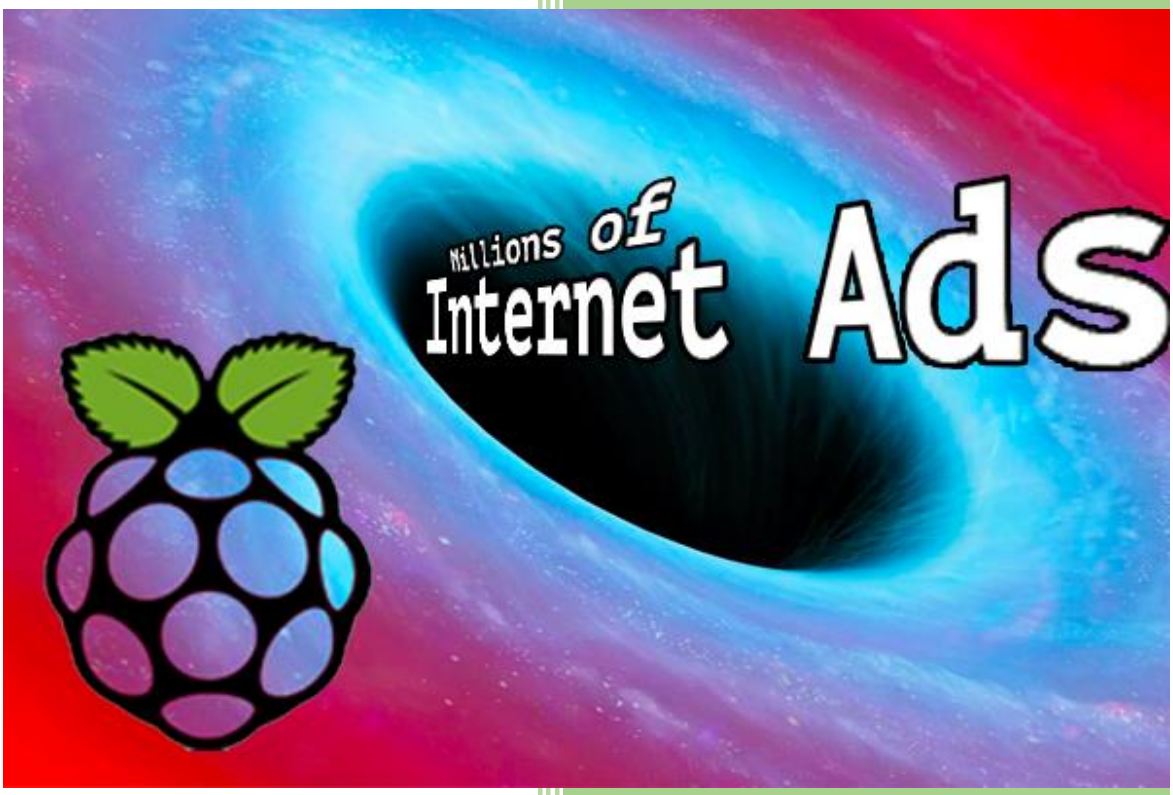
2021

Block Ads Network-wide with A Raspberry Pi-hole



https://discourse.pi-hole.net/u/jpgpi250

11-11-2021

1. About this manual.

Using this guide will turn your Raspberry pi into a secure, manageable and stable pi-hole system.

If you are reading this document, using Adobe Reader, you may click on a hyperlink to content in this document. Use the combination <Alt> <left arrow> to return to the previous location.

"Back" and "Forward" buttons can also be added to the toolbar. If you right-click on the tool bar, under "Page Navigation", they are referred to as "Previous View" and "Next View".

This document is hosted on GitHub, you can open the document (pdf), using this link.

Copying and pasting from this manual into Putty doesn't seem to work all the time. If you get an error, try typing the command…

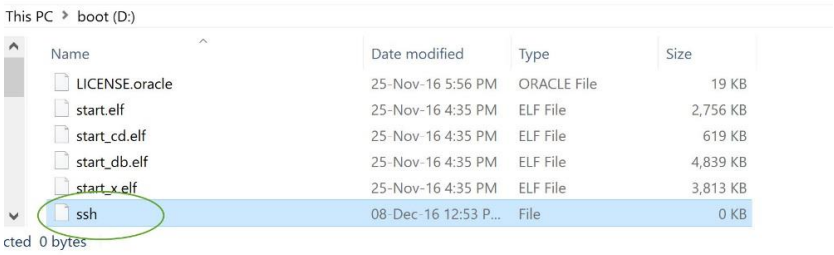
2. **Buy.**
   You can buy this anywhere, I bought them at Conrad (included links). If you buy them at Conrad, ensure you use the country specific links (conrad.de, conrad.be, conrad.nl …), this to get the proper payment and delivery options!

   - Raspberry pi:
     - Raspberry Pi® 3 Model B 1 GB w/o OS (10/100 Ethernet - item no.: 1419716) **OR** Raspberry Pi® 3 Model B+ 1 GB w/o OS (Gigabit Ethernet - item no.: 1668026)
     - Banana Pi® B+ enclosure Black RB-Case (item no.: 1274195)
   - SD card: Ensure you buy a class 10 card. You'll need an SD adapter to format and write the SD card.
     - microSDHC card 32 GB Transcend 32GB CL10 MICRO SDHC CARD Class 10 (item no.: 416521)
     - Transcend MicroSD™ Adapter auf SD (itm no.: 1413689)
   - Power Supply: If you don't have a spare one.
     - power supply unit Black RB-Netzteil3-B (item no.: 1429556)

3. **Download.**
   - Putty, ensure you download a version including PuTTYgen.
   - WinSCP
   - Win32DiskImager
   - SDFormatter
   - Raspberry Pi OS (32-bit) Lite (previously called Raspbian). This document was written, using the October 30th 2021 release, Kernel version 5.10
   - MD5 & SHA Checksum utility. Whenever possible, verify the integrity of your download, using the provided checksum.

4. **Raspberry pi Installation.**

1. Preparing the SD card.
   - Format the SD card, using SDFormatter.
   - Extract 2021-10-30-raspios-bullseye-armhf-lite.zip, this zip contains a single image file.
   - Write the extracted file (2021-10-30-raspios-bullseye-armhf-lite.img) to the SD card, using Win32DiskImager.
   - You need to create a file called "ssh" (**no extension**) in the boot partition to enable SSH (read the release notes).



   - I've tried several solutions (Win32DiskImager, Etcher) to backup and restore (clone) the SD card, unfortunately, they all fail, due to the "Not enough space error". Most internet search results recommend to shrink the size of the Linux partition, before creating the image, this to allow successful cloning, an additional Linux machine is

often required. **If you want to successfully backup / restore (clone) your SD card**, you may want to execute the steps, described in this document, before you start building your pi-hole.

- Insert the SD card in the Raspberry pi (power disconnected).

2. Preparing your DHCP server.
   You probably have an existing DHCP configuration. It is advised you make a static entry for the Raspberry pi (IP address – MAC address). This will ensure the Putty and winSCP configurations will still be functional, if you decide to reinstall from scratch. The static IP configuration will overwrite the values from the DHCP server.

3. Power on the Raspberry pi.
   You only need to connect the power and an Ethernet cable. There is no need for a keyboard, mouse or HDMI monitor.

4. Use Putty on your (Windows) workstation to connect to the Raspberry pi.
   - Session / Host Name (or IP address): enter the IP address
   - Connection / Data / Auto-login username: pi
   - Session /Saved Sessions: Enter a name for the device and click 'Save'
   - Click 'Open'
   - The default password is '**raspberry**'

5. Resize the Linux partition.
   If you disabled automatic partition expansion, you need to resize the partition, following the instructions in this document, this to allow for successful backup / restore (clone).

6. Configure the static IP address.
   Reference: http://www.suntimebox.com/raspberry-pi-tutorial-course/week-3/day-5/, read the comment from BK near the end of the page.

```
sudo nano /etc/dhcpcd.conf
```

Enter your Raspberry pi's static IP address and your network's gateway, we are using the OpenDNS servers.

```
interface eth0
static ip_address=<your Raspberry pi's static address>
static routers=<your networks gateway>
static domain_name_servers=208.67.222.222 208.67.220.220
```

Now is the time, if you haven't already done so, to configure the static DHCP entry. To find the MAC address:

```
ifconfig
```

Copy the **HWaddr** (that is the MAC address) from **eth0**

7. Update the Raspberry pi.

```
sudo apt-get update && sudo apt-get -y upgrade
```

Wait for the updates to install…

8. Reboot the Raspberry pi.

This is required to activate the static IP address and possible Raspberry pi specific patches to the Linux kernel.

