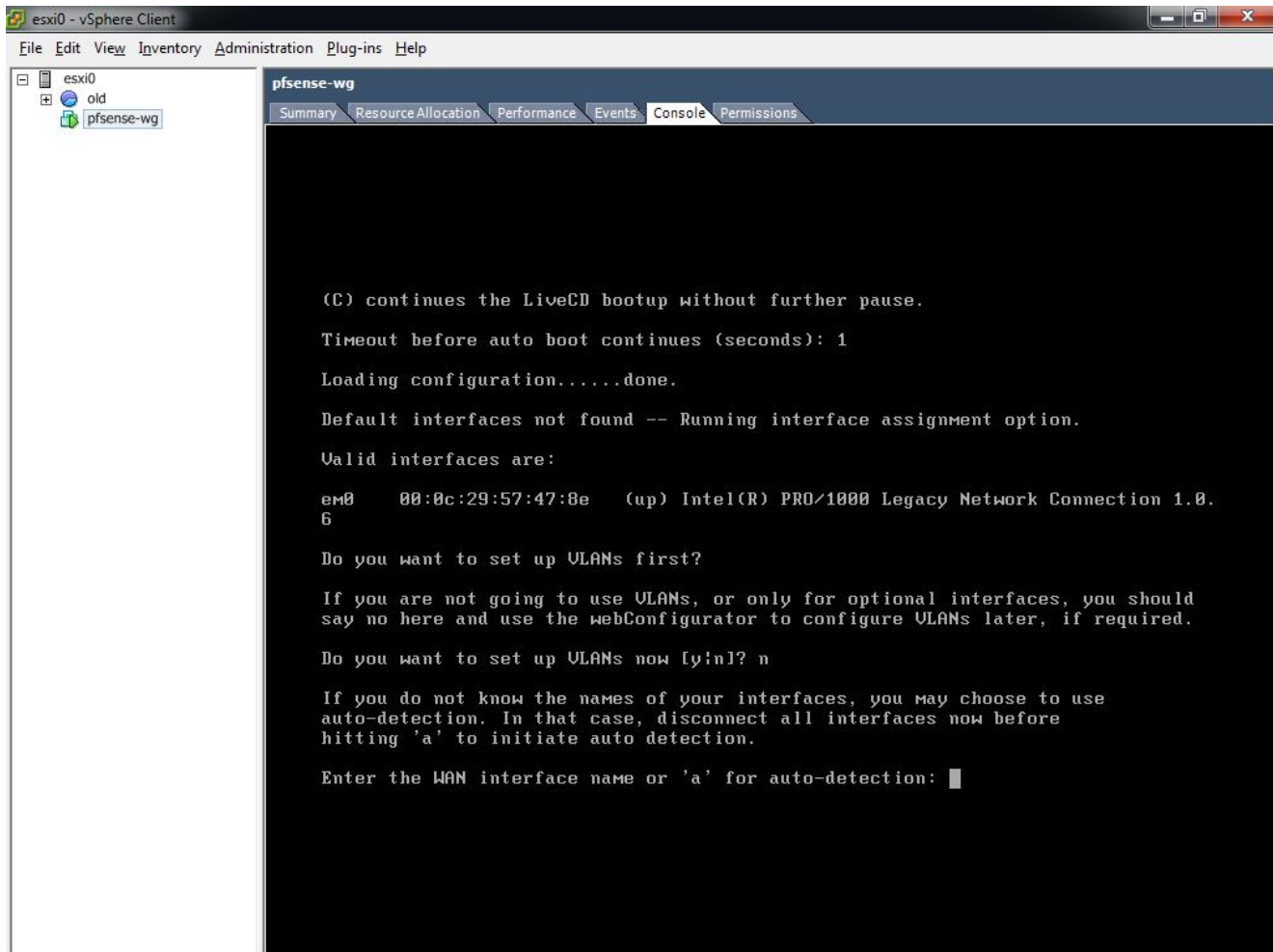
When prompted for a LAN interface choose 'a' for auto. Finally when it asks how 'interfaces will be assigned' check and choose 'y'
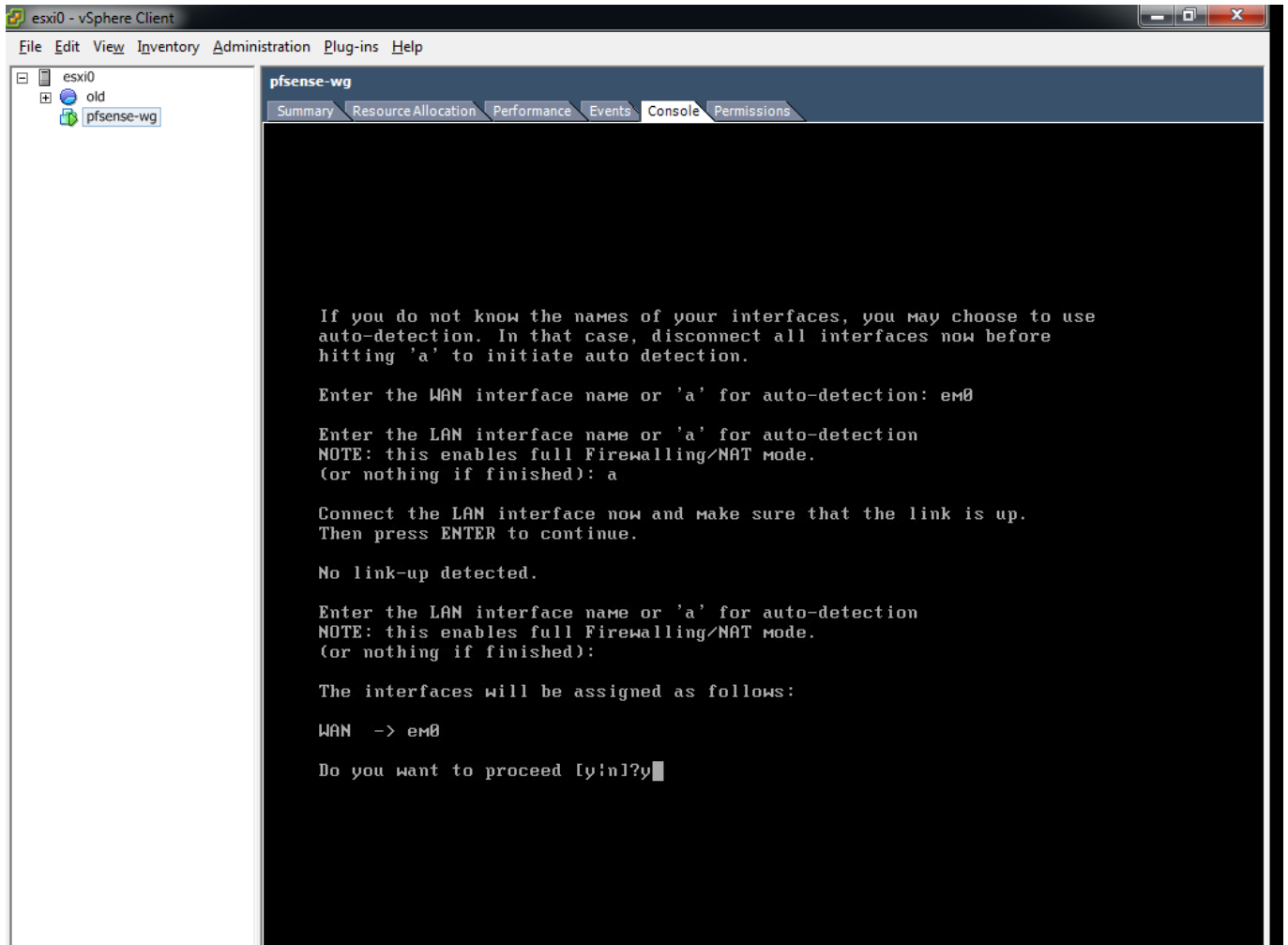
Next you will need to 'Install pfSense to a hard drive, etc..' enter '99'
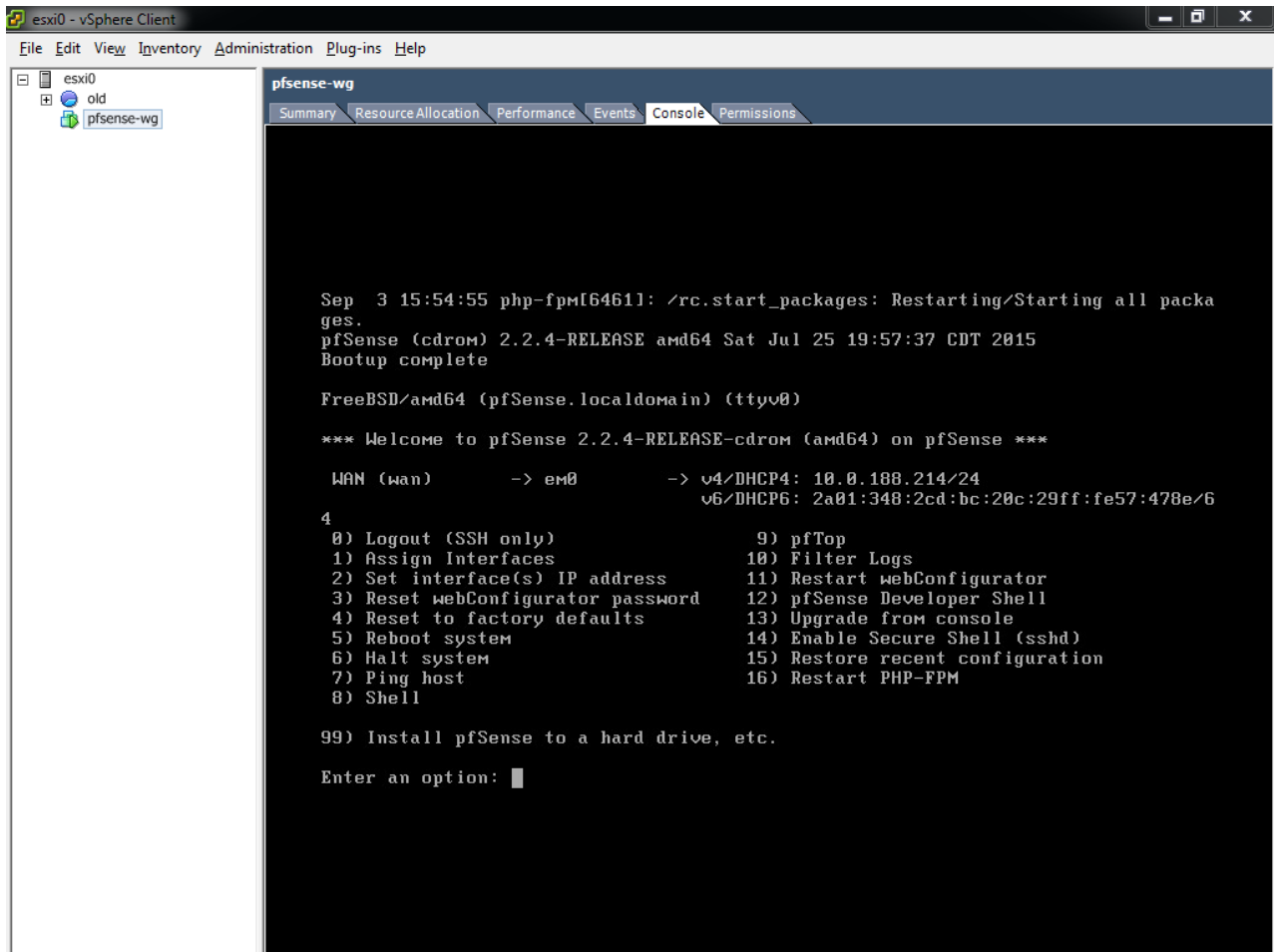
There is usually little reason to change options here. Choose 'Accept these Settings'
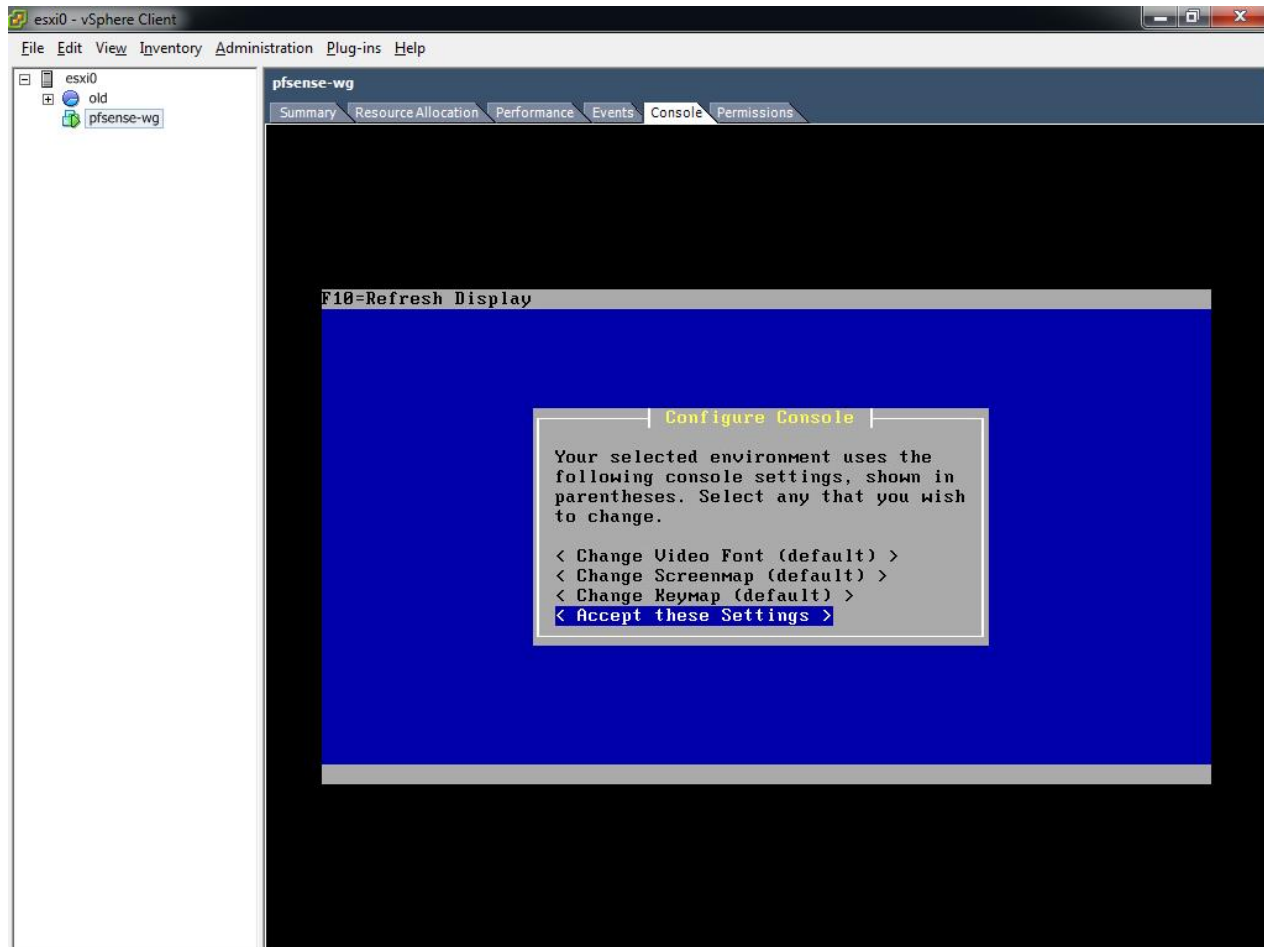
For a new installation on a VM, then choose Quick/Easy Install.

