

Networking

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MAC Addresses

MAC OUI

Reserved OUIs

Addresses	Usage	Reference
00-00-00 to 00-00-FF	Reserved	[RFC7042]
00-01-00 to 00-01-FF	VRRP (Virtual Router Redundancy Protocol)	[RFC5798]
00-02-00 to 00-02-FF	VRRP IPv6 (Virtual Router Redundancy Protocol IPv6)	[RFC5798]
00-03-00 to 00-51-FF	Unassigned	
00-52-00	PacketPWEthA	[RFC6658]
00-52-01	PacketPWEthB	[RFC6658]
00-52-02	BFD for VXLAN	[RFC8971]
00-52-03 to 00-52-12	Unassigned (small allocations)	
00-52-13	Proxy Mobile IPv6	[RFC6543]
00-52-14 to 00-52-FF	Unassigned (small allocations)	
00-53-00 to 00-53-FF	Documentation	[RFC7042]
00-54-00 to 90-00-FF	Unassigned	
90-01-00	TRILL OAM	[RFC7455]
90-01-01 to 90-01-FF	Unassigned (small allocations requiring both unicast and multicast)	
90-02-00 to FF-FF-FF	Unassigned	

[Source](#)

OUIs of virtualization platforms

Company and Products	MAC unique identifier (s)
VMware ESX 3, Server, Workstation, Player	00-50-56, 00-0C-29, 00-05-69
Microsoft Hyper-V, Virtual Server, Virtual PC	00-03-FF 00-15-5D
Parallels Desktop, Workstation, Server, Virtuozzo	00-1C-42
Virtual Iron 4	00-0F-4B
Red Hat Xen	00-16-3E
Oracle VM	00-16-3E
XenSource	00-16-3E
Novell Xen	00-16-3E
Sun xVM VirtualBox	08-00-27

[Source](#)

End

Microsoft Network Monitor

I had never heard of this tool until today... I've always used Wireshark. Today I needed to view traffic broken out by application (PID/ProcessName). I went hunting and found the Microsoft Network Monitor. Surprisingly it's very feature rich, easy to use, and did exactly what I needed it to do... and sooo much more. Check it out!

Microsoft Links

- [Information about Network Monitor 3](#)
- [Download Microsoft Network Monitor 3.4 \(archive\)](#)

Example Filters

Capturing everything except RDP:

```
!(tcp.port==3389)
```

Capture only DNS:

```
DNS
```

Filter Source or Destination IPv4 Address:

```
IPv4.Address == 1.1.1.1
```

Filter Source IPv4 Address:

```
IPv4.SourceAddress == 1.1.1.1
```

Filter IPV4 Source and Destination:

```
IPv4.Address==1.1.1.1 and IPv4.Address==2.2.2.2
```

Filter IPv4 Source or Destination to subnet:

```
((ipv4.Address & 255.0.0.0) == 10.0.0.0)
```

Filter IPv4 traffic to private only traffic (source and destination in RFC-1918 private subnets):

```
((IPv4.SourceAddress & 255.0.0.0) == 10.0.0.0) || ((IPv4.SourceAddress & 255.240.0.0) == 172.16.0.0) ||  
((IPv4.SourceAddress & 255.255.0.0) == 192.168.0.0))  
&&  
(((IPv4.DestinationAddress & 255.0.0.0) == 10.0.0.0) || ((IPv4.DestinationAddress & 255.240.0.0) ==  
172.16.0.0) || ((IPv4.DestinationAddress & 255.255.0.0) == 192.168.0.0))
```

Filter CDP traffic

```
Ethernet.Address == 01-00-0c-cc-cc-cc
```

Filter LLDP traffic

```
LLDP
```

Filter Mikrotik MNDP traffic

Microsoft netmon has no protocol disassembler for the MNDP protocol. All you will see is a UDPPayloadData Binary Large Object, however, you can see data in the Hex Details view and can extract the data you need from there fairly easily.

```
(udp.DstPort==5678 AND udp.SrcPort==5678)
```

Filter CDP + LLDP + MNDP

```
Ethernet.Address == 01-00-0c-cc-cc-cc  
OR  
LLDP  
OR  
(udp.DstPort==5678 AND udp.SrcPort==5678)
```

Filter traffic by ProcessName

The filter below allows you to see if a process is communicating with any other IP address besides the one you listed:

```
ProcessName.Contains("WindTerm.exe") && IPv4.Address!= 9.9.9.9
```

Filtering NPS + Azure MFA

The Azure MFA NPS Extension uses HTTPS to communicate with login.microsoftonline.com and credentials.azure.com. The filters below enable capturing related traffic.