Your Putty session will disconnect, wait a few seconds, right click the Putty frame and select 'restart session'.

```
sudo reboot
```

9. Repair the update (if a kernel patch has been installed).

If a Linux kernel patch has been installed, you need to issue the following commands to complete/repair the raspbian update:

```
sudo apt-get update
sudo apt-get -y --fix-broken install
sudo apt-get -y autoremove
```

10. Install mail (assumes valid gmail account).

Reference: https://websistent.com/how-to-use-msmtp-with-gmail-yahoo-and-php-mail/

Reference: https://websistent.com/msmtp-cron/

We will be installing MSMTP, you will need to upgrade the system, if you haven't already done so, before this works!

```
sudo apt-get -y install msmtp
```

Wait for the installation to complete…

Create a symbolic link for sendmail (required for webmin, see reference)

```
sudo ln -s /usr/bin/msmtp /usr/sbin/sendmail
```

Create the MSMTP configuration:

```
sudo nano /etc/msmtprc
```

Replace <your account name> (twice) with a valid gmail address and update <your password>.

```
defaults
tls on
```

```
auth on
host smtp.gmail.com
port 587
user <your account name>
password <your password>

aliases /etc/aliases

account default
from <your account name>
```

Edit the MSMTP aliases configuration.

```
sudo nano /etc/aliases
```

Add the following (replace the account information)

```
default: <your account name>
```

Optionally, send a test mail, you can read more about this here, this simple test sends a mail without a subject (replace the account information):

```
echo “msmtp test mail” | msmtp -a default <your account name>
```

You also will get some mails, while making changes to the webmin configuration.

11. Setup Key authentication

Generate the authentication keys on your Raspberry pi

```
ssh-keygen -t rsa -C "raspberrypi"
```

Accept the defaults

If you didn’t already setup WinSCP on your (Windows) workstation:

- Open WinSCP, select ‘New Site”
- File protocol: SCP
- User name: pi
- Password: raspberry
- Click ‘Advanced’
- Environment / SCP/shell /Shell: sudo su –
- Click “OK”
- Click “Save”

Login, using WinSCP

- Select the saved session
- Click “Login”
- Select Options / Preferences from the WinSCP menu
- Select Environment / Interface
- Check Commander
- Select Panels
- Check Show hidden files

Browse to the pi .ssh directory (/home/pi/.ssh)

Copy id_rsa and id_rsa.pub to your (Windows) workstation (It’s recommended you create a sources/installation/key folder for your Raspberry Pi, containing all the necessary files)

Rename id_rsa.pub to **authorized_keys** (no extension) and copy it back to the .ssh folder. If you want to restrict SSH logins to particular IP addresses, check out this reference.

Start PuTTYgen on your (Windows) workstation.

- Select “Load”
- Select the “All files” type
- Browse to your sources/installation/key folder and select id_rsa
- Click “Open”, Confirm the import
- Click “Save private key”
- Confirm you want to save the key without a passphrase
- Type an appropriate key name and save the private key file (.ppk)

Configure Putty to use the key

- Open Putty, select the saved session, click “Load”
- Connection / Data / Auto-login username: pi
- Connection / SSH / Auth
- Click “Browse”, select the private key file you created (.ppk)
- Session
- Click “Save”

Test your configuration, open a new Putty session, you should be logged on automatically.

Configure WinSCP to use the key

- Open WinSCP, select the saved session, click “Edit”
- Click “Advanced”
- SSH / Authentication
- Private key file
- Click “…” (Browse), select the private key file you created (.ppk)
- Click “OK” (closes advanced)
- Empty the password field
- Click “Save”

Test your configuration, open a new WinSCP session, you should connect, using the private key.

In order to ensure key security, apply the following:

```
sudo chown pi:pi /home/pi/.ssh/authorized_keys
sudo chmod 600 /home/pi/.ssh/authorized_keys
sudo chown pi:pi /home/pi/.ssh/id_rsa
sudo chmod 600 /home/pi/.ssh/id_rsa
sudo chown pi:pi /home/pi/.ssh/id_rsa.pub
sudo chmod 644 /home/pi/.ssh/id_rsa.pub
```

Further increase security by adding the IP address of your workstation(s):

```
sudo nano /home/pi/.ssh/authorized_keys
```

This file contains the key, used to allow authentication.

Insert the following at the beginning of the line (before the key) to add the IP address limitation (replace the IP address with the IP address of your workstation). A space after the last double quote is required:

```
from="192.168.x.x"
```

Specifying multiple IP address is an option (enter multiple IP addresses, allowed to use SSH):

```
from="192.168.x.x,192.168.x.y"
```

12. Install Webmin (version 1.981).
    Reference: http://www.webmin.com/deb.html

    Install the depencies

```
sudo apt-get -y install perl libnet-ssleay-perl openssl libauthen-pam-perl
sudo apt-get -y install libpam-runtime libio-pty-perl apt-show-versions python
sudo apt-get -y install shared-mime-info
```

    Download the package.

```
sudo wget http://prdownloads.sourceforge.net/webadmin/webmin_1.981_all.deb
```

    Install the package, this may take a while…

```
sudo dpkg --install webmin_1.981_all.deb
```

13. Additional system configuration (webmin).
    The Webmin URL: https://<Your Raspberry pi's IP address>:10000/

The username is pi, the password is raspberry, unless you've already changed that.

- Webmin / Webmin configuration / Logging:
  - Requires mail setup!
  - Send email for actions in: Select **Only log actions in ..**
    - Select (CTRL click) **Software Package Updates**
    - Select (CTRL click) **Webmin Configuration**

    Failing to make a selection (leaving the setting to **Log actions in all modules**) will cause a mail storm from the **Webmin Scheduled actions**
  - Send logged actions via email to: enter a valid (g)mail address.
- System / Software Package Updates / Scheduled Upgrades:
  - Requires mail setup!
  - Check for updates on schedule: **Yes**, every **day**.
  - Email updates report to: enter a valid (g)mail address.
  - Action when update needed: **Install any updates**.
- Hardware / system time / change timezone:
  - Select the correct time zone

  If you know the name of your time zone, you can also change it on the command line. Example for "Europe/Brussels":

```
sudo timedatectl set-timezone Europe/Brussels
```

- Webmin / Webmin Configuration / IP Access Control:
  - Select "only allow from listed addresses"
  - Enter allowed IP addresses (at least the **static** IP address of your workstation)
- Servers / SSH Server / Authentication:
  - Requires working Key authentication!
  - Allow authentication by password? **no**

14. Time (system clock) configuration.

    The latest versions of some linux distributions, including Raspbian, come with a service, called 'systemd-timesyncd.service'. This minimalistic service (not my words, see the man page) may be used to synchronize the local system clock. It also saves the local time to disk (/var/lib/systemd/clock) every time the clock has been synchronized. If you don't mind the additional writes to your SD card, you may use this service to keep time synchronized, you will need to configure the service.

    To check if the service is available:

```
sudo service systemd-timesyncd status
```

    On a fresh installed Raspbian system, this will show 'active (running)'

    To configure the service:

    Goto http://support.ntp.org/bin/view/Servers/NTPPoolServers

    Select the region you are in, there will be a list of NTP servers for your region.

```
sudo nano /etc/systemd/timesyncd.conf
```

Modify the line '#NTP=' into (replace 'debian' with the region you selected, e.g. for Europe: '0.debian.pool.ntp.org' becomes '0.europe.pool.ntp.org'. It is a space-separated list!

```
NTP=0.debian.pool.ntp.org 1.debian.pool.ntp.org 2.debian.pool.ntp.org 3.debian.pool.ntp.org
```

Restart the 'systemd-timesyncd 'service

```
sudo systemctl daemon-reload
sudo service systemd-timesyncd restart
```

To verify time synchronization, enter

```
timedatectl
```

The reply should indicate that the System clock is synchronized.

If you are happy with using the 'systemd-timesyncd 'service, move on to the next section (install DNS utils).