Custom Install can be used for features like 'Software RAID' (using two hard disks to provider RAID, but without a Hardware RAID controller)

Rescue config.xml can be used to restore a backup, so for a re-installation.
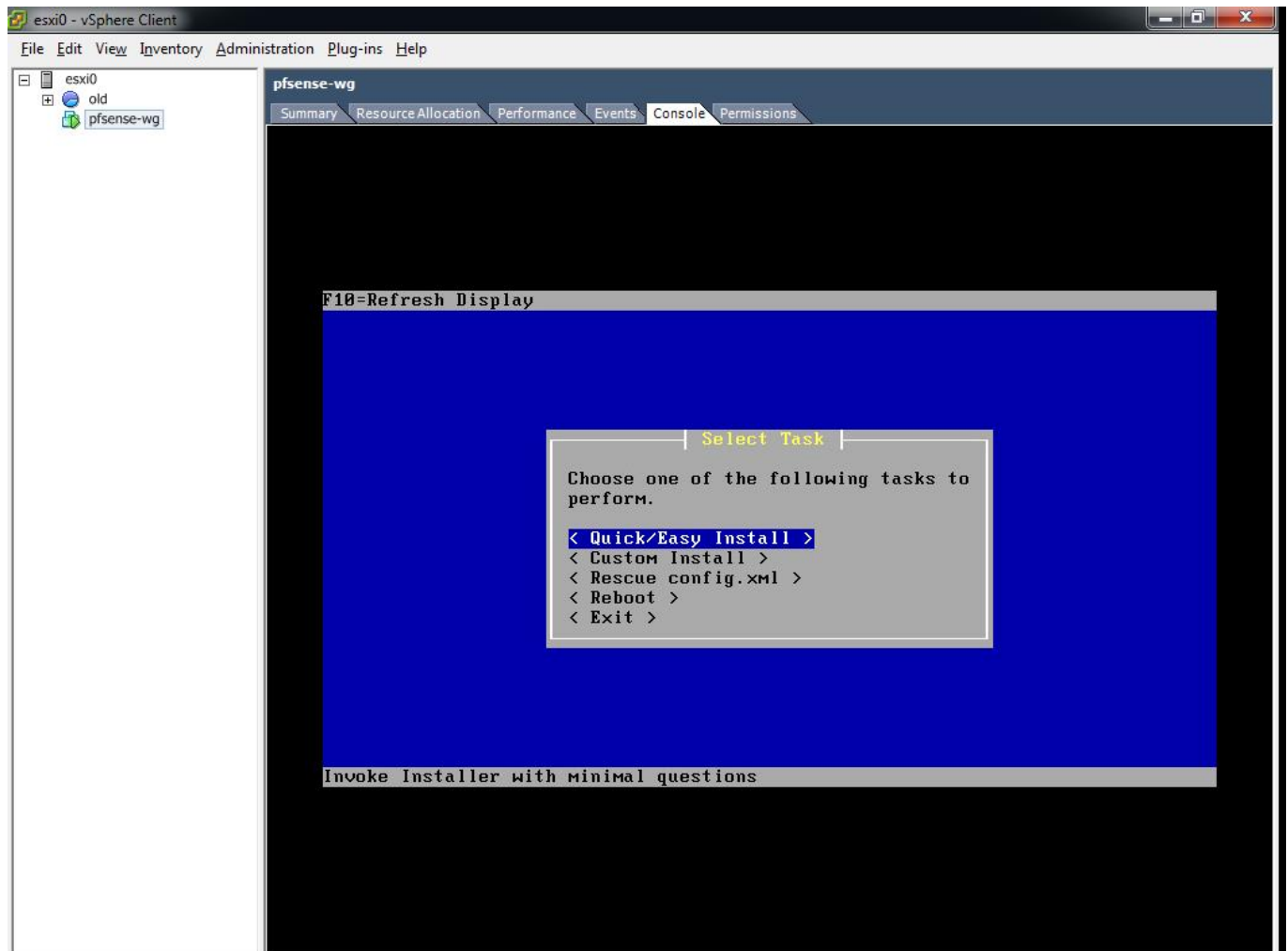
For a new VM installation there should be nothing to consider here, just choose 'OK'

For any other installation take more notice, especially if you have any disks containing data you may wish to retain.
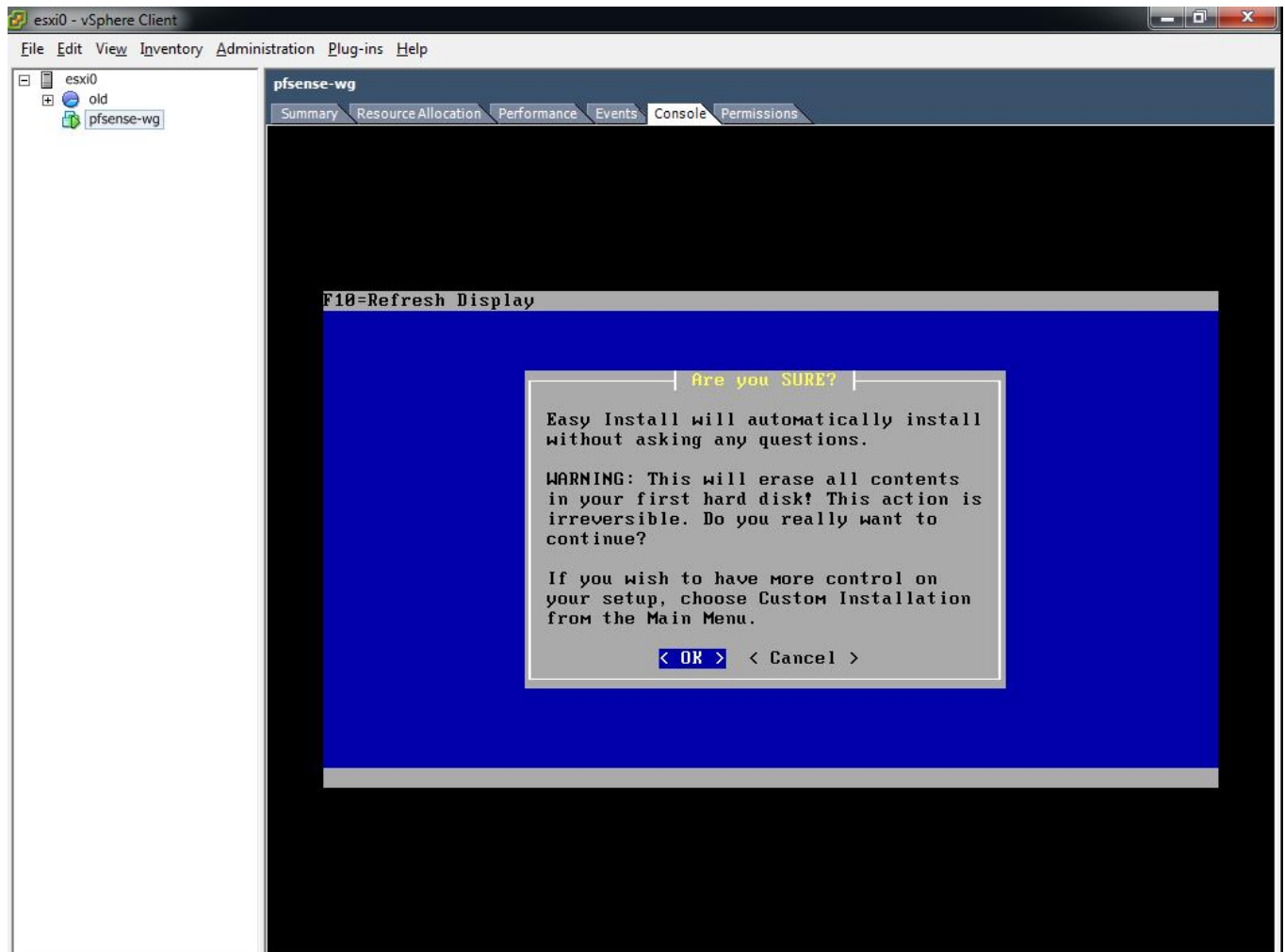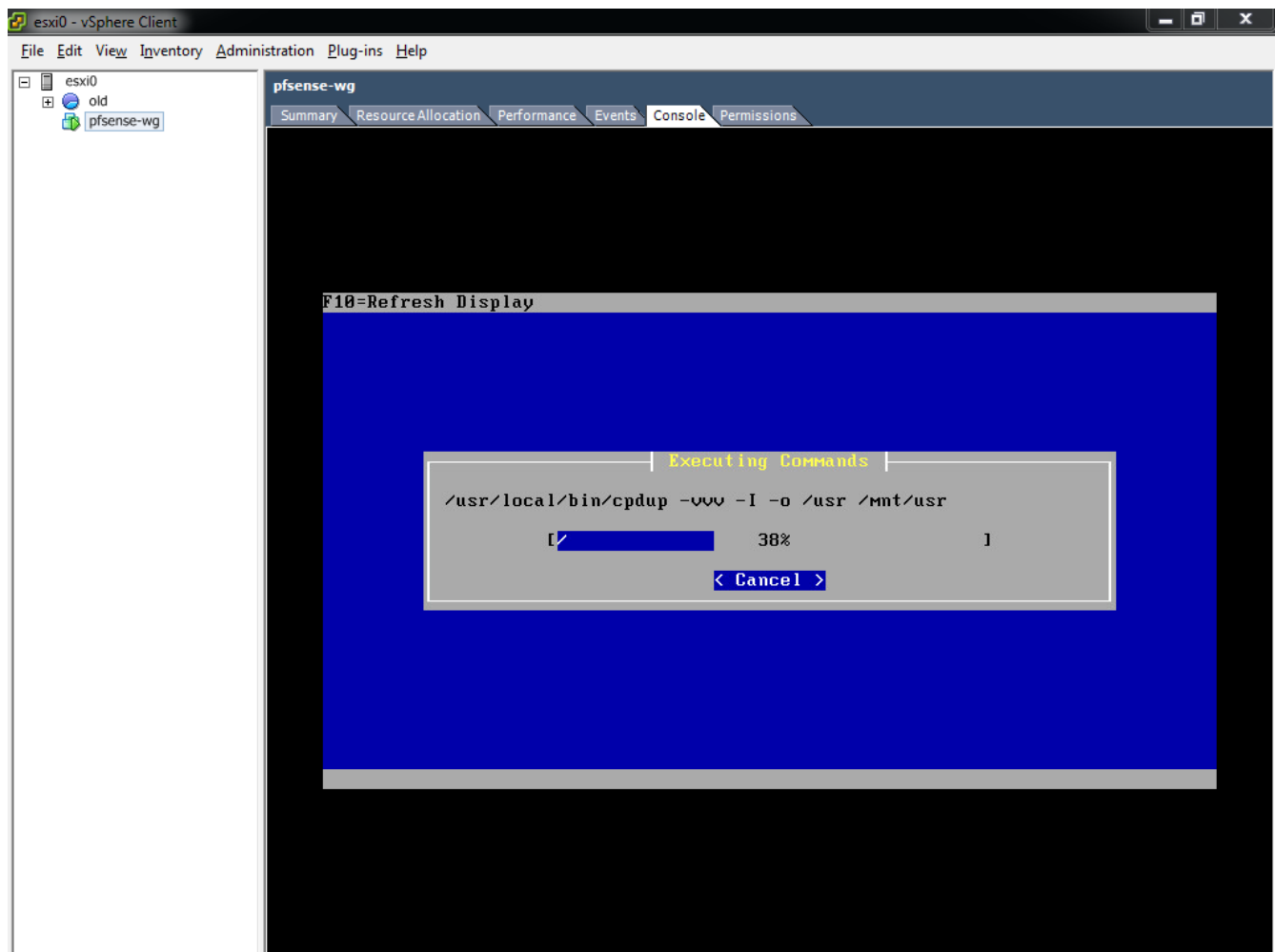