Suggested capture filter:

```
// Suggested capture filter
tcp.port == 443      // HTTPS
OR udp.port == 1812  // RADIUS
OR DNS.Qrecord.QuestionName.contains("login.microsoftonline.com")
OR DNS.Qrecord.QuestionName.contains("credentials.azure.com")
```

Suggested display filter:

```
// Suggested display filter
udp.port==1812 // RADIUS packets
OR DNS.Qrecord.QuestionName.contains("login.microsoftonline.com")
OR DNS.Qrecord.QuestionName.contains("credentials.azure.com")
OR ContainsBin(FrameData, ASCII, "login.microsoftonline.com") // Will show HTTPS certificate negotiation
packets
OR ContainsBin(FrameData, ASCII, "credentials.azure.com") // Will show HTTPS certificate negotiation packets
OR ((ipv4.SourceAddress & 255.255.0.0) == 20.190.0.0) || ((ipv4.DestinationAddress & 255.255.0.0) ==
20.190.0.0)
OR ((ipv4.SourceAddress & 255.255.0.0) == 40.126.0.0) || ((ipv4.DestinationAddress & 255.255.0.0) ==
40.126.0.0)
```

Example on other sites:

- [Network Monitor Filter Examples](#)

Running nmcap from the cmd prompt

Run the following command from anywhere to view the command line usage.

```
"C:\Program Files\Microsoft Network Monitor 3\nmcap.exe" /usage
```

Run the following command from anywhere to view the network adapters.

```
"C:\Program Files\Microsoft Network Monitor 3\nmcap.exe" /displaynetworks
```

After determining the network adapter you would like to perform the capture on, grab the command below, update the capture network interface, the capture filter, and the stop / start conditions.

```
"C:\Program Files\Microsoft Network Monitor 3\nmcap.exe" /network 4 /capture "dns || icmp || ((ipv4.Address & 255.255.248.0) == 104.244.40.0)" /CaptureProcesses /file C:\tmp\nmcap-capture-testing.cap /TerminateWhen /KeyPress x /StopWhen /TimeAfter 30 min
```

Running nmcap from PowerShell

Run the following command from anywhere to view the command line usage.

```
& 'C:\Program Files\Microsoft Network Monitor 3\nmcap.exe' /usage
```

Run the following command from anywhere to view the network adapters.

```
& 'C:\Program Files\Microsoft Network Monitor 3\nmcap.exe' /displaynetworks
```

After determining the network adapter you would like to perform the capture on, grab the command below, update the capture network interface, the capture filter, and the stop / start conditions.

```
& 'C:\Program Files\Microsoft Network Monitor 3\nmcap.exe' /network 4 /capture "dns || icmp || ((ipv4.Address & 255.255.248.0) == 104.244.40.0)" /CaptureProcesses /file C:\tmp\nmcap-capture-testing.cap /TerminateWhen /KeyPress x /StopWhen /TimeAfter 30 min
```

nmcap full command line usage

```
PS C:\> & 'C:\Program Files\Microsoft Network Monitor 3\nmcap.exe' /usage
Network Monitor Command Line Capture (nmcap) 3.4.2350.0
```

Options:

/Help /? /Usage

Displays this message.

Example Usage: nmcap /Usage

/Example(s)

Displays a list of examples.

Example Usage: nmcap /Example

nmcap /examples

/TimeFormat

Displays the list of date and time formats available for the /Time switch.

Example Usage: nmcap /TimeFormat

/DisplayNetwork(s)

Displays the network adapters that Network Monitor can capture from.

Example Usage: nmcap /DisplayNetwork

nmcap /displaynetworks

/SetNplPath <path>[;<path>;...]

Builds a profile titled "NMCap Last Path" and attempts to compile.

If compilation is successful, the new profile is set as active.

If the provided NPL cannot compile, the Active Profile is unchanged.

On success, any existing "NMCap Last Path" profile is updated.

/DisplayNplPath

Displays the NPL path.

