

# FreeBSD Wifibox

## Embedded Virtualized Wireless Router



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# What is this box?

**Embedded** | minimalistic operating system with low resource footprint

**Virtualized** | meant to be run in a virtual machine, with access to the hardware devices of the host

**Wireless** | focuses on hosting drivers and tools for running wireless network interface controllers

**Router** | exposes an IPv4/IPv6 interface over Network Address Translation for the host to communicate through *its own* wireless device

*Not a drop-in replacement for a FreeBSD wireless driver*

# Why is this box?

*Proof of concept: why not?*

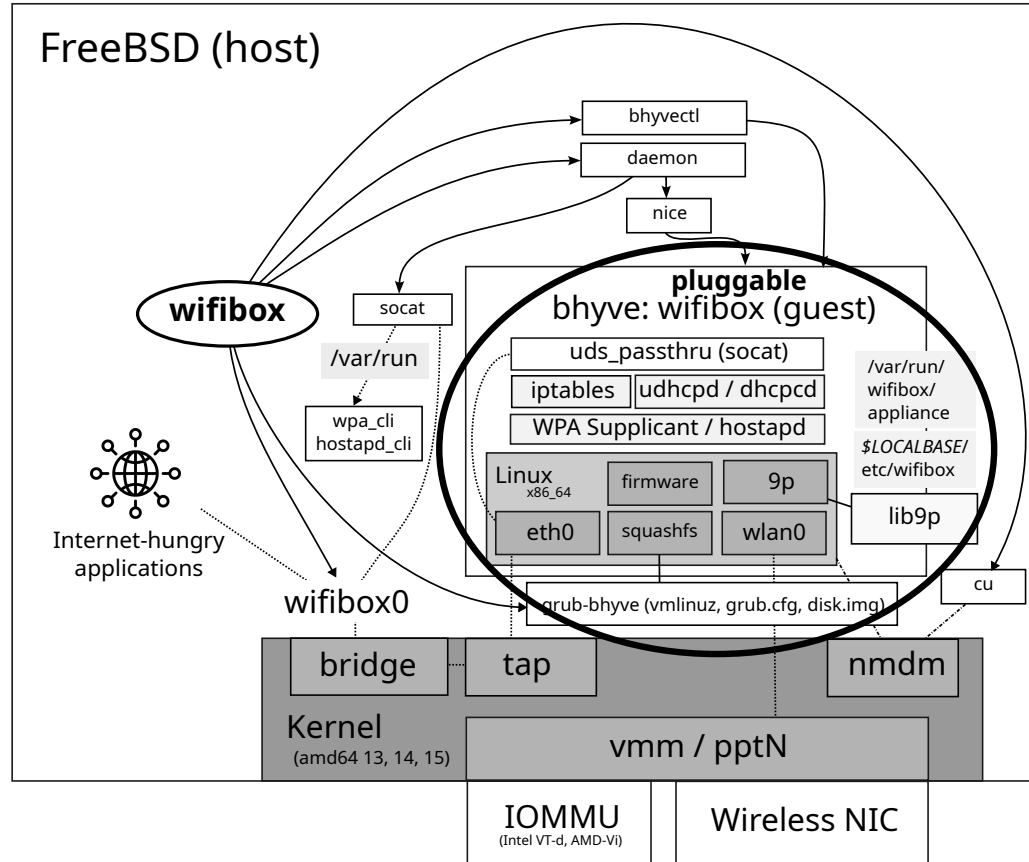
*Workaround:* the wireless support in FreeBSD has been aging and it takes a great effort to catch up with the recent developments while this is important for desktop use

*Relief:* remove stress from the developers of the native solution

*Availability of bhyve + PCI pass-through:* it would be a waste to not to leverage this excellent piece of work

*Old habits:* why to run a complete Linux system and why not to make it easier to use in this setting through ports?