Once again for a VM installation we can go with the default, so choose 'Standard Kernel'. For some physical hardware installations you may want to use the 'Embedded kernel'
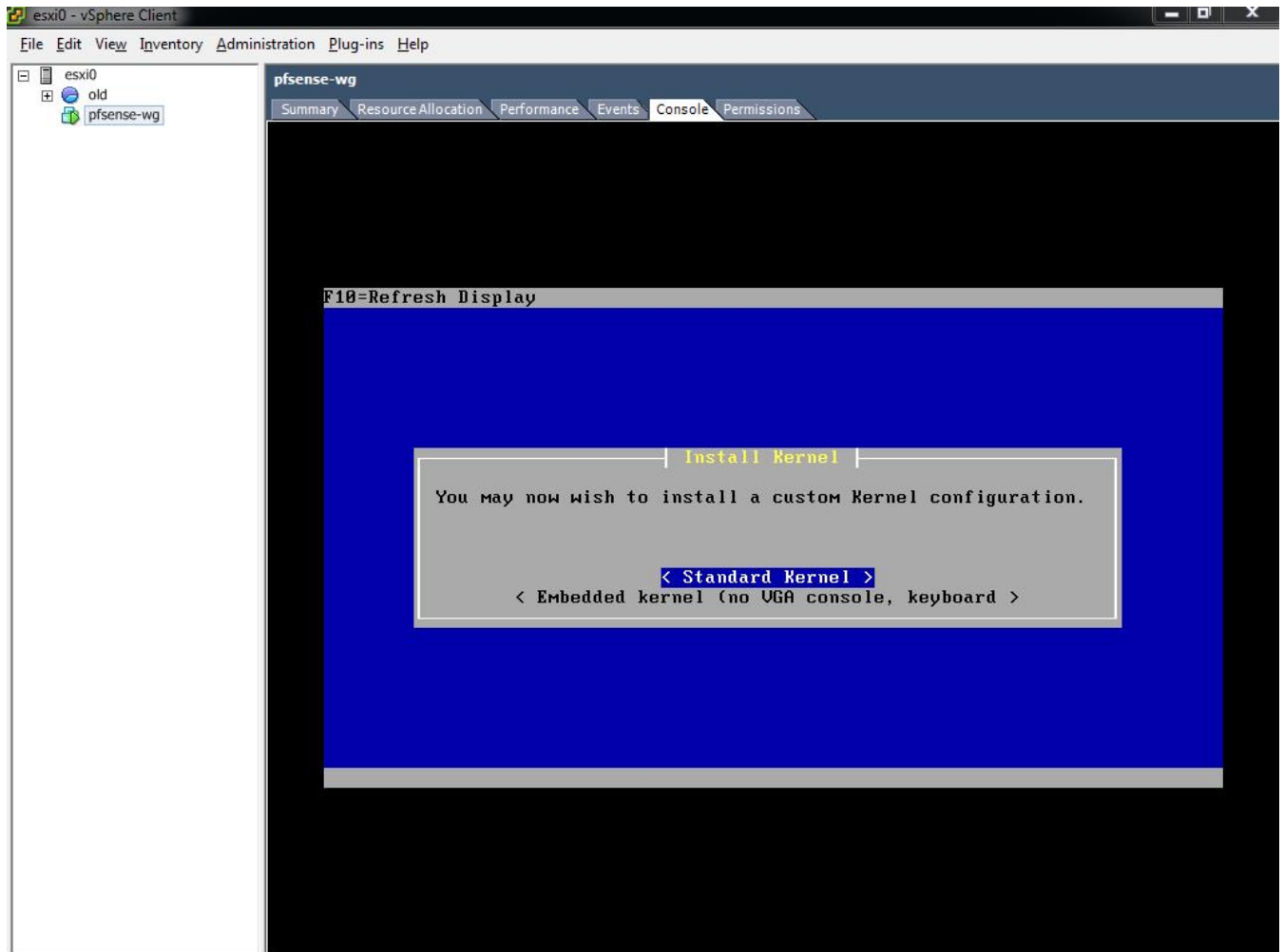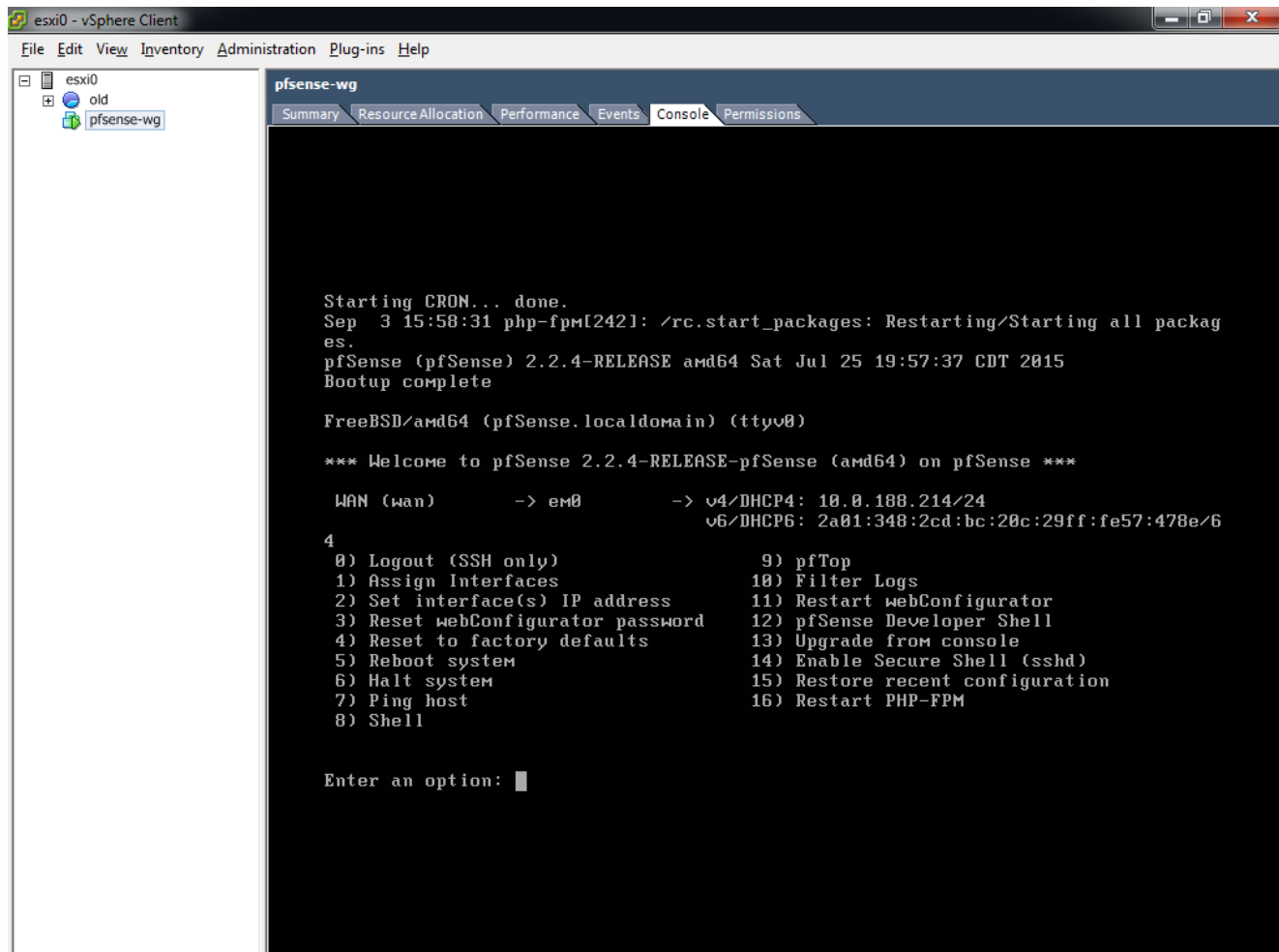
The installation will be copying files for a short time
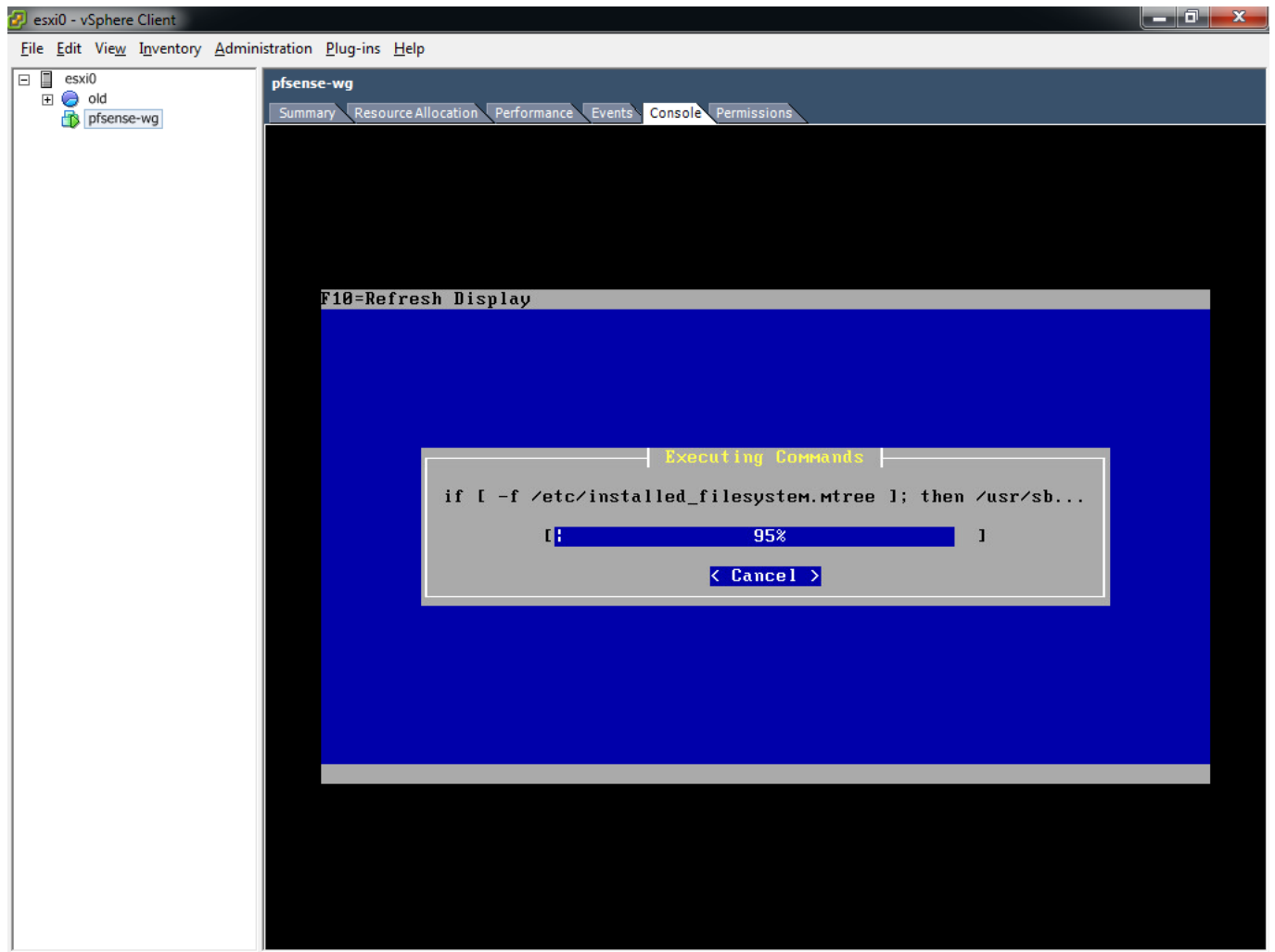
Finally when the installation is complete, you can choose to 'reboot'
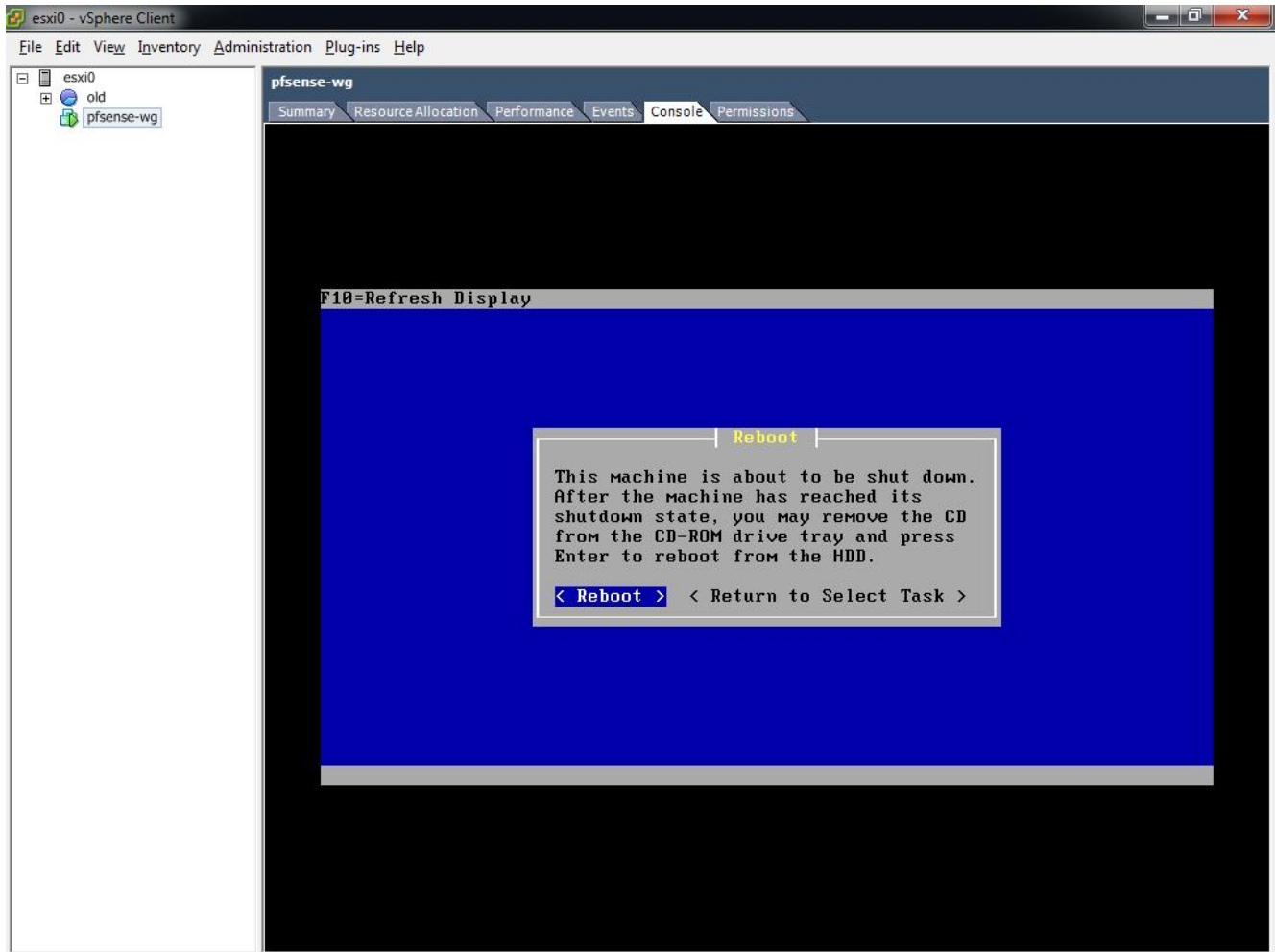
After a reboot, you should be presented with a screen similar to the following, showing that pfSense is now installed. Make a note of the WAN IP address, as you will need to visit this in a Web Browser.