Example Usage: nmcap /DisplayNplPath

Note:

Nmcap gets the NPL files in the following order:

- 1) Files in the current directory
- 2) Files in the path set by /SetNplPath
- 3) Default NMCap installation directory

/DisplayProfiles

Display the installed profiles.

/DisplayProfileInfo <Profile Key>

Display detailed information for the indicated profile.

A Profile Key can be either the GUID or the Index displayed when using the /DisplayProfiles argument.

/UseProfile <Profile Key>

Use an alternate profile for the capture session. This setting must be before any /Capture arguments. Otherwise, the active profile is used.

A Profile Key can be either the GUID or the Index displayed when using the /DisplayProfiles argument.

`/SetActiveProfile <Profile Key>`

Set the active profile for to the indicated profile. This setting changes the default profile for other Network Monitor applications, as well.

A Profile Key can be either the GUID or the index displayed when using the /DisplayProfiles argument.

`/DeleteProfile <Profile Key>`

Delete the indicated profile.

Only user-defined profiles can be deleted.

A Profile Key can be either the GUID or the index displayed when using the /DisplayProfiles argument.

`/SetDefaultParser [NplFileName.npl]`

Specifies the default NPL parser

Example Usage: `nmcap /SetDefaultParser sparser.npl`

`/DisplayDefaultParser`

Displays the default NPL parser.

Example Usage: `nmcap /DisplayDefaultParser`

Note: If you do not explicitly set the default parser using

`/SetDefaultParser`, `/DisplayDefaultParser` does not display anything.

`/MaxFrameLength <Number of Bytes>`

Specifying the Max Frame Length limits the number of bytes captured per frame to the specified value. If you enter a value of 68, every frame is truncated to the first 68 bytes. This has an impact on filtering because the filter may require elements defined in the frame which are no longer present as a result of the truncation.

Example Usage: The following captures all traffic on all adapters and limits the captured data to the first 68 bytes.

`nmcap /network * /MaxFrameLength 68`

Note: This does not apply to frames retrieved from /inputcapture files.

The following options are used together and have no meaning independently.

Refer to the examples to better understand how they can be used together.

Specifying Input Sources:

`/Network <Network Adapter> [<network Adapter> ...]`

Selects one or more space-delimited network adapters to capture from.

Adapters may be specified using their index, partial name with wildcard (*), or quoted friendly name. (find using `/DisplayNetwork` above).

Example Usage: `/Network inte* 2 'Local Area Connection 1'`

`/InputCapture <CaptureFile> [<CaptureFile> ...]`

Selects one or more space-delimited capture files to capture from.

The frames in the capture files are replayed through NMCap.

Example Usage: `/InputCapture dns.cap tcp.cap c:\temp\test.cap`

`/DisableConversations`

Disables conversations. This enhances the performance of

NMCap. Some protocols such as MSRPC require conversation to be enabled.

Example Usage: `/DisableConversations`

`/CaptureProcesses`

Enables process tracking. This is incompatible with the

`/DisableConversations` switch as process tracking requires conversations.

Example Usage: `/CaptureProcesses`

`/DisableLocalOnly`

Disables local-only capture. This enables the capture in p-mode. All frames seen by this computer are captured.

Example Usage: `/DisableLocalOnly`

`/RecordFilters`

Records the capture filters in the capture file.

Example Usage: `/RecordFilters`

`/RecordConfig`

Records the network configuration in the capture file.

Example Usage: `/RecordConfig`

`/MinDiskQuotaPercentage <Minimal Disk Size Percentage>`

Specifies the minimal disk size percentage allowed.

Note: Default minimal disk size percentage is 2 percent.

Example Usage: `/MinDiskQuotaPercentage 20`

(Sets the minimal disk size percentage to 20 percent.)

`/MinDiskQuota:<Minimal disk Size>`

Specifies the minimal disk size allowed.

Example Usage: `/MinDiskQuota 20M`

(Sets the minimal disk size to 20 MB.)

`/Frame <Filter>`

Frame filter. The frame filter is constructed from the NPL files.

You can use all the filter expressions that you can in the Netmon UI.

For more sample filters, type `nmcap /Examples` or see Standards Filter in the Filter Toolbar of the UI.

This switch must be part of `/StartWhen`, `/StopWhen`, and `/TerminateWhen`.