# What is in this box?



# Wifibox/Alpine

The Wifibox “firmware” — Small Linux distribution derived from Alpine Linux

A FreeBSD port that uses native Alpine packages to build a SquashFS VM disk image

A mix of customized and standard packages, built on Alpine Linux using aports

Read-only root file system, with 9P mounts to the host and /tmp for writing

Various flavors and optional components (mDNSResponder, tcpdump etc)

Contains WPA Supplicant or hostapd (exclusively)

Includes wireless configuration and diagnostic tools (iw, rfkill, iptables)

Footprint: 40-64 MB RAM, 16-150 MB disk space

# Unboxing

Under \$LOCALBASE/etc/wifibox:

bhyve.conf

```
cpus=1
console=no
memory=128M
passthru=
priority=50
stop_wait_max=10
```

core.conf

```
loglevel=warn
```

appliance/hostname

```
wifibox
```

appliance/iptables

```
*filter
:INPUT ACCEPT [0:0]
:OUTPUT ACCEPT [0:0]
COMMIT
*nat
:INPUT ACCEPT [0:0]
:OUTPUT ACCEPT [0:0]
:PREROUTING ACCEPT [0:0]
:POSTROUTING ACCEPT [0:0]
[0:0] -A POSTROUTING -o wlan0 -j MASQUERADE
COMMIT
```

appliance/interfaces.conf

```
iface eth0 inet static
    address 10.0.0.1
    netmask 255.255.255.0

iface wlan0 dhcp
```

appliance/udhcpd.conf

```
start      10.0.0.2
end        10.0.0.254
max_leases 64
interface  eth0
opt subnet 255.255.255.0
opt router 10.0.0.1
opt dns    8.8.8.8
opt dns    %%DNS%%
opt lease  864000
```

wpa\_supplicant/wpa\_supplicant.conf

```
ctrl_interface=/var/run/wpa_supplicant
ctrl_interface_group=0
update_config=1

network={
    ...
}
```

# Unboxing

/boot/loader.conf or /etc/sysctl.conf

```
hw.vmm.amdvi.enable=1
```

/etc/rc.conf

```
wifibox_enable="YES"  
devmatch_enable="YES"  
devmatch_blocklist="if_iwm if_iwlwifi"  
ifconfig_wifibox0="SYNCDHCP"  
ifconfig_wifibox0_ipv6="inet6 fd00::1/64 accept_rtadv auto_linklocal"  
background_dhclient_wifibox0="YES"  
defaultroute_delay="0"
```

IPv4 static routing (slightly faster):

/etc/rc.conf

```
wifibox_enable="YES"  
defaultrouter="10.0.0.1"  
ifconfig_wifibox0="inet 10.0.0.2/24"
```

```
# service routing restart
```

```
# service devmatch start  
# kldunload if_iwm if_iwlwifi  
# service devd restart  
# service wifibox start  
# service netif start wifibox0
```

# Unboxing

Start, stop, or restart the whole or specific parts of the system:

```
# wifibox start [guest | netif | vmm]
# wifibox stop [guest | netif | vmm]
# wifibox restart [guest | netif | vmm]
```

Access the console (for troubleshooting):

```
# wifibox console
```

Information collection:

```
# wifibox status
# wifibox version
```

Alternatively:

```
# service wifibox start
# service wifibox stop
# service wifibox restart
```



# Unboxing

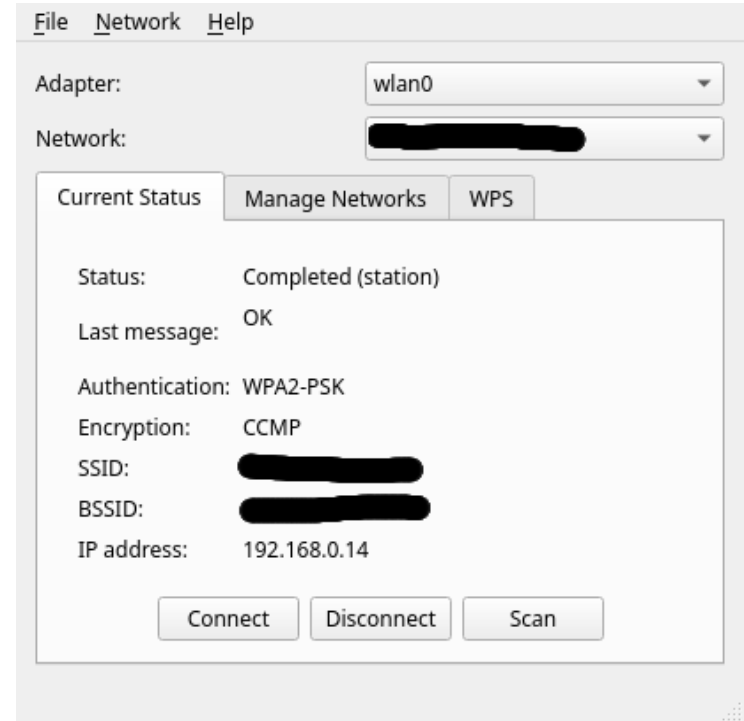
## “UNIX Domain Socket pass-through”