If you prefer to use a more robust time service, continue.

A package, available for almost all linux distributions is chrony. This package installs a daemon that will keep time synchronized.

The chrony server package isn't installed by default in this version of Raspbian.

Install the chrony package:

```
sudo apt-get install chrony
```

Goto https://support.ntp.org/bin/view/Servers/StratumTwoTimeServers

Select the region you are in, there will be a list of NTP servers for your region. Select at least two servers, use IP addresses to eliminate DNS resolver dependence. Alternatively, you might want to use your providers NTP servers.

Now add the servers to the configuration file (replace the IP addresses – use append for the second server entry), checkout the README file in /etc/chrony/sources.d/:

```
echo 'server xxx.xxx.xxx.xxx iburst' | sudo tee  /etc/chrony/sources.d/local-ntp-server.sources
echo 'server yyy.yyy.yyy.yyy iburst' | sudo tee -a /etc/chrony/sources.d/local-ntp-server.sources
```

Activate the changes:

```
sudo chronyc reload sources
```

Stop the 'systemd-timesyncd 'service (the minimalistic NTP service that might be running on your system and disable it permanently (you can enable it again if you change your mind).

```
sudo service systemd-timesyncd stop
sudo systemctl disable systemd-timesyncd
```

Check time server synchronization status.

```
chronyc sources
```

You'll get a list of servers, the primary server is marked with an asterisk (*). It may take a while for the synchronization to become active, repeat the command

15. Install DNS utils.
    It is recommended to check your system's DNS capability before installing pi-hole.

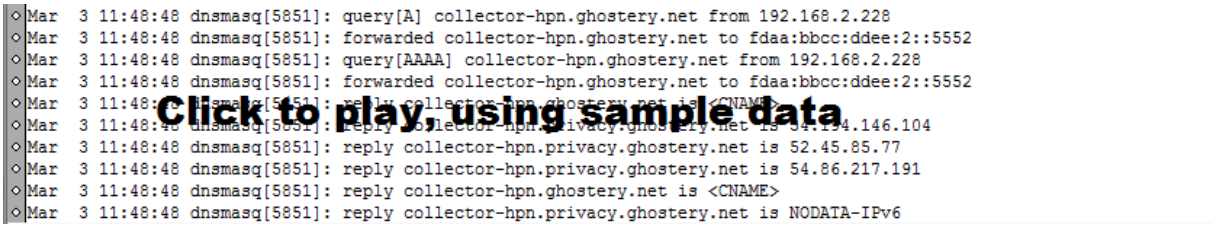
```
sudo apt-get -y install dnsutils
```

Check if name resolution is functional, remember we configured the OpenDNS servers.

```
dig google.com
```

5. Pi-hole installation (version v5.6).

1. What will pi-hole do for you?
   Pi-hole will provide an answer for all domain queries, to any device that uses pi-hole as DNS server. The answer can be the real address for the domain or an answer that will prevent the device loading content from this domain. The format of the answer can be configured, by adding a setting to /etc/pihole-FTL.conf. The blocking mode options can be found here. Pi-hole uses **'unspecified IP blocking**' by default (recommended).



   The data, used in the demo, is extracted from an operational system, using numerous block lists. All blocked entries are displayed in magenta, resulting in an unspecified IP.

2. Installation.
   Reference: https://pi-hole.net/

   - Automated install

     I've had issues with this (DNS error) see below for an alternative

```
curl -L https://install.pi-hole.net | bash
```

- Alternative Semi-Automated install

```
wget -O basic-install.sh https://install.pi-hole.net
chmod +x basic-install.sh
sudo ./basic-install.sh
```

- Read the informational dialogs, select "**Yes"** when the "**Static IP Needed**" dialog appears.
- Select the interface, eth0 is the wired interface on Raspbian. The interface choice will only appear if you have multiple interfaces.
- Select DNS servers (I've been using the OpenDNS servers).
- Select the third party lists you want to use (the latest version of the installer only offers a single list) and confirm.
- Both **IPv4 and IPv6** are selected, uncheck **IPv6** if you don't use it…
- Confirm your network settings
- Read the IP conflict dialog (this should never be an issue if you prepared your DHCP server.
- If you have selected IPv6, the address pi-hole will be using is displayed. This address may be incorrect if you have multiple IPv6 addresses. You can change the address later by editing /etc/pihole/setupVars.conf. You will need to run "pihole -g" to activate the changes.
- Select "**On** (Recommended)" to install the web admin interface. Your choice will be recorded, using the INSTALL_WEB setting in /etc/pihole/setupVars.conf.
- Select "**On** (Recommended)" to install the web server (lighttpd), unless you already installed a different web server. Using a different web server is not covered in this manual.
- Select "**On** (Recommended)" to log queries. Your choice will be recorded, using the QUERY_LOGGING setting in /etc/pihole/setupVars.conf.
- Select a privacy mode for FTL that suits you, defaults to 0 (Show everything), recommended.
- Wait for the installation to complete…
- Write down the web interface admin password. You can change it immediately, if required!
- Don't forget to configure the correct DNS settings…

3. Upgrading

You may notice a message "Update available!"

To find your pi-hole version

```
pihole version
```

You can upgrade using the command

```
pihole updatePihole
```

You can automatically install updates, if any. You'll need to add a cron job.

```
sudo nano /etc/cron.d/piholeupdate
```

Add the update job by adding the following, modify the time to meet your requirements.

```
 # Pi-hole: Update Pi-hole
30 2    * * 7   root    PATH="$PATH:/usr/local/bin/" pihole updatePihole
```

6. **Change your DNS settings.**
   Pi-hole won't do anything, unless you modify the DNS settings on your (Windows) workstation(s).

   If you have a DHCP server on your network, change the DNS settings in DHCP server setup. The first DNS server should be <Your Raspberry pi's IP address>. Don't configure a second DNS server, unless you have two pi-holes. You'll need to reboot your workstation for the new DNS setting to become active immediately.

   If you're using a local DNS configuration, you'll have to change it on all the devices.

   You'll also need to flush or configure the DNS cache on your (Windows) workstation.

```
ipconfig /flushdns
```

7. **Change the default UNIX password.**
   The default password for the pi user is raspberry. In order to protect the system, you need to change this. We're using sudo to allow simple passwords. Webmin will also be accessible, using the new password.

```
sudo passwd pi
```

   Enter the new password.

8. **Change / Recover the admin page password.**
   You can change the admin page password, using putty.

   Enter the following command:

```
sudo pihole -a -p
```

   Enter the new admin page password (twice).

   You can disable authentication by just pressing <Enter> (Blank for no password).

   You can also remove the password by removing it from the configuration file.

```
sudo nano /etc/pihole/setupVars.conf
```

Remove everything after the equal sign.

```
WEBPASSWORD=
```

9. **Adding a local LAN list**
   You have probably noticed you can get to the pi-hole admin page by entering http://pi.hole/admin.

   This was achieved (older pi-hole versions) by creating a configuration file /etc/pihole/local.list. The latest version of pi-hole achieves this automatically, no need to make an entry in the configuration file. The file /etc/pihole/local.list is now a static file (contains a warning only). The file is overwritten when running 'pihole –g ' or 'pihole –up'.

   You can use the pi-hole solution to create custom names for your devices (different from the hostname), by using the web interface, click on 'Local DNS Records' and add the 'device name' and 'IP address'. Changes are saved in /etc/pihole/custom.list.

   Due to the limitation of using the web interface, you can only use a single name for a device, example:

```
192.168.2.232 7730g
```

   The hosts file specification however, allows multiple entries (names) for a single IP address, example:

```
192.168.2.232  7730geth0.localdomain  7730g.localdomain  7730geth0  7730g
```

   Use the method below to overcome this limitation and / or **you plan to import your clients into the database**, using a script (sqlite3).

   Both methods need a careful approach. In the section 'Raspberry pi installation', 'Preparing your DHCP server', I advised you to configure the DHCP server to make a static entry for the Raspberry pi (IP address – MAC address). The same approach should be used for clients. If the client isn't configured in such a way, it may receive a different IP address, when the DHCP lease has expired (read this article, search for lease). The lease time usually (most routers) default to 14 days (this may vary, depending on make and model). As long as you connect to the network within that period, no IP change will occur, however, if you take a three week holyday, you might be in for a surprise.