Configuring pfSense

Visit the WAN IP address via https in your Web Browser in the example **https://10.0.188.214**.

You will need to accept the Self-Signed certificate that is used within pfSense
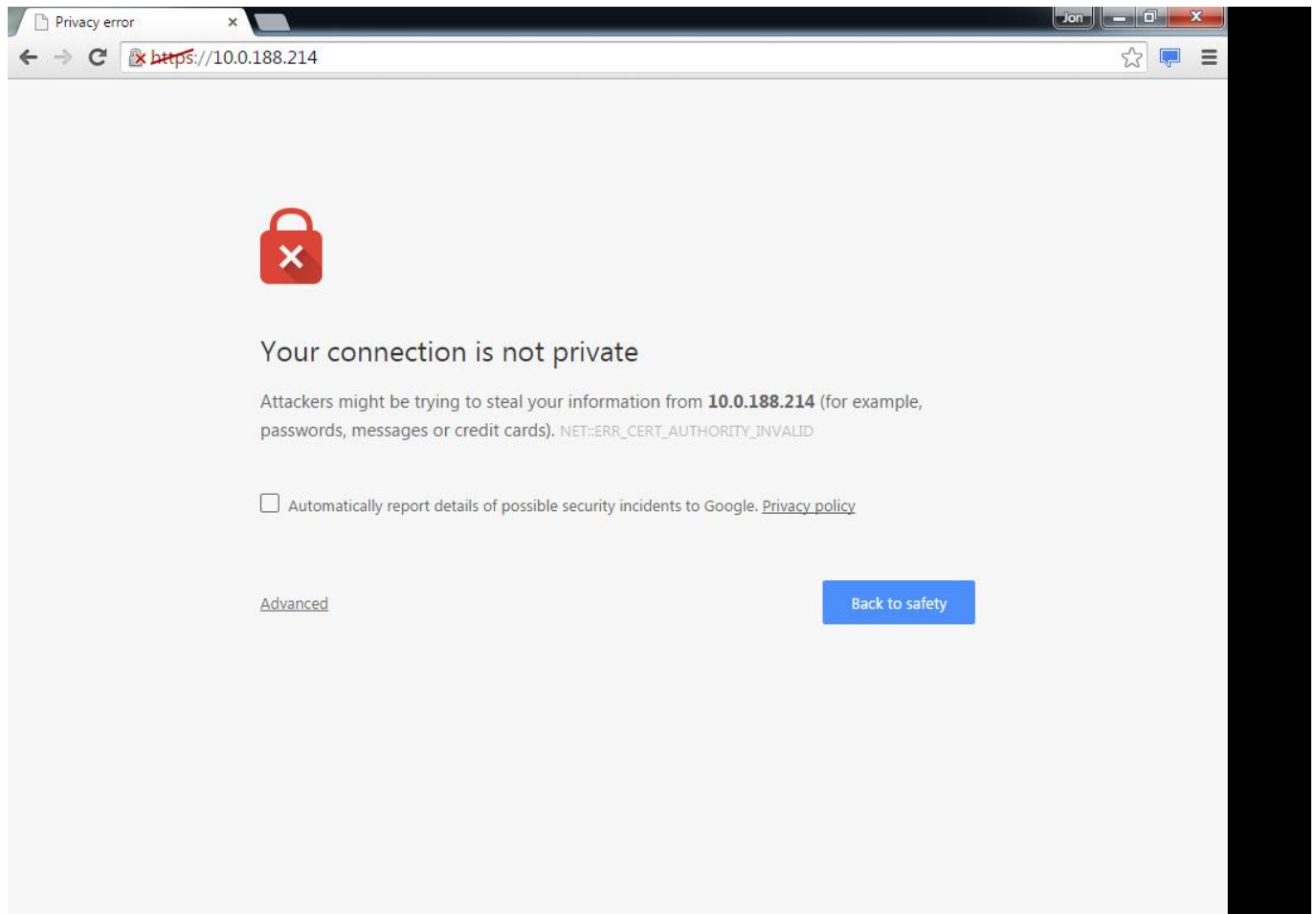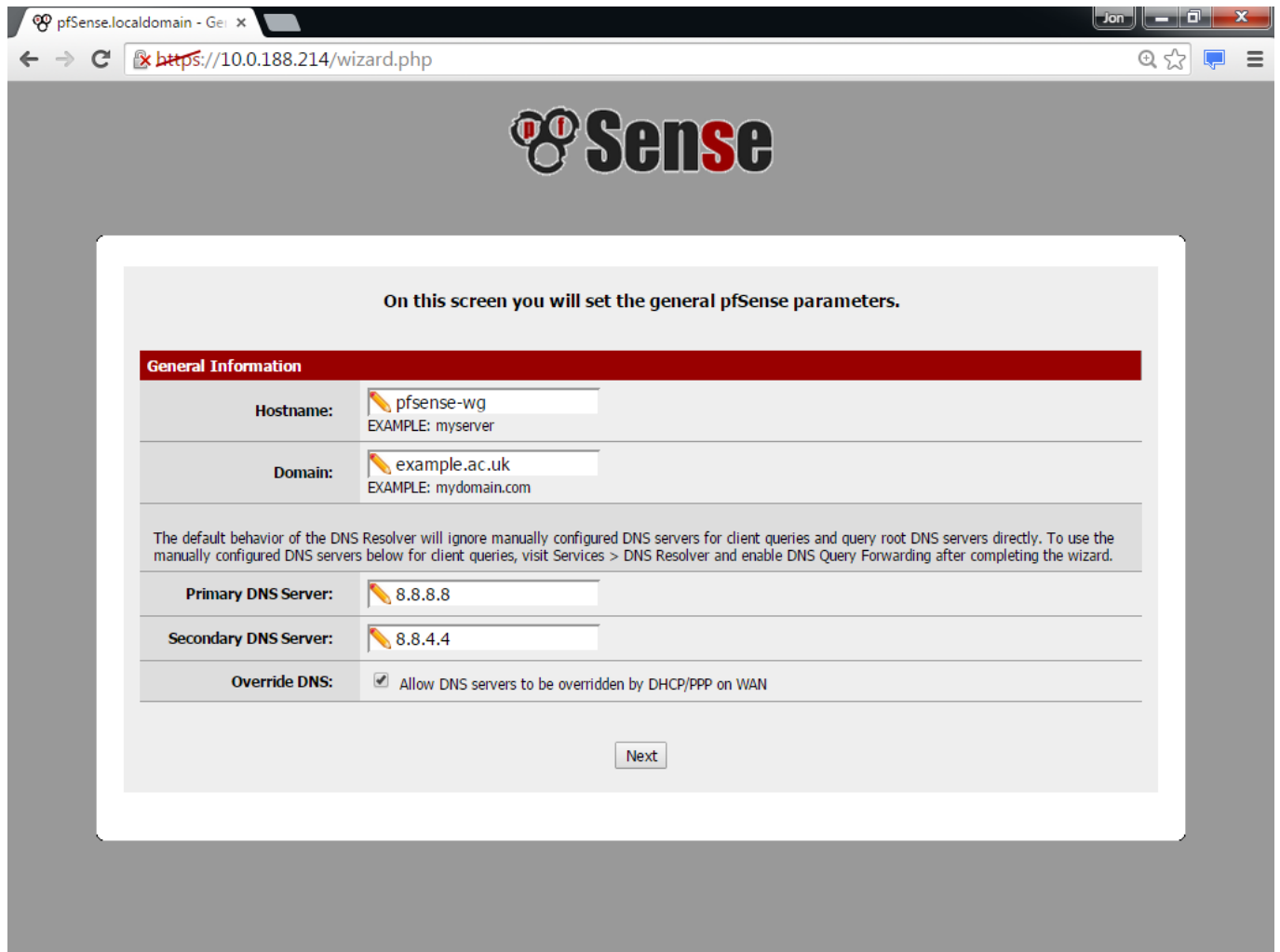
On the initial screen click 'Next'
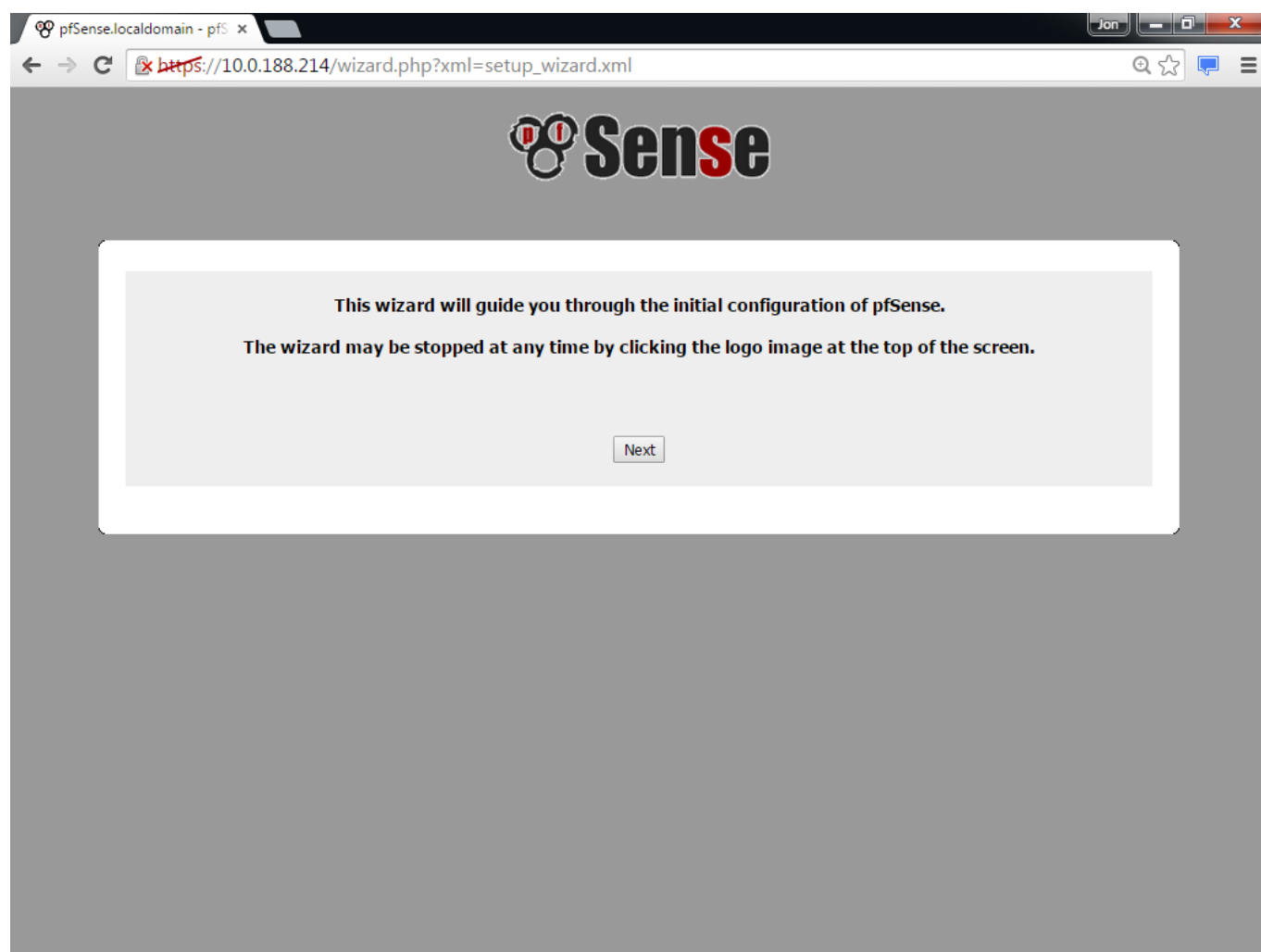
The following screen advertises the Commercial support available via a pfSense gold subscription.
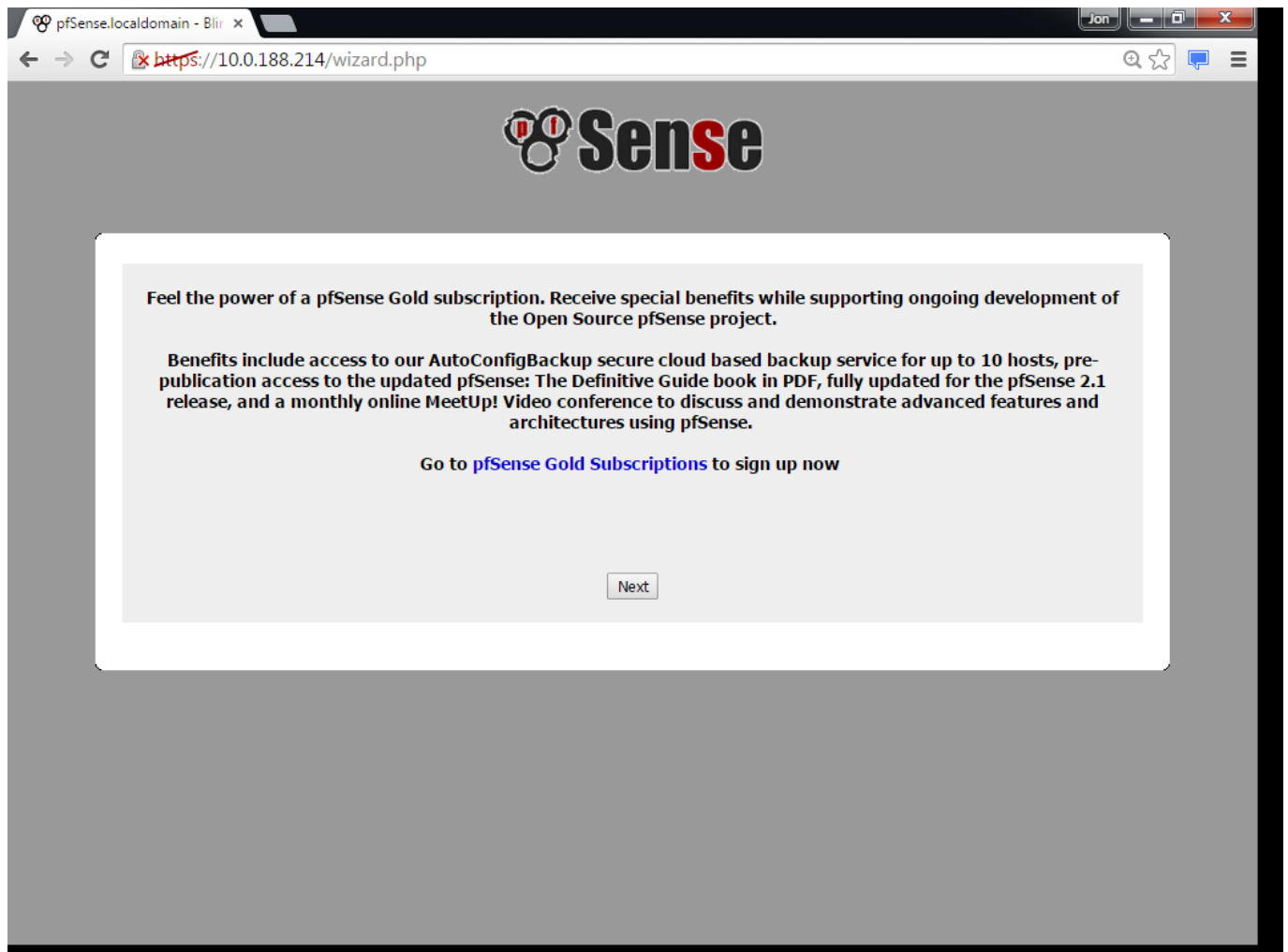
On this screen we provide the hostname and domain

Here you may provide any Time zone and NTP server settings. If you have a local NTP server enter it here.

On this screen you may wish to remove the tick related to 'Block RFC1918 Private Networks', especially if the WAN interface is on such a network.

Adding a LAN Interface

VMWare ESXi Networking Configuration

Firstly confirm that you have the required LAN or VLAN configured as a Virtual Machine Port Group in VMWare. If you do then you can skip to the section on 'Virtual Machine Networking Configuration'. If you are using a Virtual Machine cluster then you should ensure that all Virtual Machine hosts (Hypervisors) are configured identically, or at least consistently.

Choose Add, and Virtual Machine
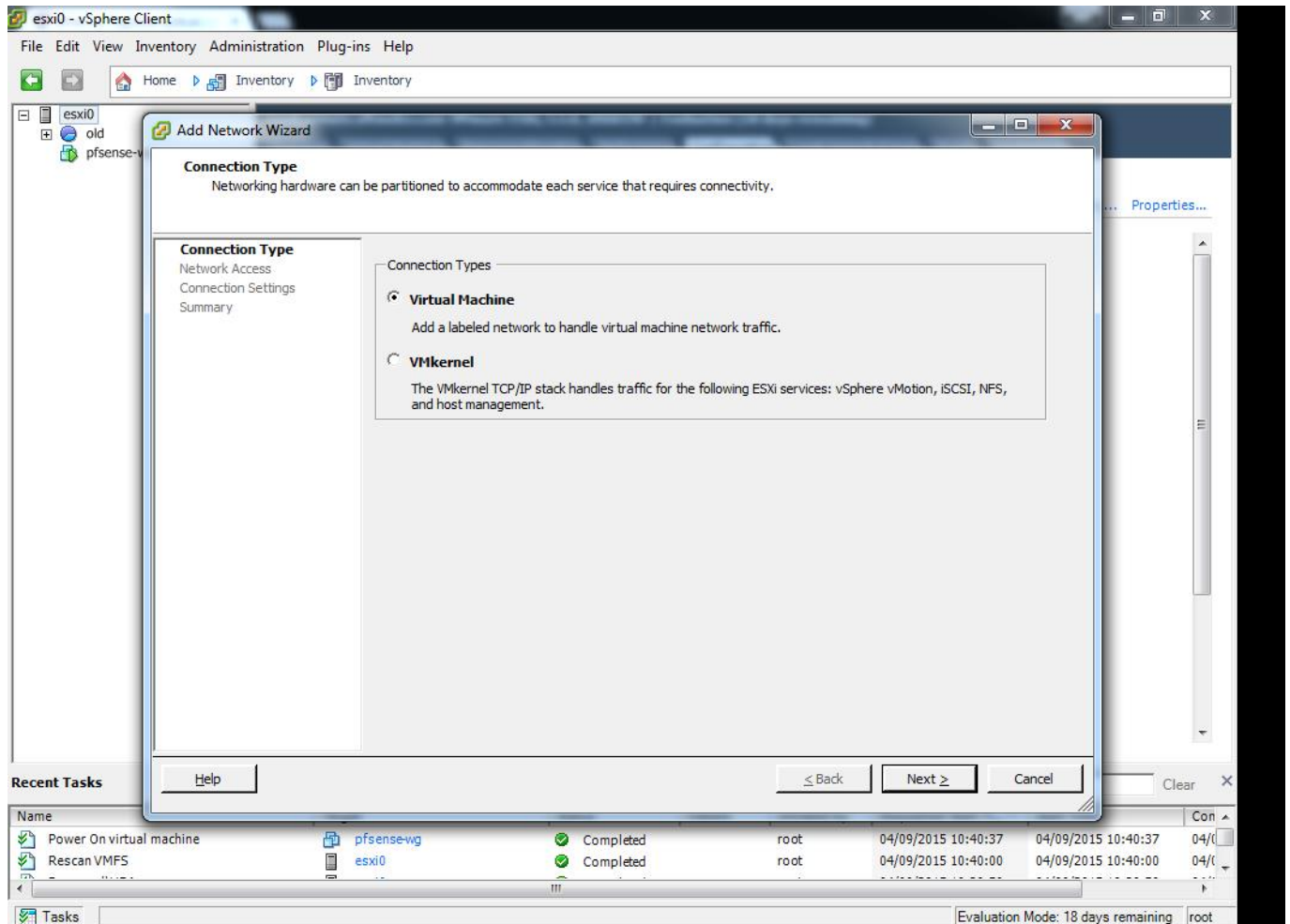
This screen is where you select the vmnic or vSwitch concerned.

- In this scenario we are using physical NIC on the ESXi server, this plugged directly into the wireless AP/Controller. You may see this in a production environment, where you are using a physical NIC to the VMWare server and untagged/access VLAN on the corresponding switch

- In most production environments you will be making use of existing NICs, and therefore an existing vSwitch and select the correct VLAN ID.
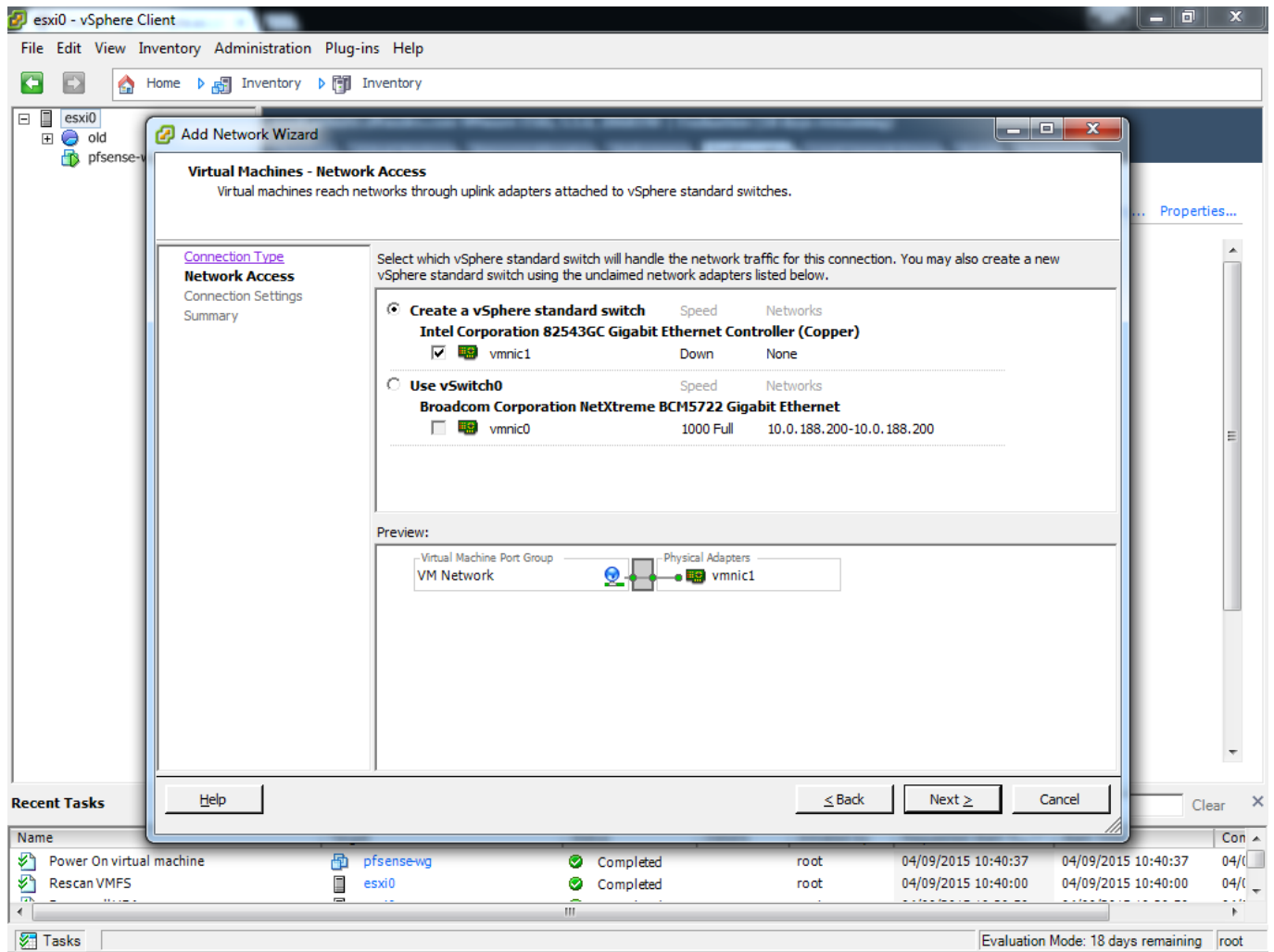
On this screen we give the network a label. It's important that label is consistent across a Virtual Machine cluster.