Example Usage: `/Frame Dns.Flags.Stats == 3`

Capture File output:

`/Capture [FrameFilter] /File <CaptureFile> [/File <CaptureFile>...]`

Saves frames that pass the frame filter to the specified capture files.

Example Usage: `/Capture dns.flags.status == 3 /File t.cap /File t2.cap`

`/ReassembleCapture [FrameFilter] /File <CaptureFile> [/File <CaptureFile>...]`

An alternate to Capture (above) Saves frames that pass the frame filter to the specified capture files, along with reassembled payloads.

Example Usage: `/ReassembleCapture tcp /File tcp.cap /File tcp2.cap`

`/File <Capture File>[:<File Size Limit>]`

Name of capture file to save frames to. Extensions are used to determine the behavior of NMCap.

`.cap` -- Netmon 2 capture file

`.chn` -- Series of Netmon 2 capture files: `t.cap`, `t(1).cap`, `t(2).cap`...

`<File Size Limit>` is optional. It limits the file size of each capture file generated. Default single capture file size limit is 20 MB. The upper bound of the file size limit is 500 MB. The lower bound of the file size limit depends on the frame size captured. (Note that the maximal size of Ethernet frames is 1500 bytes)

The files are circular, so once the size limit is reached, new data overwrites older data.

Example Usage: `/File t.cap:50M`

Starting, stopping, and events:

`/StartWhen <Command Line Switch>`

List of conditions that specify when to start capturing network frames.

If it is ignored, NMCap starts capturing immediately. When input from capture files by `/InputCapture`, this switch is generally ignored.

Example Usage: `/StartWhen /Time 7:02:00 AM 9/10/2005`

`/StopWhen <Command Line Switch>`

List of conditions that specify when to stop capturing network frames.

Example Usage: `/StopWhen /TimeAfter 20 min`

This switch becomes active only after a preceding `/StartWhen` evaluates to TRUE.

Example: `/StartWhen /TimeAfter 10 min ... /StopWhen /TimeAfter 20 min`

Nmcap starts after 10 minutes and stops after $10+20=30$ minutes.

`/StopWhen` never terminates the program while the `/StartWhen` option is set to FALSE. `/TerminateWhen` should be used to safely terminate immediately.

`/TimeAfter <number>[units]`

Indicates a time period. This switch can be part of `/StartWhen`, `/StopWhen`, and `/TerminateWhen`. The user specifies the time units. By default it is in seconds.

Example Usage: `/TimeAfter 20 seconds`

`/Time <Time/Date>`

Indicates a time of day. This switch can be part of `/StartWhen`, `/StopWhen`, and `/TerminateWhen`. The time and date format depends on the settings in the 'Region and Language' Control Panel.

Example Usage: `/Time 10:30:00 AM 9/10/2005`

`/TerminateWhen <Command Line Switch>`

This switch terminates NMCap immediately once it evaluates to TRUE.

Example Usage: `/TerminateWhen /KeyPress x`

Note:

The default relationship among the conditions following `/Startwhen`, `/Stopwhen`, and `/TerminateWhen` is AND and the order is sensitive.

For example: `/TerminateWhen /Timeafter 10 min /KeyPress x`

Nmcap terminates after 10 minutes have passed and the user presses the 'x' key.

And: `/TerminateWhen /KeyPress x /Timeafter 10 min`

Nmcap terminates 10 minutes after the user press 'x' key.

`/KeyPress <character>`

Specifies which key to press. This switch can be part of `/StartWhen`, `/StopWhen`, and `/TerminateWhen`.

Example Usage: `/KeyPress z`

-end

Netplan, Bonding, and VLANs

Creating a bond interface with Netplan

The example below shows two Ethernet interfaces bonded using the active-passive mode.

The following packages are required: ifenslave and vlan

```
network:
  version: 2
  ethernets:
    enp1s0:
      dhcp4: no
      optional: true
    enp2s0:
      dhcp4: no
      optional: true
  # match all other ports if desired
  ethernetPorts:
    dhcp4: no
    optional: true
    match:
      name: eth*|em*|en*
  bonds:
    bond0:
      interfaces: [ enp1s0, enp2s0, ethernetPorts ]
      addresses: [ 192.168.168.115/24 ]
      gateway4: 192.168.168.1
      nameservers:
        search: [ mydomain.com ]
        addresses: [ 192.168.168.1, 8.8.8.8, 8.8.4.4 ]
      parameters:
        mode: active-backup
        primary: enp1s0
        primary-reselect-policy: always
```

```
mii-monitor-interval: 100
up-delay: 3s # must be a multiple of mii-monitor-interval, make sure its longer than STP/RSTP/MSTP
learning interval also
# routes:
# - to: 10.0.0.0/8
#   via: 192.168.168.1
# - to: 172.16.0.0/12
#   via: 192.168.168.1
# - to: 192.168.0.0/16
#   via: 192.168.168.1
```