   Create /etc/localdns.list:

```
sudo nano /etc/localdns.list
```

   Content, you need to replace the IP addresses, hostnames and domainname, to match your own environment, on Windows you can find your domain name by entering 'ipconfig /all' (look for Connection-specific DNS Suffix), on linux you can find your domain name by entering 'dnsdomainname'. Example:

```
192.168.2.5       s9.localdomain        s9
192.168.2.53      macbook.localdomain   macbook
192.168.2.102     ps4.localdomain       ps4
```

You can enter as many entries (lines) as you need.

Now we need to tell the system to use the newly created list (/etc/localdns.list).

Create a new dnsmasq configuration file:

```
sudo nano /etc/dnsmasq.d/localdns.conf
```

Content (you need to change the 'domain' and 'local' value to match your own):

```
domain=localdomain
expand-hosts
local=/localdomain/
addn-hosts=/etc/localdns.list
```

All we have to do now is activate the new configuration:

```
sudo service pihole-FTL restart
```

As soon as the restart is completed, you can use the dnsname to get to your devices, e.g., 'ping ps3', 'nslookup ps3', 'dig ps3'. Depending on your systems settings, it might be required to use the full name, e.g. 'ping ps3.localdomain'. You can change that, but these changes need to be done on the workstation (windows 10, linux, mac).

Warning: All files in /etc/dnsmasq.d are saved when using 'Teleporter' (web interface / Settings / Teleporter / Export), the file /etc/localdns.list however, is a pi-hole customization, thus NOT saved by 'Teleporter'. Always keep a backup copy on a different machine.

10. Windows Whitelist.

The windows registry (\HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\NlaSvc\Parameters\Internet) key, contains information, needed to determine the systems internet connection status.

In order to correctly update the windows internet status (network icon in the system tray) you need to add whitelist exceptions.

- Open the pi-hole admin page: http://<Your Raspberry pi's IP address>/admin/
- Select Whitelist
- Add the following entries, select the type 'Exact Whitelist' ((windows 7 and 10 entries are listed):

```
www.msftncsi.com
dns.msftncsi.com
```

```
ipv6.msftncsi.com
www.msftconnecttest.com
ipv6.msftconnecttest.com
```

Pi-hole entries can be made, using the pi-hole admin page. The next section(s) will explain alternate methods to enter new entries.

An alternative approach would be to use a 'Regex whitelist' or 'Wildcard whitelist' entries. Remember that **whitelist entries always win**, if a domain matches a whitelist entry ('Exact whitelist', 'Regex whitelist' or 'Wildcard whitelist'), pi-hole will allow the domain, regardless of what may be on the block lists.

It is recommended to be extremely careful, when using 'Regex whitelist' or 'Wildcard whitelist', because it might open the door for domains you don't want.

Example, the regular expression

```
(\.|^)msftncsi\.com$
```

would be a replacement for the three 'Exact whitelist' entries in the above list, however, the domain tracker.msftncsi.com (example, doesn't currently exist) would also be allowed, which isn't really what we try to achieve. If you want to test what a new regular expression does or doesn't achieve, regex101 allows you to test your regex, regexper explains how your regex works.

11. **Modify lists using the 'pihole' command.**
    If you simply enter 'pihole' on the command line of your putty session, you will be presented with a list of possible options.

    You can add an entry to a list by using the appropriate 'pihole' command.

    Example: add the domain 'ipinfo.io' to the whitelist (always allow access to this site, even if the domain is in a block list)

```
pihole -w ipinfo.io
```

    This method can be used to add whitelist (-w), blacklist (-b), wildcard blacklist domains (wildcard), regex blacklist domains (regex).

    pihole-FTL will pick up the changes immediately, no need to restart pihole-FTL (part of the 'pihole' command).

12. **Modify lists using sqlite3.**
    The pi-hole lists are no longer separate files (adlists.list, black.list, whitelist.txt), all data is now maintained in the sqlite3 database (/etc/pihole/gravity.db).

    You can explore or modify the database by installing phpLiteAdmin, a web interface that will give you access to all sqlite3 databases. The installation (NOT part of pi-hole – NOT supported) is described here.

You can add an entry to a list by using the appropriate sqlite3 command.

Example: add the domain 'ipinfo.io' to the whitelist (always allow access to this site, even if the domain is in a block list)

```
sudo sqlite3 /etc/pihole/gravity.db
insert or ignore into domainlist (domain, enabled) values ("ipinfo.io", 1);
.quit
```

OR add the domain and comment

```
sudo sqlite3 /etc/pihole/gravity.db
insert or ignore into domainlist (domain, comment, enabled)
values ("ipinfo.io", "IP Address Data", 1);
.quit
```

Note you can split the command on multiple lines, "**;**" marks the end of the command. You will see "**...>**" on the screen after the first line, enter the second line after this.

pihole-FTL does NOT pick up the changes immediately, you'll need to reload the configuration.

```
pihole restartdns reload
```

Adding a single entry, using sqlite3 requires more effort than using the 'pihole' command, however, using sqlite3 is very useful to add multiple entries from a text file. This will be explained in the regex section.

13. **Adding Wildcard sites to the blacklist.**

Wildcard configuration (/etc/dnsmasq.d/03-pihole-wildcard.conf) is no longer supported by pi-hole, instead regular expressions are used.

You may still want to use wildcards, as it is a valid dnsmasq feature. FTLDNS, used by pi-hole, is based on dnsmasq. If you want to block an entire an entire domain and don't want to use regular expressions, create an additional configuration file for dnsmasq.

Warning! The entries in this list are **NOT affected** by the **disable** function in the pi-hole web interface. A change of the configuration file requires a restart ('sudo service pihole-FTL stop / sudo service pihole-FTL start)

Warning! The entries in this list do NOT trigger the CNAME feature. If you want to create an entry that blocks CNAMEs, you need to use a regular expression.

```
sudo nano /etc/dnsmasq.d/wildcard.conf
```

In this example, we will block the entire ligatus.com domain, using null blocking. Add the following line to the file (only use a single entry per domain, either the IPv4 example **OR** the IPv4 and IPv6 example):

```
# Entry for IPv4 only
address=/ligatus.com/0.0.0.0
# Entry for IPV4 and IPv6
address=/ligatus.com/#
```

You can add multiple 'address' lines

Reload and restart the FTLDNS service

```
sudo service pihole-FTL stop
sudo service pihole-FTL start
```

14. Regular expressions.

As of pi-hole v4.0, regular expressions are used, to block domains. You can add wildcards or regular expressions, using the web interface (settings), the pihole command, or by editing the database. In pi-hole v4.1, PRIVACYLEVELS are introduced. By default, the level is 0 (Show everything). Regular expressions cannot be used if privacy level 4 (Disabled statistics) is used. The privacy level can be changed in the web interface (Settings / Privacy). The privacy level is stored in /etc/pihole/pihole-FTL.conf.

To add a regular expression, using the 'pihole' command (example block 'doubleclick', notice the double quotes!):

```
pihole regex "(^|\.)doubleclick\.net$"
```

To add a regular expression using sqlite3 (example block 'facebook', notice the double quotes! - the regex can also be copied here, discussion here):

```
sudo sqlite3 /etc/pihole/gravity.db
insert or ignore into domainlist (domain, type, enabled)
values ("^(.+\.)?(facebook|fb(cdn|sbx)?|tfbnw)\.[^.]+$", 3, 1);
.quit
```

Note you can split the command on multiple lines, "**;**" marks the end of the command. You will see "**...>**" on the screen after the first line, enter the second line after this.

As you can see, as opposed to the sqllite3 whitelist example, a type field is used. It isn't used in the whitelist example, because the default value is zero. Here, you can find an overview of the different types and some additional information on the domainlist database table.

Another example of regular expressions (block amp pages), reference here:

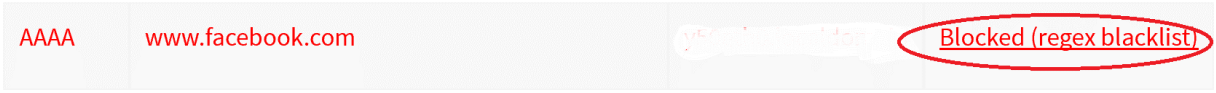
```
^(.+[_.-])?amp(project)?\.
```

You can learn more about regular expressions in this pi-hole document. Examples of regular expressions are provided here.