The VLAN ID, in this case (and in cases where the port from the physical network switch into VMWare is configured as an untagged/access VLAN) then you leave it as 'None (0)'. For instances with a tagged/trunk VLAN port you would enter the VLAN ID here.
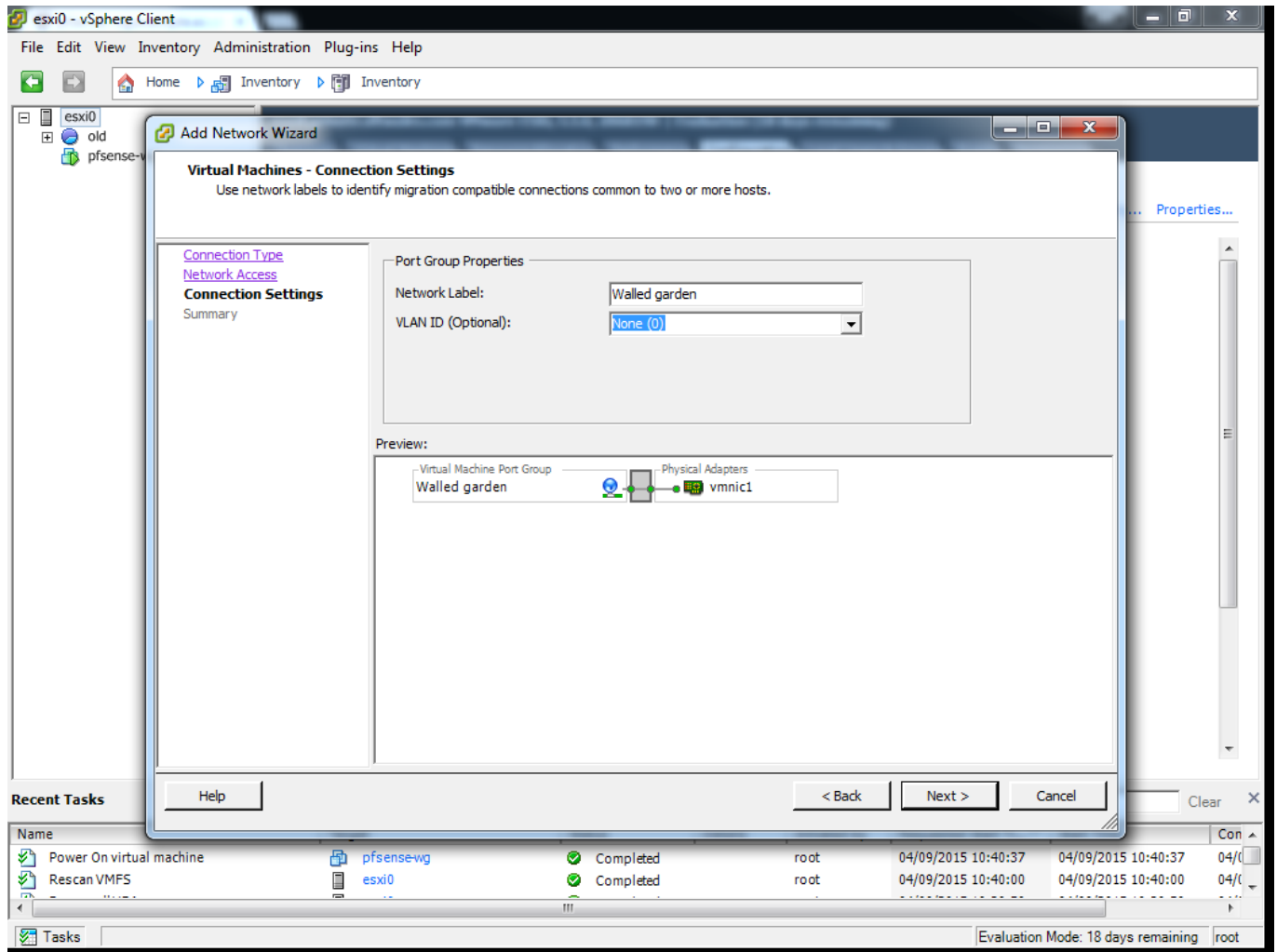
You should see your new 'Virtual Machine Port Group' appear in the Networking section.   In this instance you can see 'Walled garden' and it currently connected to a NIC (Physical Adapter) that doesn't have a physical connection. In a production environment you should see this Group assigned to a vSwitch that has a connected NIC before proceeding.

Virtual Machine Networking Configuration

Click Edit Settings, on the pfSense VM
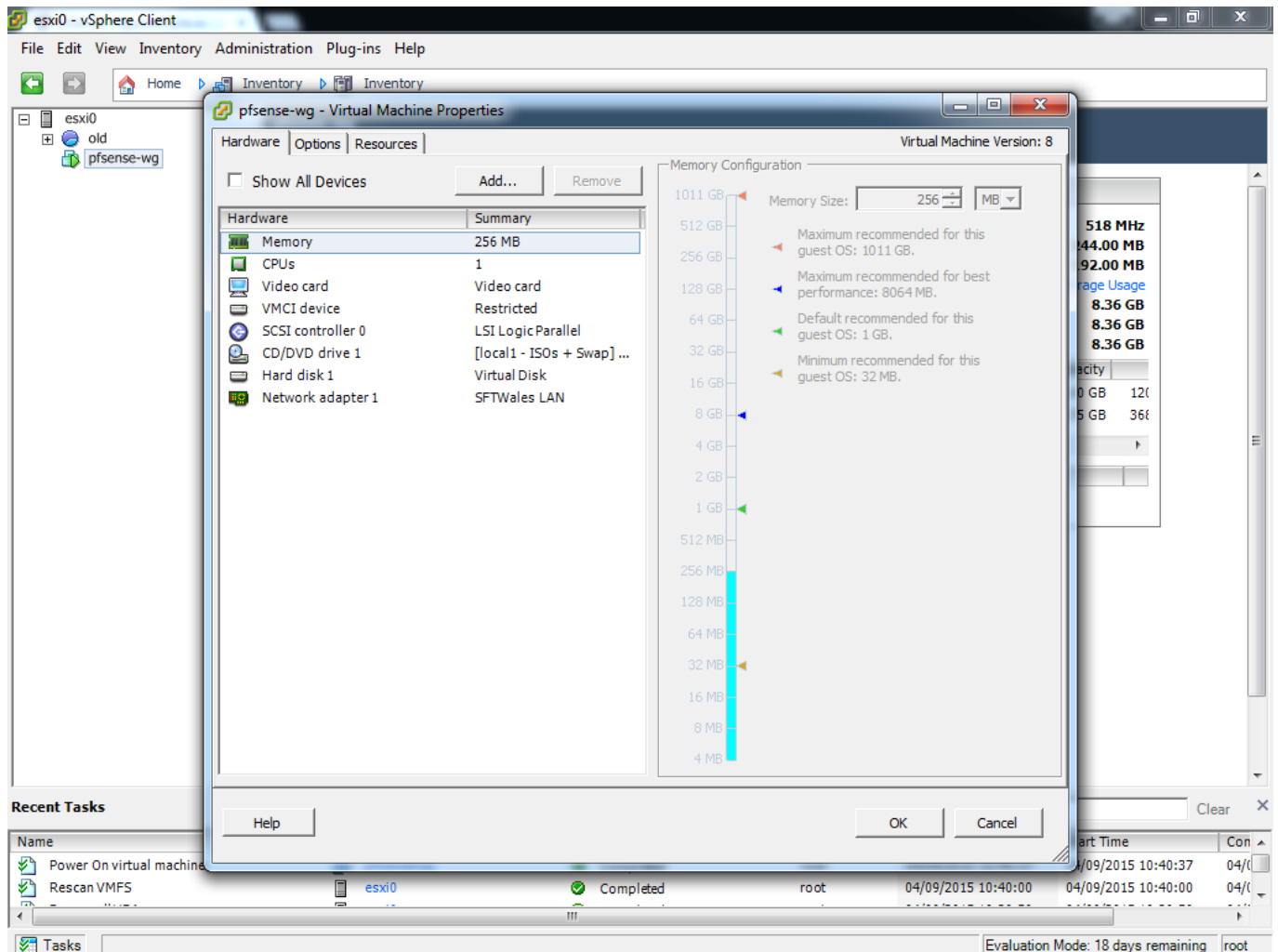
Next Choose Add, and Ethernet Adapter
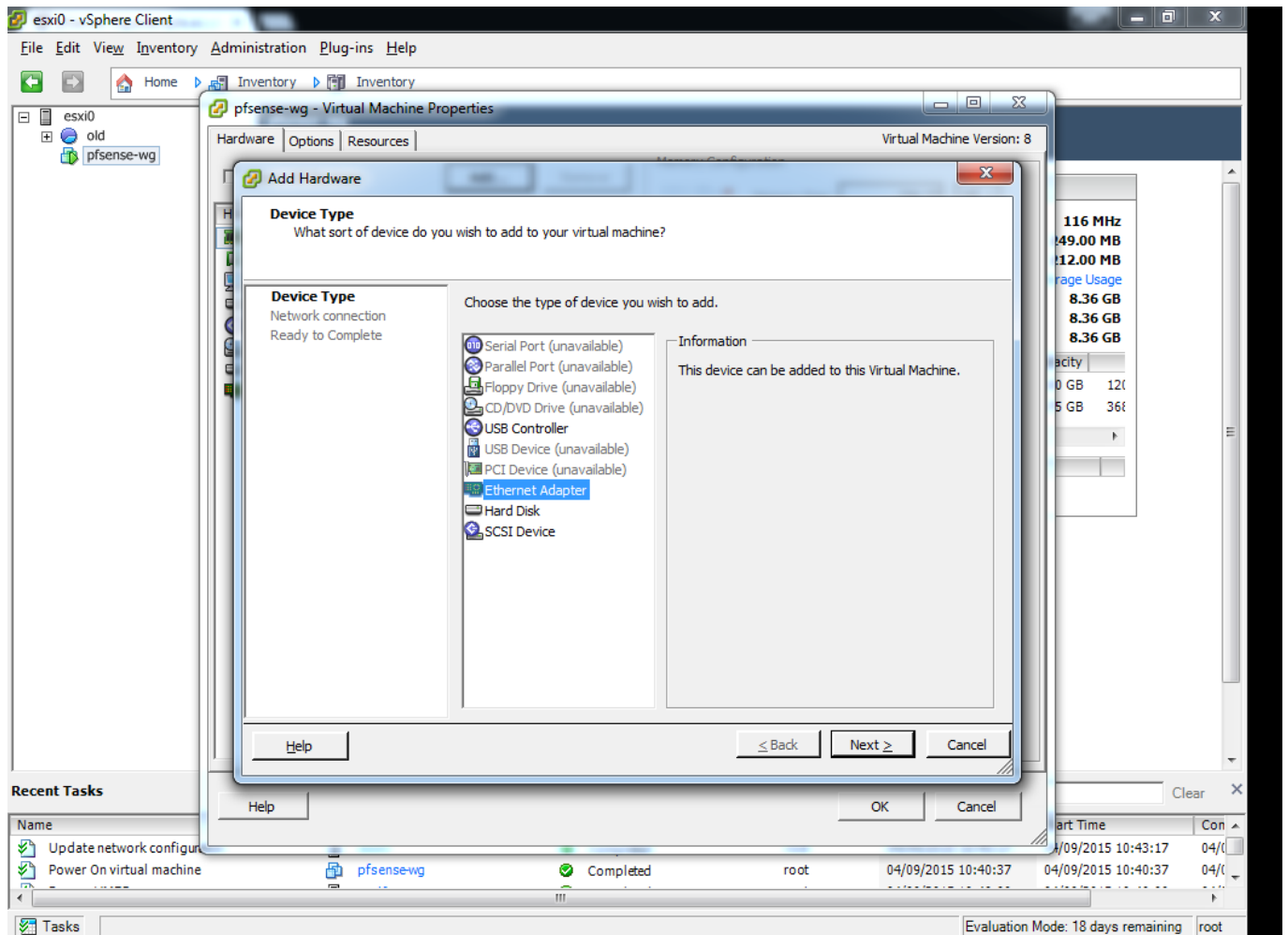
You will be asked to select the Adapter Type, E1000 is the default and can be used with pfSense.

Network Label – here you will choose the Virtual Machine Port group you configured earlier. In this case example we select 'Walled garden'
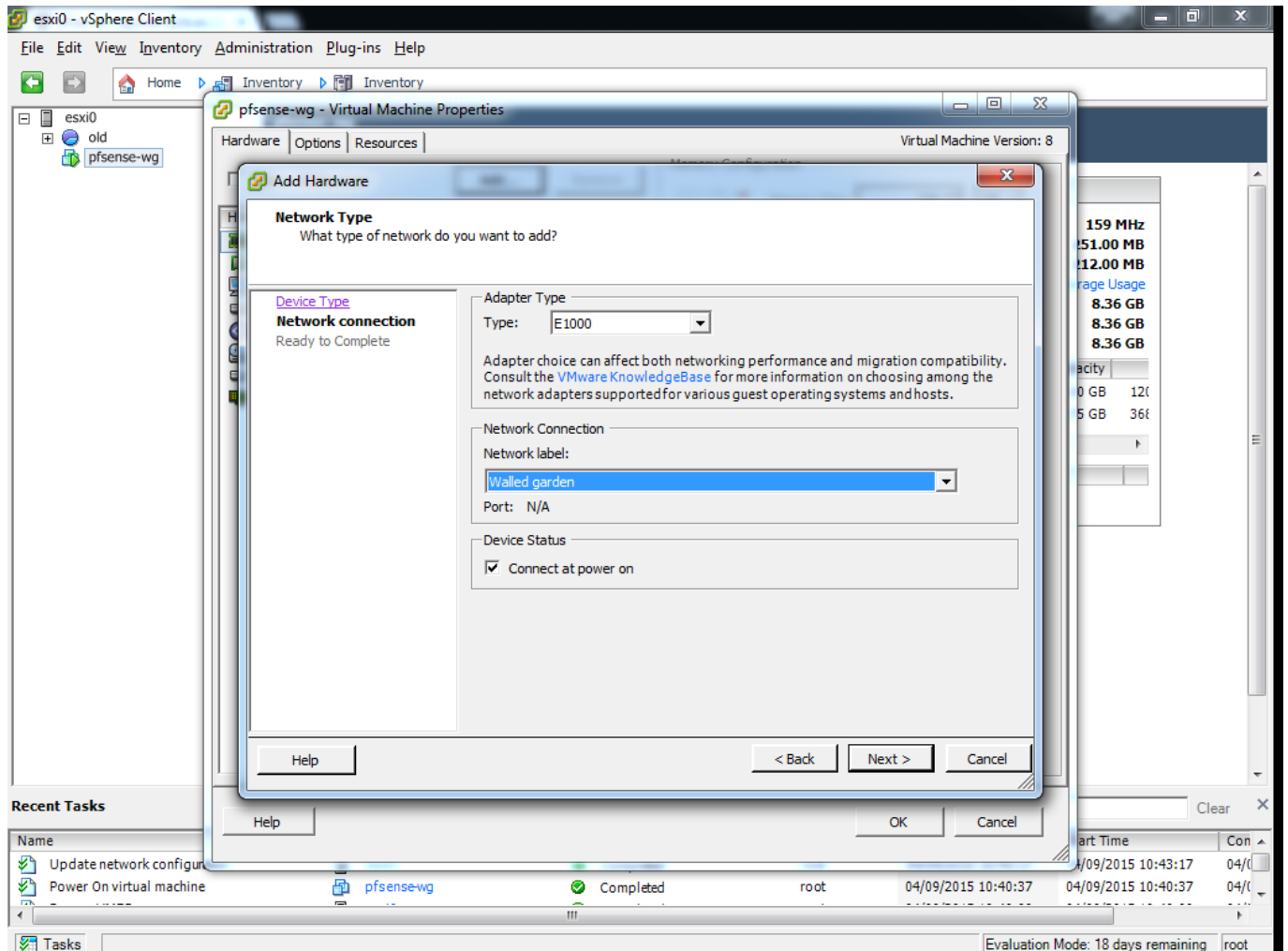
Adding the interface into pfSense