appliance/uds\_passthru.conf

```
network=10.0.0.1:255.255.255.0
```

```
_sockdir=/var/run/wpa_supplicant  
_perms="user=root,group=0,mode=770"  
sockets="path=${_sockdir}/wlan0,${_perms},port=1200  
path=${_sockdir}/p2p-dev-wlan0,${_perms},port=1201"
```

```
$ wpa_cli  
wpa_cli v2.10  
Copyright (c) 2004-2022, Jouni Malinen <j@w1.fi> and contributors  
  
This software may be distributed under the terms of the BSD license.  
See README for more details.  
  
Selected interface 'wlan0'  
  
Interactive mode  
  
> ping  
PONG  
> []
```



```

2024-09-15T09:22:49+0200 DEBUG Program started as /usr/local/sbin/wifibox, with arguments: stop
2024-09-15T09:22:49+0200 INFO Begin wifibox stop
2024-09-15T09:22:49+0200 DEBUG stopfn
2024-09-15T09:22:49+0200 INFO Tearing down Unix Domain Socket pass-through
2024-09-15T09:22:49+0200 INFO Daemonized socat processes found: [1007
1016]
2024-09-15T09:22:49+0200 DEBUG [socat] 2024/09/15 09:22:49 socat[1017] W exiting on signal 15
2024-09-15T09:22:49+0200 DEBUG [socat] 2024/09/15 09:22:49 socat[1008] W exiting on signal 15
2024-09-15T09:22:49+0200 INFO Stopping guest wifibox, managed by PID [633], GPID [633]
2024-09-15T09:22:49+0200 INFO Pulling bhyve options from configuration file
2024-09-15T09:22:49+0200 DEBUG cpus=2
2024-09-15T09:22:49+0200 DEBUG memory=64M
2024-09-15T09:22:49+0200 DEBUG passthru=[3/0/0]
2024-09-15T09:22:49+0200 DEBUG console=yes
2024-09-15T09:22:49+0200 DEBUG priority=25
2024-09-15T09:22:49+0200 DEBUG stop_wait_max=1
2024-09-15T09:22:49+0200 DEBUG bhyve_max_cpus=4
2024-09-15T09:22:49+0200 INFO Check if the guest is still running [1/1]: 955
2024-09-15T09:22:50+0200 INFO Grace period over, forcing shutdown of guest wifibox
2024-09-15T09:22:50+0200 INFO Destroying guest wifibox
2024-09-15T09:22:51+0200 INFO Pulling bhyve options from configuration file
2024-09-15T09:22:51+0200 DEBUG cpus=2
2024-09-15T09:22:51+0200 DEBUG memory=64M
2024-09-15T09:22:51+0200 DEBUG passthru=[3/0/0]
2024-09-15T09:22:51+0200 DEBUG console=yes
2024-09-15T09:22:51+0200 DEBUG priority=25
2024-09-15T09:22:51+0200 DEBUG stop_wait_max=1
2024-09-15T09:22:51+0200 DEBUG bhyve_max_cpus=4
2024-09-15T09:22:51+0200 INFO Destroying bhyve PPT device: pci3:0:0
2024-09-15T09:22:51+0200 INFO Unlinking tap interface from wifibox0: tap0
2024-09-15T09:22:51+0200 INFO Destroying linked tap interface: tap0
2024-09-15T09:22:51+0200 INFO Destroying bridge interface: wifibox0
2024-09-15T09:22:51+0200 INFO End: wifibox stop
2024-09-15T09:23:09+0200 DEBUG Program started as /usr/local/sbin/wifibox, with arguments: start
2024-09-15T09:23:09+0200 INFO Begin wifibox start