Adding a single entry, using sqlite3 requires more effort than using the 'pihole' command, however, using sqlite3 is very useful to add multiple entries from a text file. A well know and used list of regular expressions can be found here. You can add these regular expressions by running /home/pi/regex.sh:

Click on the icon to view the script in a browser. Copy the content and make the script executable (sudo chmod +x /home/pi/regex.sh). You can also use wget (click on Basic usage) to copy the script directly. Execute the script with 'sudo'!

The web interface identifies a domain, blocked due to a regex match as follows (example):



Clicking on the link ('Blocked (regex blacklist') will open a new page (<CTRL> click if your browser doesn't support this), showing the regex (highlighted), responsible for blocking.

You can either delete the regex, NOT recommended, as it will allow all domains, previously blocked due to the regex OR whitelist the domain on the first screen (query Log).

15. **Deep CNAME inspection**

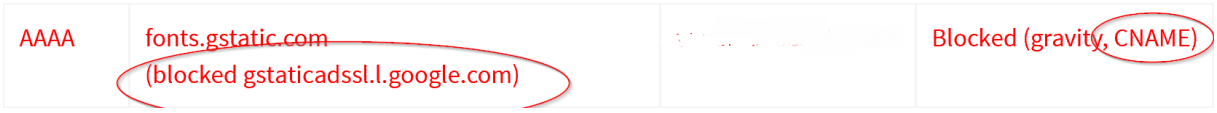
Several articles (search for 'CNAME cloaking') describe the latest method advertisers and trackers use to bypass add blockers. Naturally, ad blockers, including pi-hole, have found a solution for this.

'Deep CNAME inspection' is enabled by default, you can disable it (NOT recommended) by adding

```
CNAME_DEEP_INSPECT=false
```

to /etc/pihole/pihole-FTL.conf.

The web interface identifies a domain, blocked due to a CNAME match as follows (example):



This example shows fonts.gstatic.com is NOT in any block list (use 'pihole -q' to verify), but gstaticadssl.l.google.com (the CNAME) is (gstaticadssl.l.google.com is on 4 of my block lists), thus fonts.gstatic.com (the original request) will be blocked because of the CNAME. You can use the command 'dig @8.8.8.8 A fonts.gstatic.com' to verify the CNAME relation. This example is provided, using my block list set, it may not produce the same result on your system, because you don't use different block lists.

Pi-hole shows blocking, due to deep CNAME inspection, in the pi-hole log (/var/log/pihole.log). If a domain is blocked, due to deep CNAME inspection, you'll see something like (example used above):

reply fonts.gstatic.com is <CNAME>
reply gstaticadssl.l.google.com is blocked during CNAME inspection

Never whitelist a CNAME (gstaticadssl.l.google.com in the example). Several other, possibly undesired domains may use the same CNAME! In the above example, you would whitelist fonts.gstatic.com (**pi-hole developer recommendation**).

NextDNS, a DNS provider, has a github page, explaining CNAME cloaking, and a list of companies (domains) that use this technique. In order to defend yourself against this practice, you can add these domains as regex (regular expressions), manually, or by running /home/pi/NextDNS.sh:

Click on the icon to view the script in a browser. Copy the content and make the script executable (sudo chmod +x /home/pi/NextDNS.sh). You can also use wget (click on Basic usage) to copy the script directly. Execute the script with 'sudo'!

The Adguard Team also has a github page (reported by Sudoku) with a list of companies (domains) that use this technique. Although a lot of the domains are already in the NextDNS list, you can add some additional domains (extracted from the json file) as regex (regular expressions), manually, or by running /home/pi/AdguardTeam.sh:

Click on the icon to view the script in a browser. Copy the content and make the script executable (sudo chmod +x /home/pi/AdguardTeam.sh). You can also use wget (click on Basic usage) to copy the script directly. Execute the script with 'sudo'!

16. Adding host lists.

Pi-hole comes with a default set of host lists (URL's), used to create the gravity list. Pi-hole stores the URLs in the database (/etc/pihole/gravity.db / table adlist).

These URLs are used every Sunday, using a cron job, to update the gravity (blocked domains) database (/etc/pihole/gravity.db / table gravity).

You can add entries to this table, using the web interface (Settings / Blocklists), whenever you add an entry to the list, using the web interface, the gravity list is rebuild (Save and Update).

To add entries to the list manually, using sqlite3 (example):

```
sudo sqlite3 /etc/pihole/gravity.db
insert or ignore into adlist (address, enabled)
values ("http://someonewhocares.org/hosts/", 1);
.quit
```

Note you can split the command on multiple lines, "**;**" marks the end of the command. You will see "**…>**" on the screen after the first line, enter the second line after this.

You can also add an entry with a comment, see modifying lists using sqlite3.

Some URL's, containing lists I added:

```
http://someonewhocares.org/hosts/
https://www.malwaredomainlist.com/hostslist/hosts.txt
http://winhelp2002.mvps.org/hosts.txt
http://www.hosts-file.net/download/hosts.txt
http://v.firebog.net/hosts/Easyprivacy.txt
# cryptojacking
https://raw.githubusercontent.com/hoshsadiq/adblock-nocoin-list/master/hosts.txt
https://gitlab.com/ZeroDot1/CoinBlockerLists/raw/master/list.txt
```

You should always check the format of a new host list, before adding it to your list. Not all lists can be parsed correctly.

An interesting set of lists, can be found here. This page will let you choose from 3 sets of lists, I've been using the non-crossed lists. This page will display a set of URLs that can be added. Using sqlite3, it is possible to add these list with a script. You can add these lists by running /home/pi/firebog.sh:

Click on the icon to view the script in a browser. Copy the content and make the script executable (sudo chmod +x /home/pi/firebog.sh). You can also use wget (click on Basic usage) to copy the script directly. Execute the script with 'sudo'!

Some lists cannot be downloaded from an URL but the compressed file can be retrieved. I have been using lists from this site. Use the script to download and extract the lists to your local file system.

Click on the icon to view the script in a browser. Copy the content and make the script executable (sudo chmod +x /home/pi/shallalist.sh). You can also use wget (click on Basic usage) to copy the script directly. Execute the script with 'sudo'!

The result is a new folder /home/pi/BL. This folder contains a lot of lists that can be used with pi-hole. I've been using:

```
BL/tracker/domains
```

To add this list to your set of lists, using sqlite3 (or the web interface)

```
sudo sqlite3 /etc/pihole/gravity.db
insert or ignore into adlist (address, enabled)
 values ("file:///home/pi/BL/tracker/domains", 1);
.quit
```

Notice we are using a local file, hence the "**file:///**".

If you have added new lists, using sqlite3 or a script, remember to activate the new lists:

```
pihole -g
```

Always remember to flush or configure the DNS cache on your workstation, to ensure correct responses, after adding new lists.

```
ipconfig /flushdns
```

17. Group Management

Up to pi-hole v4.3.2, all block lists were applied to all clients. This often was a dilemma for the administrator, a specific user may need or request access to a specific web page, the only option to grant the request was to whitelist the domain, unfortunately, that whitelist entry affected all users.

Pi-hole uses group management to overcome this limitation, use this wisely!

The developer's documentation, contains very detailed examples, on how to use group management, and can be found here.

It's NOT always easy to get the desired result. You could for example exclude an 'adlist' for a specific group, but the domains in that 'adlist' may exist in multiple lists. Always use:

```
pihole -q <domain>
```

This, to verify if a domain exists on multiple 'adlists'. Excluding a specific 'adlist' from a group is pointless, if the domains in the list exist in multiple 'adlists'.

Remember, 'whitelist' entries always have precedence. You can block what you want, if there is a 'whitelist' or 'regex whitelist' entry, the domain will never be blocked!

Changes made in the Group Management section don't appear to take effect until you restart pihole-FTL.

```
pihole restartdns reload-lists
```

1. Groups.
   A default group exists, the 'The default group'. By default, all clients, even the ones not defined in the 'Clients' section, are member of this group, you can change membership in the 'Clients' section. You can add a new group, using the web interface (Group Management / Groups)

2. Clients
   By default, there are no configured clients. You can add a client, using the web interface (Group Management / Clients). A client must be a member of at least one group, by default, this will be the 'The default group'. If a client isn't a member of any group, nothing will be resolved (no internet). If you are using both IPv4 and IPv6 on your network, and want to allow the client to bypass a specific 'Domain' or not use a specific 'Adlist', you need to add a 'Client' entry for both the IPv4 and IPv6 'Client' address.