Log back into pfSense and choose Reboot system
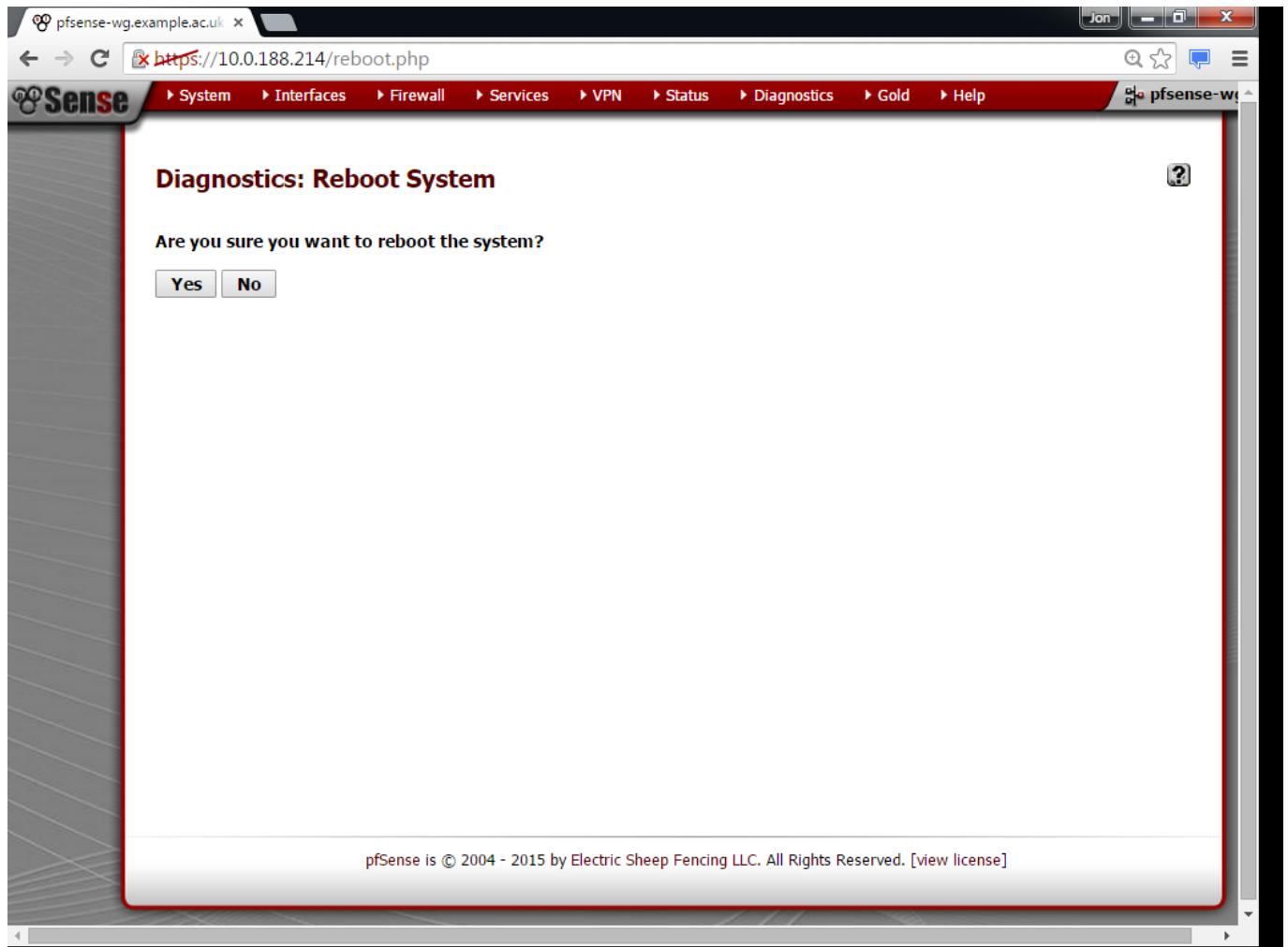
Following reboot, log back into pfSense via the Web Interface. Before you assign an interface, ensure that you have a Firewall rule that looks like the following to allow HTTPS access on the WAN interface, if it doesn't exist then add one. Otherwise, when you add a new interface pfSense will lock you out, and you will need to connect via the LAN interface ('Walled garden' VLAN)

Now Choose, Interfaces, Assign, You should see an 'Available network port'
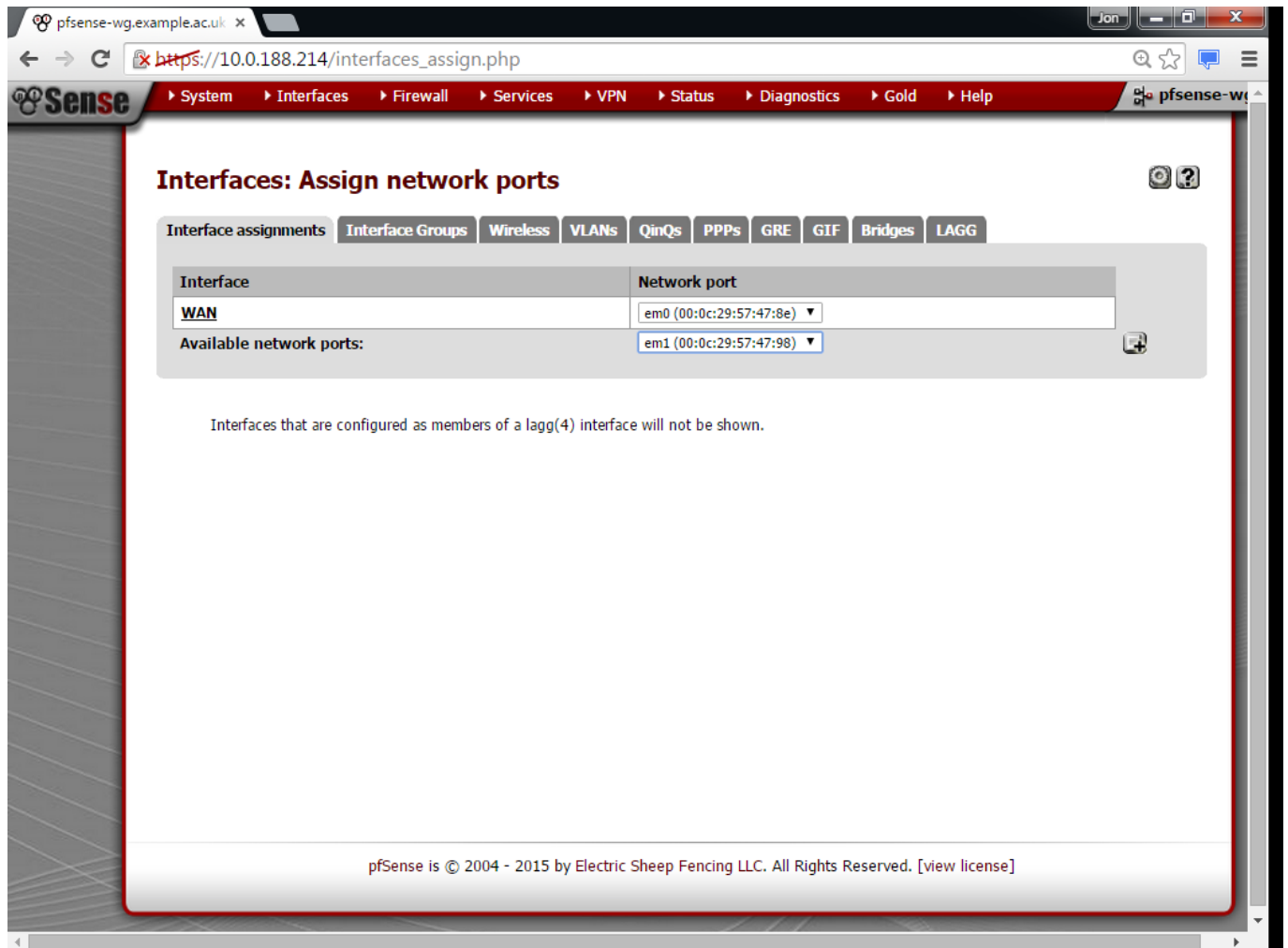
Choosing add will create a LAN interface

Click on LAN to edit the interface. We would recommend changing the description to something like 'Walled Garden' reflecting the Network Label/VLAN name used on the network. The same can be done for the WAN interface.

Next we assign an IP address to the LAN/Walled Garden interface.   The IP address and IP subnet should be

- Unique on your network to prevent any unexpected behaviour

- Within one of the IP subnets permitted for use on LANs as per RFC-1918

   o   172.16.0.0 – 172.31.255.255 (172.16.0.0/12)

   o   10.0.0.0 – 10.255.255.255 (10.0.0.0/8)

   o   192.168.0.0 – 192.168.255.255 (192.168.0.0/16)

- We would recommend a minimum of 256 (i.e. a /24) and a maximum of 1024 (/22)

- In this example we use documentation IP address space 198.51.100.254/24 - Do not use this on your LAN!

- It is very unlikely that you will need Public IP address for this solution

Next reconfigure the DHCP server. By going to Services, DHCP. You will need to enter the IP range to be assigned via DHCP.

Generally you can assign almost the complete 'Available range'. We would recommending keeping some IPs free if you are aware that your wireless controller(s) require SVIs (Meru and Cisco do).

Captive Portal configuration

Under Services, you will find Captive Portal

Choose to add a Captive Portal Zone, and you will be presented with the following window. Note the restriction around zone names.

This is the main captive portal configuration page.

Under Interfaces

Choose the appropriate interface. In this case we have named the interface concerned 'WALLEDGARDEN'

Under Pre-authentication redirect URL – you should insert the help page you wish to use for your Walled Garden, this could be a direct link to eduroam CAT, as suggested below, but maybe your organisations eduroam support webpage.

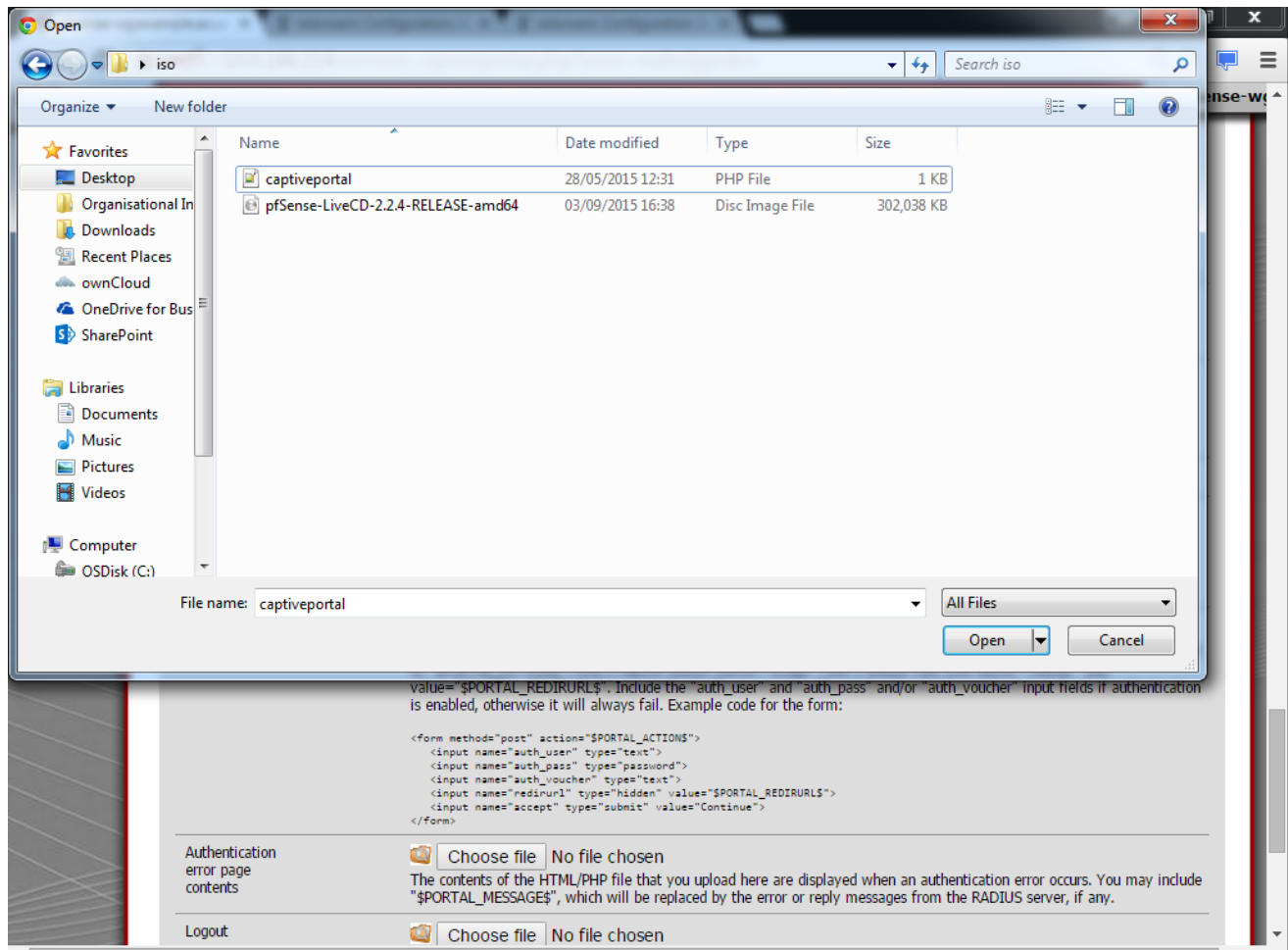Under 'portal contents page', you will need to select 'Choose file'… At this point it would state 'No file chosen'

Under preparation you should have downloaded the **RAW (PHP) version** of the following code from **Gist/GitHub**. In the example below it is the 'captiveportal.php' file on the local machine.

Under portal page contents, you should now see captiveportal.php listed

Under the Allow Hostnames tab, you should now be able to add hostnames of websites which you want to be accessible via the Walled Garden. The next section discusses this further.

Configuring allowed websites

We would suggest the following as a minimum;

- The 'Required' list from the **eduroam CAT (Configuration Assistance Tool)** website (the list is recreated in the next section)

- Your organisations eduroam support web page.

- eduroam support web page of any partners who may make regular use of your network.

Note: webpages will be available over an open public Wi-Fi network, and so you should avoid sites that may pass sensitive information e.g. authentication, and pay close attention to any sites which may open up wider access e.g. Google which are part of the recommendations from eduroam CAT

eduroam CAT website list

The following are a list of websites that should be opened via a walled garden. These are taken directly from the eduroam CAT website, and are available on the 'About eduroam CAT' link. The screenshot and tables below were taken on 6th July 2016.