2024-09-15T09:23:09+0200 DEBUG startfn
2024-09-15T09:23:09+0200 INFO Creating bridge interface: wifibox0
2024-09-15T09:23:09+0200 DEBUG [ifconfig] wifibox0
2024-09-15T09:23:10+0200 INFO Linking tap interface to wifibox0: tap0
2024-09-15T09:23:10+0200 DEBUG Check location: kmod=vmx, kmod_files=/boot/kernel/vmx,ko
2024-09-15T09:23:10+0200 INFO vmx,ko is expected at path: /boot/kernel/vmx,ko
2024-09-15T09:23:10+0200 INFO vmx,ko is found at path: /boot/kernel/vmx,ko
2024-09-15T09:23:10+0200 DEBUG Hsnt: loaded: kmod=vmx, kmod_files=/boot/kernel/vmx,ko
2024-09-15T09:23:10+0200 INFO Hsnt: hardware support present: iommu=1, andvi=0
2024-09-15T09:23:10+0200 DEBUG Backends reported by bhyve:
2024-09-15T09:23:10+0200 DEBUG [bhyve] ahci
2024-09-15T09:23:10+0200 DEBUG [bhyve] ahci-hd
2024-09-15T09:23:10+0200 DEBUG [bhyve] ahci-rcd
2024-09-15T09:23:10+0200 DEBUG [bhyve] ei1000
2024-09-15T09:23:10+0200 DEBUG [bhyve] dummy
2024-09-15T09:23:10+0200 DEBUG [bhyve] hda
2024-09-15T09:23:10+0200 DEBUG [bhyve] huf
2024-09-15T09:23:10+0200 DEBUG [bhyve] and_hostbridge
2024-09-15T09:23:10+0200 DEBUG [bhyve] hostbridge
2024-09-15T09:23:10+0200 DEBUG [bhyve] lpc
2024-09-15T09:23:10+0200 DEBUG [bhyve] nvme
2024-09-15T09:23:10+0200 DEBUG [bhyve] passthru
2024-09-15T09:23:10+0200 DEBUG [bhyve] virtio-9p
2024-09-15T09:23:10+0200 DEBUG [bhyve] virtio-blk
2024-09-15T09:23:10+0200 DEBUG [bhyve] virtio-console
2024-09-15T09:23:10+0200 DEBUG [bhyve] virtio-input
2024-09-15T09:23:10+0200 DEBUG [bhyve] virtio-net
2024-09-15T09:23:10+0200 DEBUG [bhyve] virtio-nd
2024-09-15T09:23:10+0200 DEBUG [bhyve] virtio-scsi
2024-09-15T09:23:10+0200 DEBUG [bhyve] uart
2024-09-15T09:23:10+0200 DEBUG [bhyve] xhci
2024-09-15T09:23:10+0200 INFO Waiting for bhyve to start up
2024-09-15T09:23:10+0200 DEBUG Program started as /usr/local/sbin/wifibox, with arguments: _manage_vm
2024-09-15T09:23:10+0200 DEBUG Hsnt: daemonized: parent=daemon
2024-09-15T09:23:10+0200 INFO VM manager launched
2024-09-15T09:23:10+0200 INFO Gathering necessary configuration files for launching the guest
2024-09-15T09:23:10+0200 INFO Pulling bhyve options from configuration file
2024-09-15T09:23:10+0200 DEBUG cpus=2
2024-09-15T09:23:10+0200 DEBUG memory=64M
2024-09-15T09:23:10+0200 DEBUG passthru=[3/0/0]
2024-09-15T09:23:10+0200 DEBUG console=yes
2024-09-15T09:23:10+0200 DEBUG priority=25
2024-09-15T09:23:10+0200 DEBUG stop_wait_max=5
2024-09-15T09:23:10+0200 DEBUG bhyve_max_cpus=4
2024-09-15T09:23:10+0200 DEBUG Check location: kmod=ndm, kmod_files=/boot/kernel/ndm,ko
2024-09-15T09:23:10+0200 INFO ndm,ko is expected at path: /boot/kernel/ndm,ko