This setup needs a careful approach. In the section 'Raspberry pi installation', 'Preparing your DHCP server', I advised you to configure the DHCP server to make a static entry for the Raspberry pi (IP address – MAC address). The same approach should be used for clients. If the client isn't configured in such a way, it may receive a different IP address, when the DHCP lease has expired (read this article, search for lease). The lease time usually (most routers) default to 14 days (this may vary, depending on make and model). As long as you connect to the network within that period, no IP change will occur, however, if you take a three week holyday, you might be in for a surprise.

If you have created /etc/localdns.list, as described here (local LAN list), you can use a script to add the IP addresses and a comment (last entry of the line) to your pi-hole configuration.

Click on the icon to view the script in a browser. Copy the content and make the script executable (sudo chmod +x /home/pi/clients.sh). You can also use wget (click on Basic usage) to copy the script directly. Execute the script with 'sudo'!

3. Domains.
   The 'Domains' list contains all whitelist, blacklist, regex whitelist and regex blacklist entries you have defined on your system. The steps, required to assign a whitelist, blacklist, regex whitelist or regex blacklist entry are very well explained in the developer's documentation, thus NOT explained here.

4. Adlists
   The 'Adlists' list contains all adlists you have defined on your system. The steps required to assign an 'adlist' entry are very well explained in the developer's documentation, thus NOT explained here.

18. Group Management, a whitelist example.

I had a problem with my android devices, notifications didn't work anymore. I found a hint to the solution. Turns out a number of block lists started adding mtalk.google.com entries (example: alt2-mtalk.google.com).

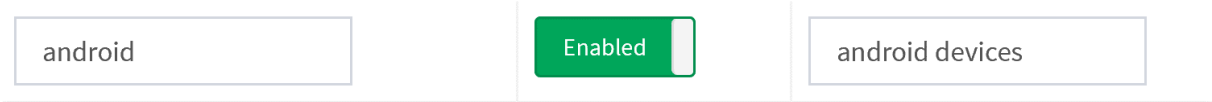
A solution, using a **regex whitelist** entry, for **android devices only**:

1. Create the whitelist regex entry (menu Whitelist):

```
^((alt)[0-9](-))?mtalk\.google\.com$
```

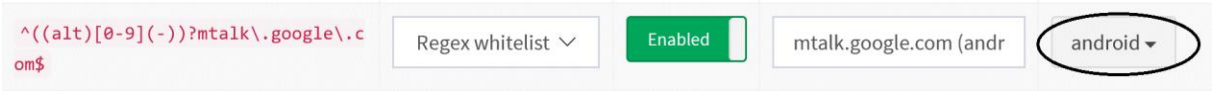
Result will look like this:

2. Create a new group 'android' (menu Group Management / Groups)

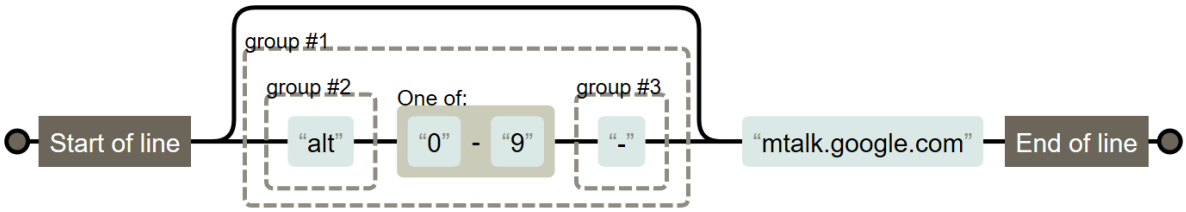


3. Add the android device, you've already imported (see the clients script) to the 'android' group. Ensure the devices are assigned to all the groups, e.g. if the 'android' group was the first you created, the entry will look like this (IP address and client name will differ), repeat this for all android devices:

4. Assign the domain entry to the android group. Ensure the domain (whitelist regex) is only assigned to the 'android' group (menu Group Management / Domains).



All android devices will now receive a valid response, when requesting info for the mtalk.google.com domain and specific subdomains. The regex accomplishes the following (analyze a regex here):



Another example of selective whitelisting (whitelisted google ad links from the google search results) can be found in this document.

19. Group Management, duplicate blacklist and whitelist entries

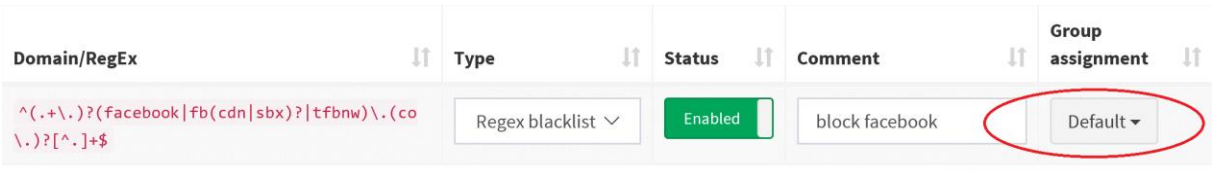
Pi-hole allows you to create an identical blacklist AND whitelist entry.

An example: Assuming you want to block facebook, but allow access for a specific device (or devices).

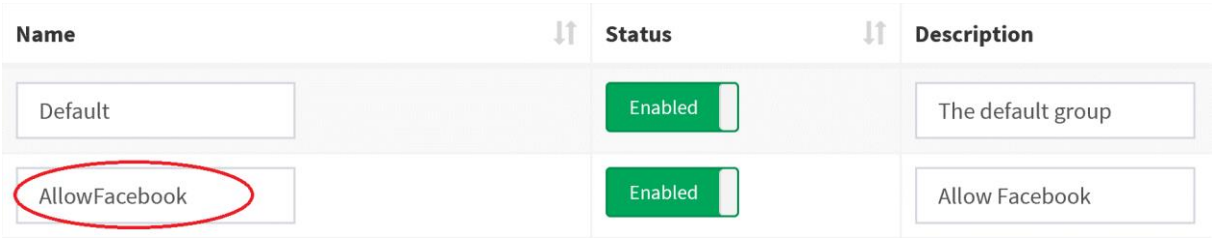
The regular expression:

```
^(.+\.)?(facebook|fb(cdn|sbx)?|tfbnw)\.(co\.)?[^.]+$
```

1. Create a blacklist regular expression for facebook and assign it to the default group, this will block facebook for all clients:

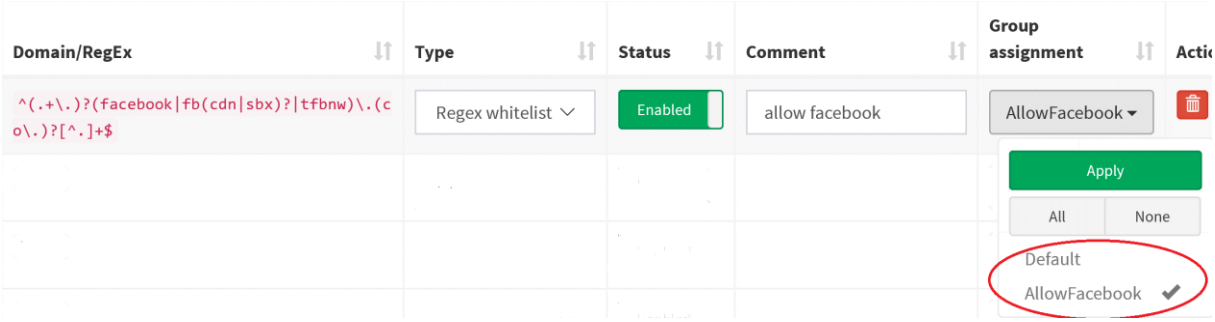


2. Create a group to allow access to facebook:



3. Add a client(s) to the group, assign the client to both the default and the AllowFacebook groups:

4. Create the whitelist regular expression (identical to the blacklist regular expression) for facebook and assign it to the AllowFacebook group:



Done, facebook will now be accessible for the specific device(s) only, this because a **whitelist entry always wins**.