Screenshot

eduroam CAT is publicly accessible. To enable its use behind captive portals (e.g. on a 'setup' SSID which only allows access to CAT for device configuration), the following hostnames need to be allowed for port TCP/443 in the portal:

REQUIRED

- **cat.eduroam.org** (the service itself)
- **crl3.digicert.com, crl4.digicert.com** (the CRL Distribution Points for the site certificate), also TCP/80
- **ocsp.digicert.com** (the OCSP Responder for the site certificate), also TCP/80
- **android.l.google.com** (Google Play access for Android App)
- **android.clients.google.com** (Google Play access for Android App)
- **play.google.com** (Google Play access for Android App)
- **ggpht.com** (Google Play access for Android App)

RECOMMENDED for full Google Play functionality (otherwise, Play Store will look broken to users and/or some non-vital functionality will not be available)

- **photos-ugc.l.google.com**
- **googleusercontent.com**
- **ajax.googleapis.com**
- **play.google-apis.com**
- **googleapis.l.google.com**
- **apis.google.com**
- **gstatic.com**
- **www.google-analytics.com**
- **wallet.google.com**
- **plus.google.com**
- **checkout.google.com**

Lists

Required	Recommended
cat.eduroam.org	photos-ugc.l.google.com
crl3.digicert.com	googleusercontent.com
crl4.digicert.com	ajax.googleapis.com
ocsp.digicert.com	play.google-apis.com
android.l.google.com	googleapis.l.google.com
android.clients.google.com	apis.google.com
play.google.com	gstatic.com
ggpht.com	www.google-analytics.com
	wallet.google.com
	plus.google.com
	checkout.google.com

Installing Open VM Tools

If you have installed into VMware then you should install the VMware tools. In this case we use the Open VM Tools which are available as package within pfSense.

Choose System, and Packages

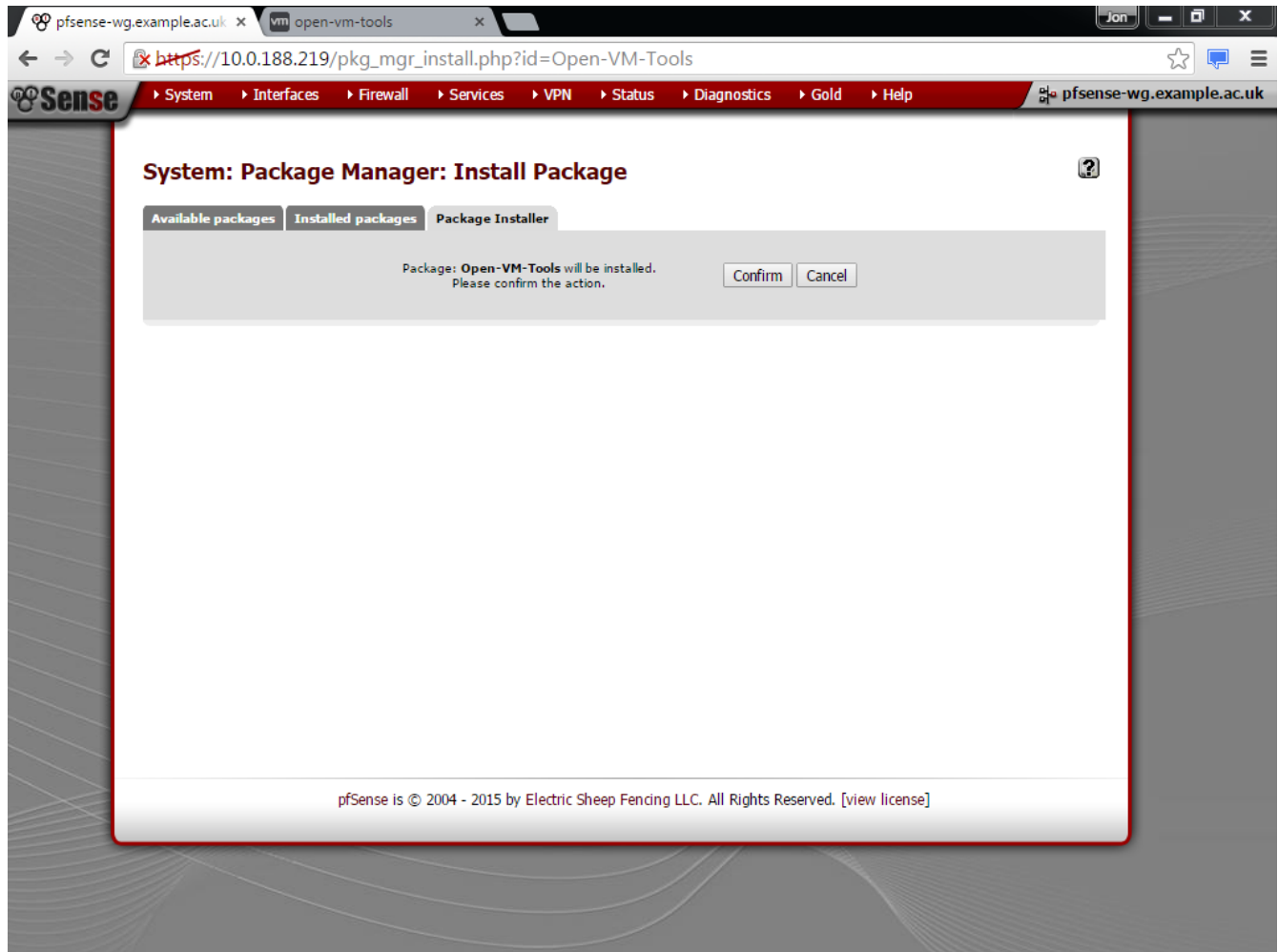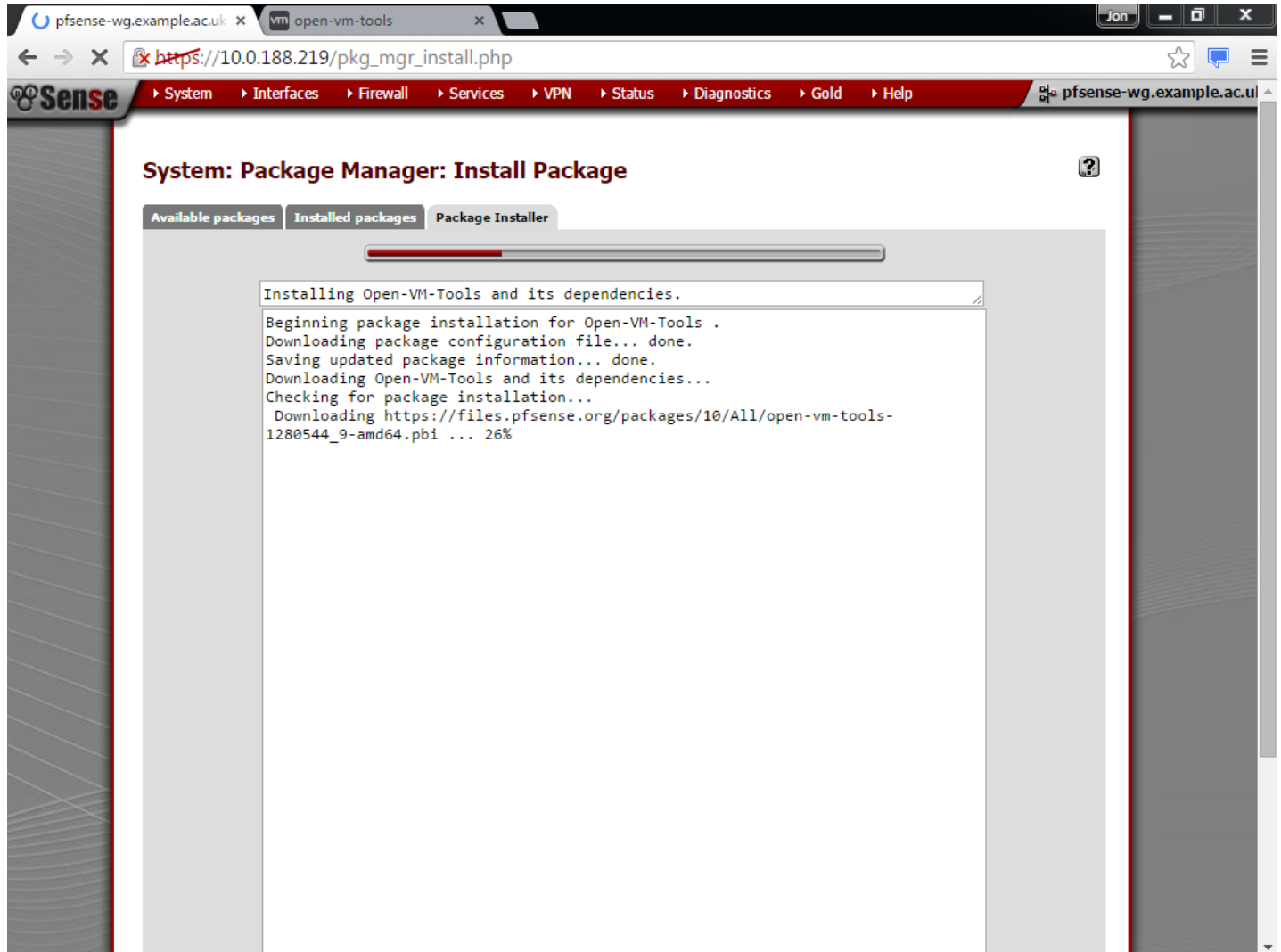From within Package Manager choose Available Packages.
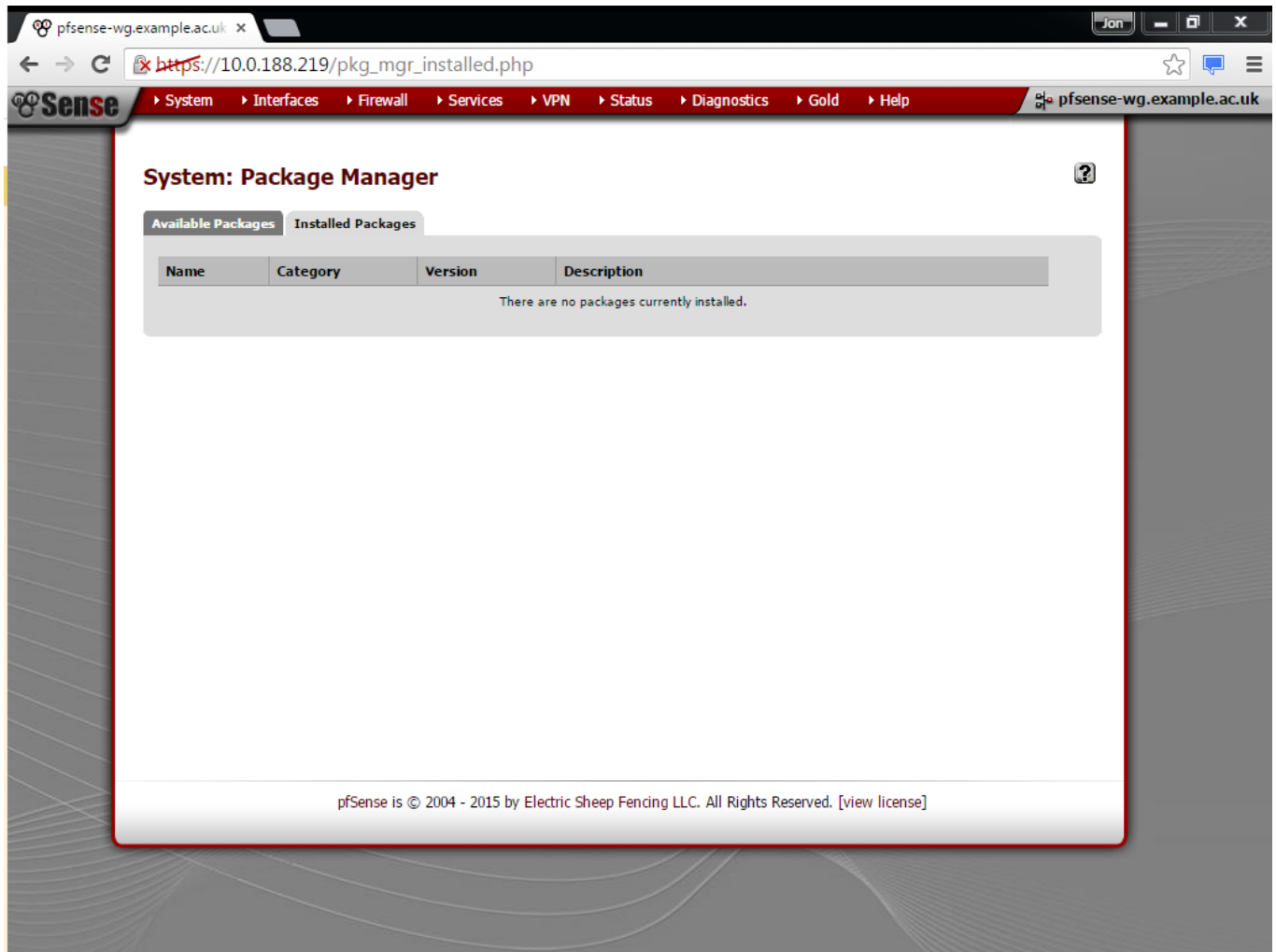
You will find Open-VM-Tools in the All Packages list. Once located Choose the Install button on the right hand side.