```

```

/usr/local/sbin/wifibox.log

```

```

Host: 4134K used, 5524K free, 232K shrd, OK buff, 1502K cached
CPU: 0.1% user 0.8% sys 0.0% nic 99.3% idle 0.0% to 0.0% irq 0.1% irq
Load average: 0.02 0.01 0.00 1/78 2086

```

PID	PPID	USER	STAT	VSZ	RVSZ	CPU	PCPU	COMMAND
1963	1417	root	R	1394	2.9	1	0.5	top
614	2	root	SM	0	0.0	1	0.1	[irq/40-tlwlwifi]
1103	1	dhepcd	S	1304	2.7	0	0.0	dhepcd: wlan0 [ip4] [ip6]
1277	1267	root	S	996	2.1	0	0.0	/usr/bin/socat TCP4-LISTEN:1200,rc
7	2	root	IW	0	0.0	0	0.0	[worker/0:0-mm.]
13	2	root	RM	0	0.0	1	0.0	[rcu_sched]
1001	1000	root	S	8916	18.9	1	0.0	/sbin/insu-supplicant -wlan0 -c/et
1278	1267	root	S	1388	2.9	1	0.0	{uds_passthru} /bin/sh /sbin/uds_p
1283	1267	root	S	1388	2.9	0	0.0	{uds_passthru} /bin/sh /sbin/uds_p
1267	1266	root	S	1388	2.9	0	0.0	{uds_passthru} /bin/sh /sbin/uds_p
1282	1267	root	S	1388	2.9	1	0.0	{uds_passthru} /bin/sh /sbin/uds_p
1417	1	root	S	1390	2.9	0	0.0	-sh
2026	1	root	S	1372	2.9	0	0.0	/usr/sbin/udhcpd -S /tmp/udhcp.co
1	0	root	S	1394	2.9	1	0.0	init
938	1	root	S	1394	2.9	0	0.0	/sbin/syslogd -b -m
1385	1	root	S	1384	2.9	1	0.0	/usr/sbin/crond -c /etc/crontabs -
1286	1283	root	S	1384	2.9	0	0.0	/bin/sleep 365d
1310	1	root	S	1384	2.9	0	0.0	/sbin/acpid -f
1171	1104	dhepcd	S	1232	2.7	1	0.0	dhepcd: [DHCP6 proxy] fe80::7e76:3
1104	1103	root	S	1288	2.7	0	0.0	dhepcd: [privileged proxy] wlan0 [

```

[ 0.000000] Linux version 6.6.50-0-lts (pg@wifibox-dev) (gcc (Alpine 13.2.1_git20240309), GNU ld (GNU Binutils) 2.42) #1-Alpine SMP Wed, 1
Sep 2024 06:28:02 +0000
[ 0.000000] Command line: console=ttyS0 BOOT_IMAGE=(host)/usr/local/share/wifibox/vmlinuz module=squashfs root=/dev/vda rootfstype=squashfs clocksourceshpe
t tsc=unstable
[ 0.000000] BIOS-provided physical RAM map:
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x00000000009fffff] usable
[ 0.000000] BIOS-e820: [mem 0x0000000001000000-0x00000000003fffff] usable
[ 0.000000] NX (Execute Disable) protection: active
[ 0.000000] APIC: Static calls initialized
[ 0.000000] SMBIOS 2.6 present.
[ 0.000000] DM: FreeBSDBHYVE/BHYVE, BIOS 13.0 11/10/2020
[ 0.000000] tsc: Detected 2500.000 MHz processor
[ 0.000009] e820: update [mem 0x00000000-0x00000fff] usable ==> reserved
[ 0.000013] e820: remove [mem 0x0000a000-0x000fffff] usable
[ 0.000015] last-pfn = 0x4000_max_arch_pfn = 0x400000000
[ 0.000141] MTRR: disabled by BIOS
[ 0.000147] x86/PAT: Configuration [0-7]: WB UC UC~ UC~ WB UP UC~ WT
[ 0.000182] Using GB pages for direct mapping
[ 0.000274] ACPI: Early table checksum verification disabled
[ 0.000277] ACPI: RSDP 0x0000000000f2400 000024 (v02 BHYVE )
[ 0.000282] ACPI: XSDT 0x0000000000f2470 00004c (v01 BHYVE BVXSDT 00000001 BSL 20220504)
[ 0.000288] ACPI: FACP 0x0000000000f24C0 000114 (v05 BHYVE BVFACP 00000001 BSL 20220504)
[ 0.000293] ACPI: DSDT 0x0000000000f2750 00066c (v02 BHYVE BVSDT 00000001 INTL 20201113)
[ 0.000465] ACPI: FACS 0x0000000000f2700 000040
[ 0.000469] ACPI: FRCS 0x0000000000f2700 000040
[ 0.000472] ACPI: APIC 0x0000000000f25E0 000062 (v01 BHYVE BVAPIC 00000001 BSL 20220504)
[ 0.000476] ACPI: HPET 0x0000000000f2650 000038 (v01 BHYVE BVHPET 00000001 BSL 20220504)
[ 0.000479] ACPI: MCFG 0x0000000000f2630 00003c (v01 BHYVE BVMGFC 00000001 BSL 20220504)
[ 0.000481] ACPI: SPCR 0x0000000000f2740 000050 (v01 BHYVE BVSPCR 00000001 BSL 20220504)
[ 0.000483] ACPI: Reserving FACP table memory at [mem 0xf24e0-0xf25d5]
[ 0.000485] ACPI: Reserving DSDT table memory at [mem 0xf2750-0xf275f]
[ 0.000486] ACPI: Reserving FACS table memory at [mem 0xf2700-0xf273f]
[ 0.000487] ACPI: Reserving FACP table memory at [mem 0xf25a0-0xf2541]
[ 0.000487] ACPI: Reserving APIC table memory at [mem 0xf2650-0xf2687]
[ 0.000488] ACPI: Reserving HPET table memory at [mem 0xf2630-0xf26cb]
[ 0.000488] ACPI: Reserving SPCR table memory at [mem 0xf2740-0xf278f]
[ 0.000511] system APIC only can use physical flat
[ 0.000515] APIC: Switched APIC routing to: physical flat
[ 0.000538] Zone ranges:

```

```

/usr/local/sbin/wifibox/app/patches/top/changes

```

# Wifibox vs. native drivers

## Pros

Already stable + fast and has been since FreeBSD 11.4

No direct interaction with the FreeBSD kernel, pure Linux

Includes a built-in firewall

Not shipped with the base system

## Cons

Works only on AMD64, requires Intel VT-d or AMD-Vi, a PCI device

Network Address Translation

Suspend / resume is not trivial

Bluetooth support

Not shipped with the base system

Less optimal CPU utilization

Longer suspend/resume cycle

# Final thoughts...

<https://github.com/pgj/freebsd-wifibox>

<https://github.com/pgj/freebsd-wifibox-port>

<https://github.com/pgj/freebsd-wifibox-alpine>

```
# pkg install wifibox
```

```
$ man wifibox
```

```
$ man wifibox-alpine
```

## Special thanks to

bhyve, Linux, and Alpine developers

Matt Churchyard (vm-bhyve)

Gábor Záhemszky (bsd.hu)

Ashish Shukla (FreeBSD)

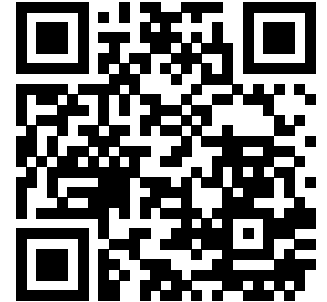
Michel Kohanim (Universal Devices)

John Grafton

Joshua Rogers

Björn Zeeb (FreeBSD)

YOU for trying it!



Slides ↓