20. Windows DNS cache.

Enable/Disable pi-hole, using the pi-hole admin console, will not have an effect unless you change the windows DNS cache time permanently

To disable the Windows DNS cache:
Create a registry file with the following contents and add the info to the registry:

```
Windows Registry Editor Version 5.00
[HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\Dnscache\Parameters]
"MaxCacheTtl"=dword:00000001
```

Double click the file to add the setting to the registry.

To enable the Windows DNS cache:
Create a registry file with the following contents and add the info to the registry:

```
Windows Registry Editor Version 5.00
[HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\Dnscache\Parameters]
"MaxCacheTtl"=-
```

Double click the file to add the setting to the registry.

21. **Changing the hostname.**
    If you have multiple pi's running, you might want to change the hostname, this to easily identify the host you're working on, using putty. Enter the following command:

```
sudo hostnamectl set-hostname <newhostname>
```

If you've installed webmin, you may need to change an additional setting in the webmin configuration.

- Webmin / Webmin configuration / Sending Email:
  - Requires mail setup!
  - From address for email from Webmin:
    - Select **Address**
    - **E**nter the (g)mail address you used in the mail setup.

22. **Protect your Raspberry Pi.**
    We've already enabled key authentication, changed the UNIX password and disabled password logon, we can however increase the security even more.

    Depending upon you paranoia level, you can apply all security measures, described here, however this document is limited to MITM attacks, spoof protection and disabling routing.

```
sudo nano /etc/sysctl.conf
```

Remove the comment sign from the lines below (red comment signs only)

```
# Uncomment the next two lines to enable Spoof protection (reverse-path filter)
# Turn on Source Address Verification in all interfaces to
# prevent some spoofing attacks
#net.ipv4.conf.default.rp_filter=1
#net.ipv4.conf.all.rp_filter=1

# Additional settings - these settings can improve the network
# security of the host and prevent against some network attacks
# including spoofing attacks and man in the middle attacks through
# redirection. Some network environments, however, require that these
# settings are disabled so review and enable them as needed.
#
# Do not accept ICMP redirects (prevent MITM attacks)
#net.ipv4.conf.all.accept_redirects = 0
#net.ipv6.conf.all.accept_redirects = 0
```

```
# Do not send ICMP redirects (we are not a router)
#net.ipv4.conf.all.send_redirects = 0

# Do not accept IP source route packets (we are not a router)
#net.ipv4.conf.all.accept_source_route = 0
#net.ipv6.conf.all.accept_source_route = 0
```

Reboot the Raspberry pi

```
sudo reboot
```

23. Disable unused hardware (Raspberry Pi® 3B, 3B+, 3A+, 4B and Zero W).

You may want to disable the WIFI interface and Bluetooth (reference here).

1. Disable WIFI.

```
echo "dtoverlay=disable-wifi" | sudo tee -a /boot/config.txt
```

2. Disable Bluetooth.

```
echo "dtoverlay=disable-bt" | sudo tee -a /boot/config.txt
sudo systemctl disable hciuart
```

Reboot the Raspberry pi

```
sudo reboot
```

24. Install some useful system tools

1. Install watchdog

   Your system might get into trouble, by running a CPU hogging script, or a package that misbehaves. This might lead to an inaccessible (unresponsive) system, leaving you no choice, but to cut the power to regain access, **which might cause damage to your SD card**. Raspbian has a kernel module (bcm2835_wdt) that can help you avoid this drastic intervention.

   Enable watchdog to send mails, whenever triggered:

```
sudo ln -s /usr/bin/msmtp /usr/lib/sendmail
```

   Install watchdog

```
sudo apt-get -y install watchdog
```

   Configure the watchdog

```
sudo nano /etc/watchdog.conf
```

Uncomment the following lines, don't uncomment "max-load-1", this may cause unexpected reboots!

```
max-load-5              = 18
max-load-15             = 12
watchdog-device         = /dev/watchdog
```

And add the following at the end of the file:

```
watchdog-timeout = 15
```

Reboot to start the watchdog with these settings:

```
sudo reboot
```

The watchdog will now be able to reboot your system, as soon as the load on the system is excessive. Normal load can be monitored on the pi-hole admin page (upper left corner) or by entering

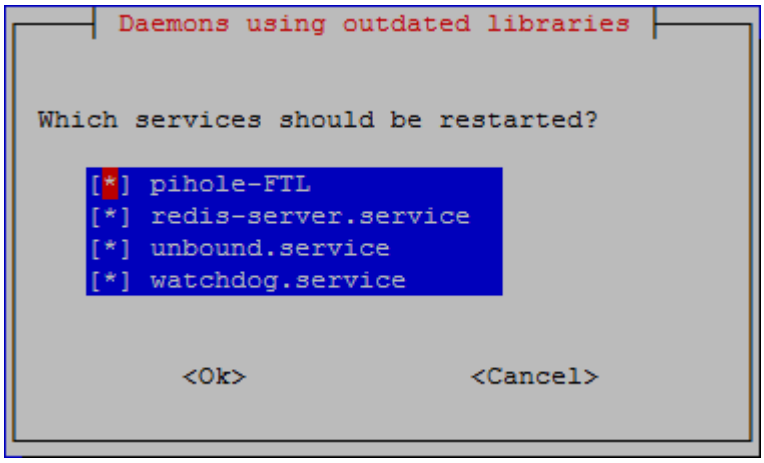
```
uptime
```

2. Install schedtool
   Some packages can use schedtool, to optimize the CPU use and cores. Install the package to allow CPU use optimization.

```
sudo apt-get -y install schedtool
```

3. Install needrestart.
   If you installed and configured daily automatic updates, using Webmin, your system will be kept up to date automatically, however Webmin doesn't restart daemons, still using the outdated libraries. The package needrestart allows you to determine which daemons need a restart. You will need to restart the daemon manually.

   Needrestart integrates with apt-get, so running 'sudo apt-get –y upgrade' will automatically trigger the test. Webmin doesn't trigger needrestart, you will have to check it manually (sudo needrestart), or have a daily cron job and script to check it for you, and send you a mail (requires mail setup).



Installing needrestart:

```
sudo apt-get -y install needrestart
```

On a raspberry pi, some settings need to be modified in the configuration file, we don't want to test kernel updates and microcode updates, as these tests will generate false positives. Change the following settings in /etc/needrestart/needrestart.conf

```
$nrconf{kernelhints} = 0;
$nrconf{ucodehints} = 0;
```

These setting are commented out (#) in the original configuration file (near the end of the file), uncomment and change the value where required.

To avoid having to check things manually, the following script will perform the required checks, and send you an email. Create a cron job to execute it daily, read this document if you don't know how to do this.

Click on the icon to view the script in a browser. Copy the content and make the script executable (sudo chmod +x /home/pi/needrestart.sh). You can also use wget (click on Basic usage) to copy the script directly. Execute the script with 'sudo'!

4. Helping the RANDOM number generator.
   To avoid unexpected messages and warnings (you might see messages like 'System doesn't have enough entropy') whenever the system needs a random number, install rng-tools. As of the april 2019 version of raspbian, this package is already installed, you only need to modify the configuration file.

```
sudo apt-get -y install rng-tools
```

Edit the configuration file

```
sudo nano /etc/default/rng-tools-debian
```

Add the following line (**bold** only):

```
#HRNGDEVICE=/dev/hwrng
#HRNGDEVICE=/dev/null
HRNGDEVICE=/dev/urandom
```

25. IPv6 address.

If you are using the default blocking mode, the value of the IPv6 address, registered by the pi-hole installation doesn't really matter, unless you use the address to browse to the admin web interface. If however, you are using a blocking mode where the IPv6 address is used, you may be confronted with the problem your ISP hands out IPv6 addresses that changes regularly. To overcome this problem (implies you have completed mail setup):

Create a script (/home/pi/IPv6check.sh) with the following content (you need to update '<your account name>'):

Click on the icon to view the script in a browser. Copy the content and make the script executable (sudo chmod +x /home/pi/IPv6check.sh). You can also use wget (click on Basic usage) to copy the script directly. Execute the script with 'sudo'!