Choose Confirm

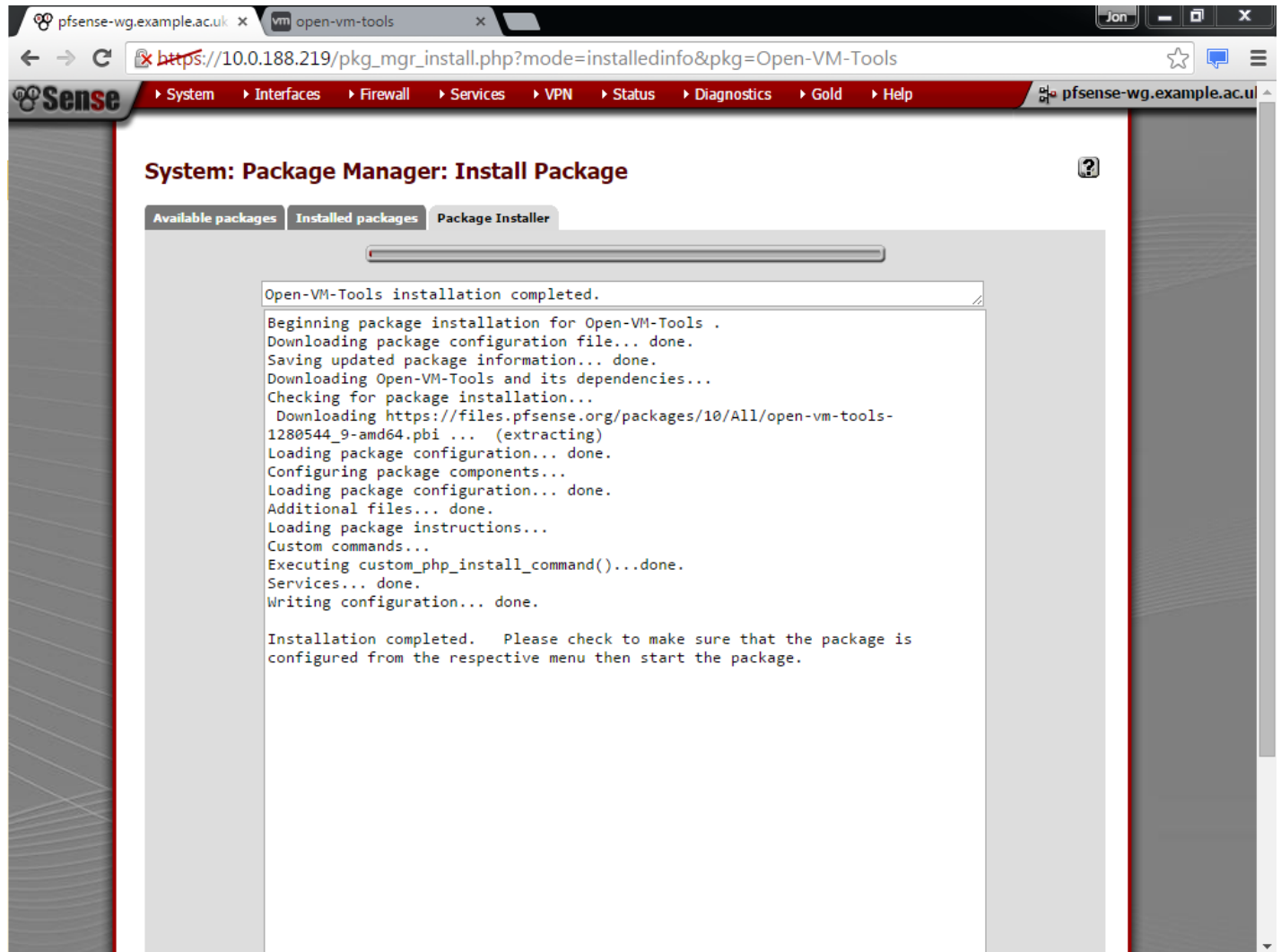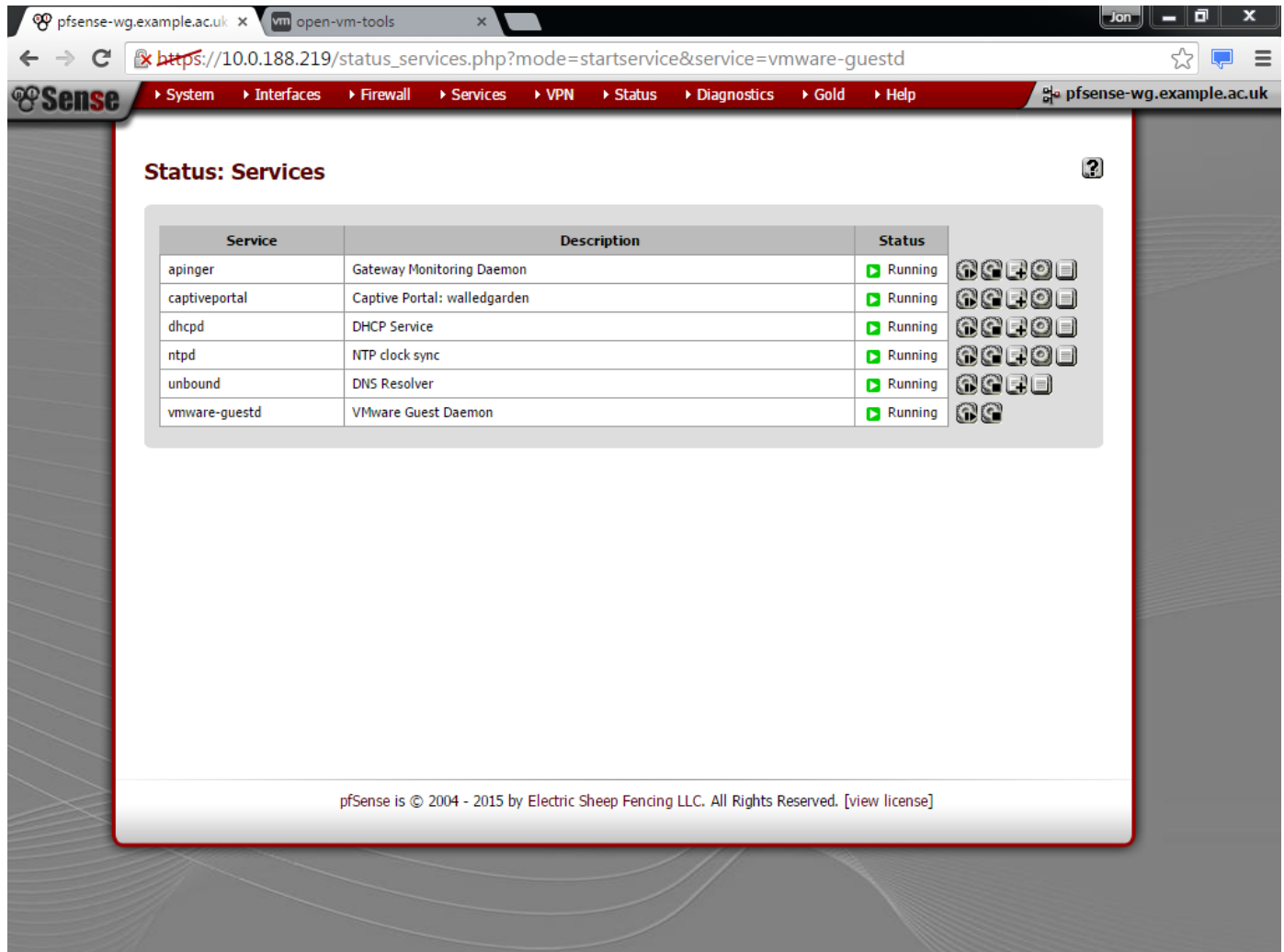This is the Open-VM-Tools package installing…

Once the Open-VM-Tools package is complete, you will see 'Installation completed'.

You should check that that Open-VM-Tools (vmware-guestd) is running by choosing Status, Services.

You should also check that the underlying VMware Hypervisor/Virtualisation Software sees that Tools are now installed. As you can see it reports 'Running (3rd-party/Independent)'.

Access Point configuration

There are many access points and potential configurations that you may have. The following points should assist you in considering those steps

- For VM installations (particularly VMWare)

    o Ensure that you have added the Walled Garden VLAN to all VMware Servers in your Cluster, and across all interfaces that connect to that vSwitch.

    o Ensure that all interfaces between the VMware Nodes (Hypervisors) have added the Walled Garden VLAN to all Switch ports that connect with VMware.

        ▪ These can be problematic to trace. Neighbour discovery protocols such as LLDP and CDP can help here.

- For physical installations

    o Ensure that you have added the Walled Garden VLAN to the LAN port of the pfSense device/server. You will (unless you configured VLANs in pfSense) need to use a port with no 802.1q VLAN tagging in place (untagged / access VLAN)

- For all installations

    o Ensure that the Walled Garden VLAN is tagged between the pfSense server/VM and your Access Point or Access Point Controller.

    o Create a single Open SSID with no authentication, and ensure that it allocates devices to the Walled Garden VLAN.

    o For this Open SSID ensure that Client Isolation is turned on, such that devices can only communicate with the pfSense LAN interface within the Walled Garden VLAN, and not with each other

# Testing the user experience

This is an example from an Android device; the user will see an open network – in this case 'exampleorg-setup'. You must not call this 'eduroam-setup' as it violates the **eduroam(UK) Technical specification**, ideally you should put your organisation name (or a fairly unique derivative of that your users will recognise)
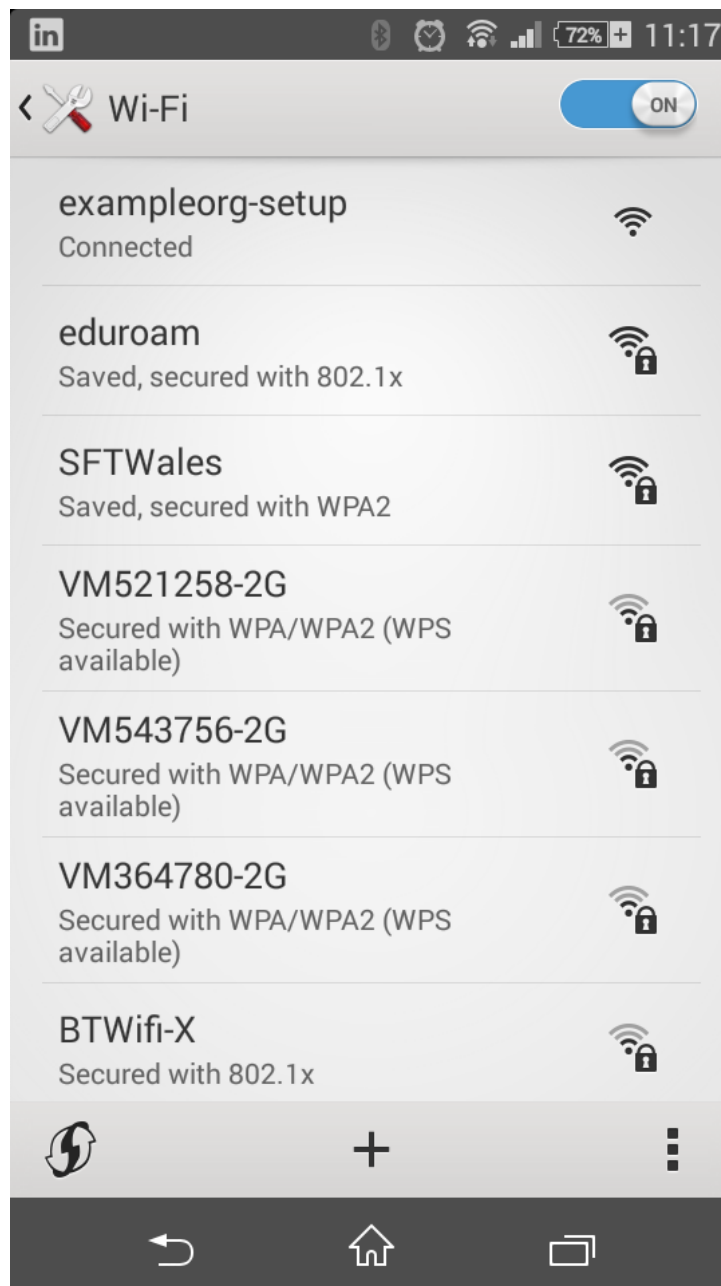
Once connected they should receive an IP address. Ensure this is consistent with what you have configured within pfSense on the LAN interface.
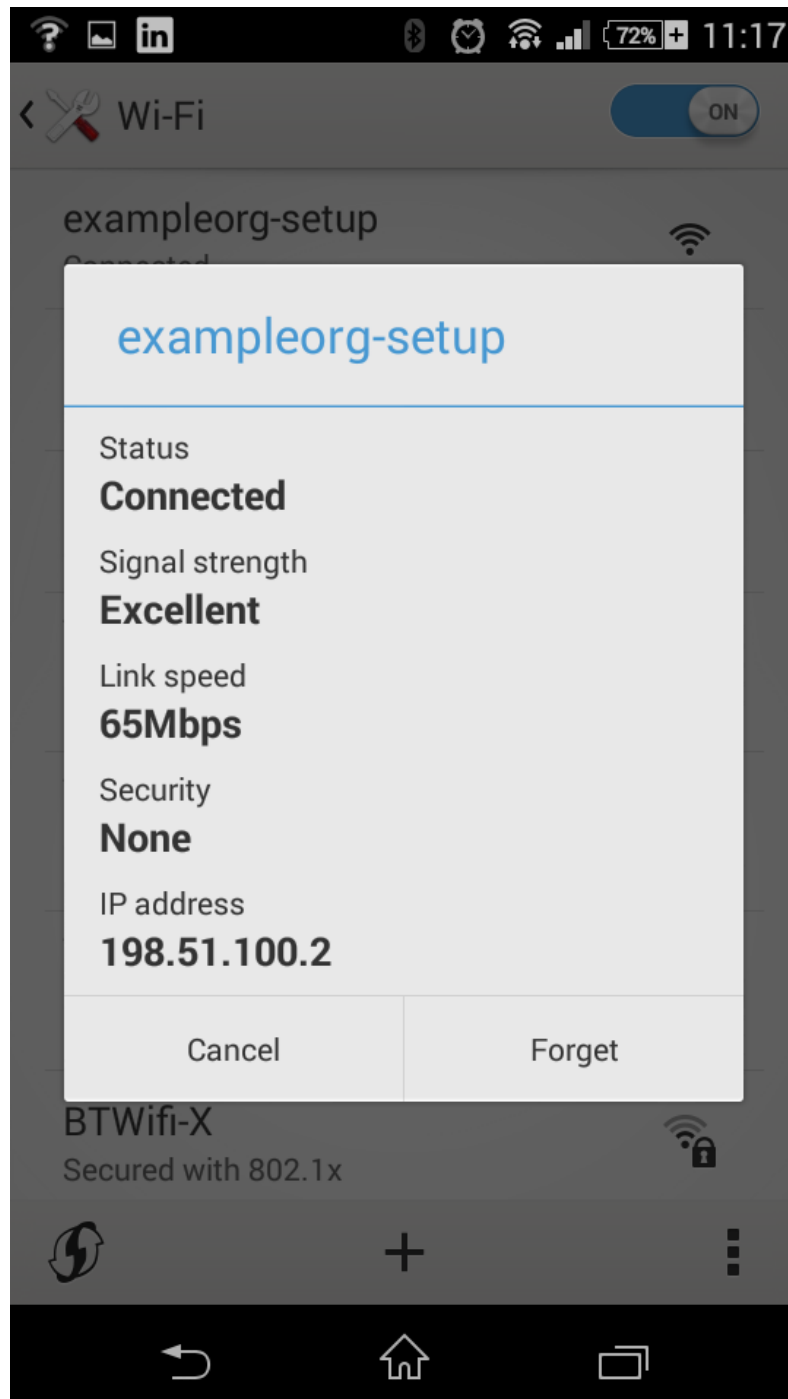
Many device operating systems and browsers will detect that they are in a captive portal and ask users to 'Sign into Wi-Fi' this should redirect them to your help page or the eduroam CAT page for your organisation.
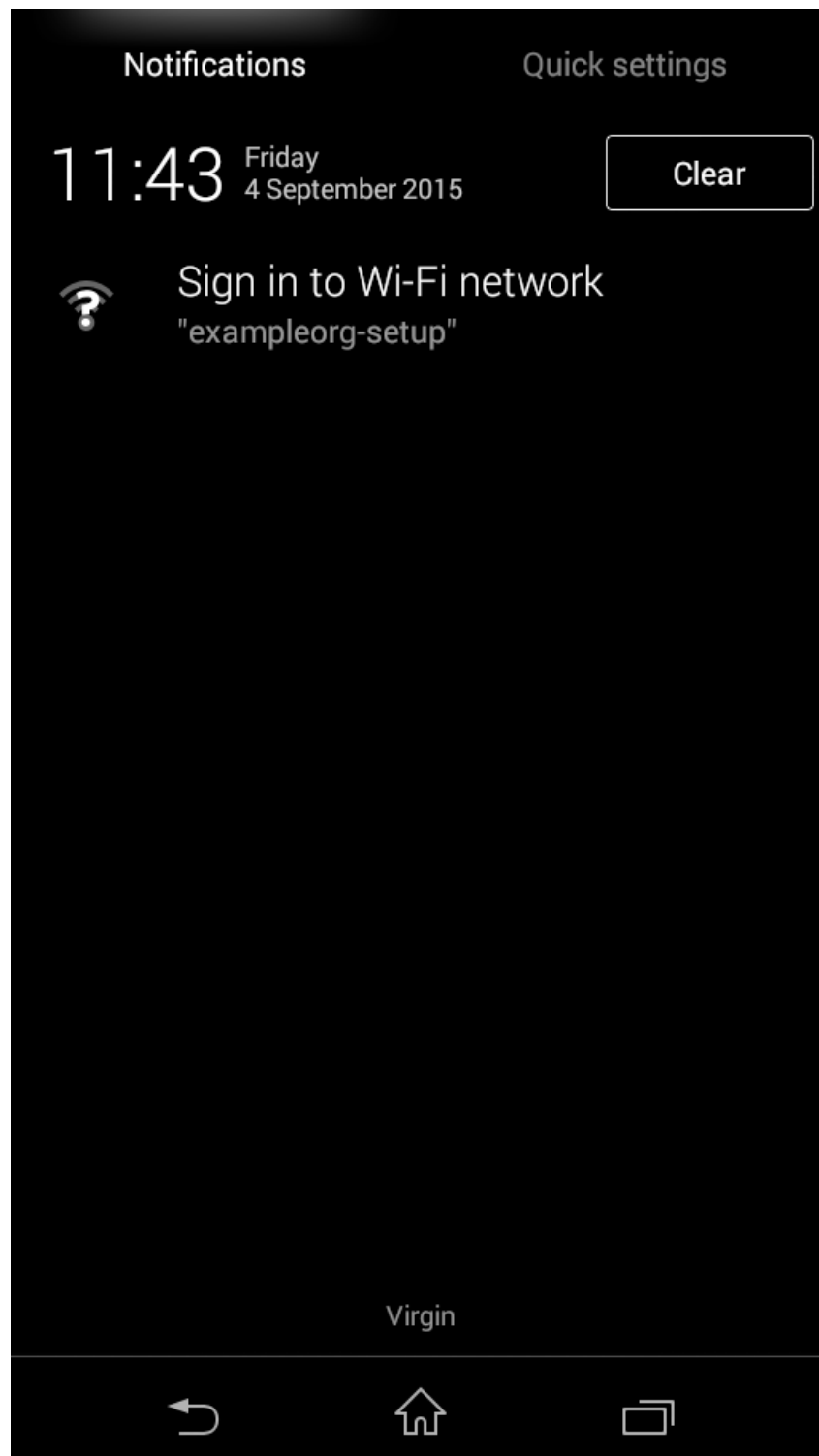
This is an example of a device being directed to your help page or the eduroam CAT page for your organisation.