Using GUA: Replace the first few digits ('2a02' in my case) in the grep command to match your own!!!
Using LUA: Replace '2a02' in the grep command with 'fc\|fd'

Make the script executable

```
sudo chmod +x /home/pi/IPv6check.sh
```

Create a cron job (/etc/cron.d/IPv6check) with the following content:

```
19 7    * * *   root    PATH="$PATH:/home/pi/" /home/pi/IPv6check.sh
```

Change the time to something appropriate for your system, the example runs at 07h19

26. Backup your pi-hole.

This procedure will only work, if you manually created a smaller Linux partition, explained in this document. If you didn't reserve some free space, to allow for successful cloning, you probably will have to shrink the Linux partition first.

Once you have a working pi-hole, you can avoid setting it all up again by creating an image of your system.

Shutdown your system

```
sudo poweroff
```

Remove the SD card from the Raspberry Pi.

Use Win32DiskImager to create an image

- Insert the SD card into your computer.
- Start Win32DiskImager.
- Image File: Select a location and name for the image, e.g. C:\temp\pi-hole.img
- Device (source): Select the drive, holding the SD card, multiple partitions (drives) exist on the SD card, select the first one (all partitions will be processed).
- Select **Read**

Wait…

Use Win32DiskImager to write the image
- Insert the new (or used) SD card into your computer.
- Format the SD card, using SDFormatter.
- Start Win32DiskImager.
- Image File: Select a location and name for the image, e.g. C:\temp\pi-hole.img
- Device (target): Select the drive, holding the SD card.
- Select **Write**

Wait…

Whenever you cloned (use Win32DiskImager) a backup image, the first thing you should do is set the date and time and restart the NTP service. If you are using 'systemd-timesyncd.service', the systems default NTP service, this might be done automatically (never tested). If you have opted for the more robust NTP daemon, you need to do this manually, because the NTP daemon only allows for small time corrections, this to avoid large adjustments from an incorrect time source.

```
sudo /etc/init.d/ntp stop

sudo ntpd -gq

sudo /etc/init.d/ntp start
```

27. Customizing pi-hole (optional).

1. PHP info.
   Pi-hole relies on PHP. If you want to add your own PHP scripts, you need to know how PHP is configured.

   Create a file info.php in /var/www/html, content:

```
<?php

phpinfo();

?>
```

   To view the PHP info, browse to:

```
http://<your Raspberry pi's static address>/info.php
```

2. Lighttpd Server Status.
   The default web server (lighttpd) has a status page, however, it isn't activated with a default pi-hole installation.

   Reference: https://redmine.lighttpd.net/projects/1/wiki/Docs_ModStatus

   To enable this page, run the following script (/home/pi/lighttpdstatus.sh):

   Click on the icon to view the script in a browser. Copy the content and make the script executable (sudo chmod +x /home/pi/lighttpdstatus.sh). You can also use wget (click on Basic usage) to copy the script directly. Execute the script with 'sudo'!

   Make the script executable:

```
sudo chmod +x /home/pi/lighttpdstatus.sh
```

   Unfortunately, this configuration will be lost, as soon as you upgrade (pihole -up) or reconfigure (pihole -r) your system. Simply run the script again, the script will add the missing entries.

   Run the script, assuming the current directory is /home/pi.

```
sudo ./lighttpdstatus.sh
```

   To view the Server status, browse to:

```
http://<your Raspberry pi's static address>/server-status?refresh=15
```

3. Browsing the FTL database.
   The FTL database is a sqlite3 database, it contains the data, required to populate pi-hole's admin website.

   Reference: https://www.phpliteadmin.org/download/

   You can browse this database by installing phpLiteAdmin. To enable this, run the following script (/home/pi/phpliteadmin.sh):

   Click on the icon to view the script in a browser. Copy the content and make the script executable (sudo chmod +x /home/pi/ phpliteadmin.sh). You can also use wget (click on Basic usage) to copy the script directly. Execute the script with 'sudo'!

   Make the script executable:

```
sudo chmod +x phpliteadmin.sh
```

   Run the script, assuming the current directory is /home/pi

```
sudo ./phpliteadmin.sh
```

To access the database (password: '**admin**'), browse to:

```
http://<your Raspberry pi's static address>/phpliteadmin.php
```

Information regarding the content of the database can be found here.

The database will be accessible in read-only mode, you cannot make any changes. To make the database writable, execute the following commands:

```
# Write permissions on the Database
sudo usermod -a -G pihole www-data
sudo chmod 775 /etc/pihole
sudo chmod 664 /etc/pihole/pihole-FTL.db
sudo chmod 664 /etc/pihole/gravity.db
sudo service lighttpd stop
sudo service lighttpd start
```

28. DoT / DoH

Pi-hole will only filter DNS requests, if your devices use pi-hole as their only DNS server. Some devices (example Chromecast), use a hard coded DNS server (example 8.8.8.8), the DNS requests from these devices will never be processed by pi-hole. To overcome this, it is necessary to implement a firewall rule, that redirects all DNS requests (port 53), **not originating from pi-hole**, to pi-hole.

Pi-hole cannot be used to filter DoT (DNS over TLS) requests, the DoT request will have a DOT server as destination, thus bypassing pi-hole. Fortunately, it's easy to block DoT requests on your network, by implementing a firewall rule that blocks port 853, thus effectively killing DoT.

Pi-hole cannot be used to filter DoH (DNS over HTTPS) requests, the DoH request will have a DoH server as destination, thus bypassing pi-hole. DoH cannot be easily blocked, because it uses port 443, which happens to be the same port, used for HTTPS.

Unfortunately, some applications have implemented DoH capability, thus allowing the application to completely ignore the systems DNS settings. Those applications will thus bypass pi-hole, and have unfiltered access to the internet.

Pi-hole implemented a way to prevent Firefox from using DoH, by ensuring the domain use-application-dns.net (canary domain) is resolved as an NXDOMAIN, thus informing Firefox to use the DNS system settings.

Pi-hole also implemented a way to warn the user he should use a specific network without using a Private Relay (icloud private Relay, the apple version of oDoH).

You can read more about this here (scroll down to section 6 – Network control, using DNS entries).

Other applications however, do not have a straight forward (or none at all) method, to ensure they don't use DoH. The only way to prevent these applications from using DoH, is to ensure the DoH destination server cannot be reached. There are a number of sites that list information, regarding existing DoH servers. Available to you now, compiled from several sources, updated daily, are two lists (DOHipv4.txt and DOHipv6.txt), you can use to implement a firewall rule, blocking port 443 for the destinations in the list. **You must ensure to block only port 443** for these IP's, the list contains the IP's for servers that reply to both port 443 and port 53, blocking all access to these IP's could possibly break pi-hole.

Unfortunately, some of the IP addresses in the above lists, cannot be blocked, as the IP is the destination for both DoH and content. For example, the DoH server dns.cloudflare.com has the same IP(s) as cdnjs.cloudflare.com, the later is used to serve some scripts, used by several by several websites, such as linuxquestions.org. If the IP for dns.cloudflare.com (DoH) is blocked, the webpage will load extremely slow, as it cannot load the required content. To overcome this, two additional lists (DOHexceptionsIPv4.txt and DOHexceptionsIPv6.txt) are provided. The idea here is to create exceptions (allow) these addresses for **specific devices only**.

In order to use the list(s), you will need to create a Firewall URL Table Alias and a firewall rule that blocks port 443 for the DoH server destinations, using the alias. **This will NOT be possible on all firewalls**, check your firewalls documentation.

A method to setup the required aliases and rules on pfsense, is described in this document.

29. Change Log

06-09-2019

- Updated version of phpliteadmin (v1.9.8.2) requires php-mbstring to be installed.

30-09-2019

- Added download link for MD5 & SHA Checksum utility.

22-11-2020

- Added backup / restore (clone) instructions.

05-03-2021

- Added AdguardTeam CNAME script.

29-08-2021

- Webmin 1.981 released.

01-09-2021

- Added "changing the hostname" section
- Added "install needrestart" section.

23-10-2021

- Pi-hole core v5.6, Pi-hole web v5.8, Pi-hole-FTL v5.11 released.

30-10-2021

Raspberry Pi OS Lite October 30th 2021 released.

11-11-2021

- Replaced **ntp** with **chrony**. When running bullseye, the **ntp** service is restarted whenever the DHCP lease reaches the renewal period (lease time 7200 seconds -> restart every 3600 seconds). This didn't occur with buster.