Notes:

- "**optional: true**" instructs Netplan to boot the operating system even if the network interface is unavailable or not connected or unavailable. Without this option, the system will not fully boot until all network cables are connected.
- "**mii-monitor-interval: 100**" must be set to some value or link up / down events will not actually be detected. A value of zero, which is the default, will disable the detection of interface changes, which seems rather counter-intuitive when we're configuring the mode as active-backup.
- "**up-delay: 10000**" prevents packet loss when connecting an interface. It must be a multiple of the mii-monitor-interval value.

Using a VLAN on a bond interface

This is a configuration using from Ubuntu 18.04 LTS. Two Ethernet interfaces are bonded using the active-passive mode. The untagged bond0 interface is for private traffic, while a public IP address is being delivered to a tagged VLAN sub interface using VLAN 262.

The following packages are required: ifenslave and vlan

```
network:
  version: 2
  ethernets:
    enp1s0:
      dhcp4: no
      optional: true
    enp2s0:
      dhcp4: no
      optional: true
  # match all other ports if desired
  ethernetPorts:
```

```

dhcp4: no
optional: true
match:
  name: eth*|em*|en*
bonds:
  bond0:
    interfaces: [ enp1s0, enp2s0, ethernetPorts ]
    addresses: [ 192.168.168.115/24 ]
    parameters:
      mode: active-backup
      primary: enp1s0
      primary-reselect-policy: always
      mii-monitor-interval: 100
      up-delay: 3s # must be a multiple of mii-monitor-interval, make sure its longer than STP/RSTP/MSTP
learning interval also
#   routes:
#     - to: 10.0.0.0/8
#       via: 192.168.168.1
#     - to: 172.16.0.0/12
#       via: 192.168.168.1
#     - to: 192.168.0.0/16
#       via: 192.168.168.1

vllans:
  bond0.262:
    id: 262
    link: bond0
    addresses: [ 1.1.1.123/28 ]
    gateway4: 1.1.1.113
    nameservers:
      search: [ servers.domain.com ]
      addresses: [ 1.1.1.113, 8.8.8.8, 8.8.4.4 ]

```

systemd-networkd-wait-online.service

Ubuntu 22.04

In Ubuntu 22.04, even though the netplan configuration is correct, the service systemd-networkd-wait-online.service will wait for 120 seconds if one of the network interfaces is not connected.

In order to get around this, one solution is to add the "--any" option to the ExecStart line as shown below. You can also reduce the default timeout from 120 seconds to 10 seconds by adding the "--timeout=10" option.

On Ubuntu, the file is located at /etc/systemd/system/

On Debian, the file is located at /var/lib/systemd/system/

```
[Unit]
Description=Wait for Network to be Configured
Documentation=man:systemd-networkd-wait-online.service(8)
DefaultDependencies=no
Conflicts=shutdown.target
Requires=systemd-networkd.service
After=systemd-networkd.service
Before=network-online.target shutdown.target

[Service]
Type=oneshot
ExecStart=/lib/systemd/systemd-networkd-wait-online --any --timeout=10
RemainAfterExit=yes

[Install]
WantedBy=network-online.target
```

Alternatively, you could just disable and mask the service altogether as it actually isn't needed. If you are going to disable the service, I would strongly recommend adding the two options shown above in addition just in case the service gets re-enabled in the future.

Debian 11 (Raspberry Pi)

On a Raspberry Pi running Debian 11.5, we had a similar issue. We never were able to get rid of the message, but making the above configuration changes made sure the system booted properly regardless of how many Ethernet interfaces were physically connected to switches at boot time.

Error during boot:

```
[FAILED] Failed to start Wait for Network to be Configured.
See 'systemctl status systemd-networkd-wait-online.service' for details.
```

Output from systemctl status commands:

```
# OUTPUT FROM systemctl status systemd-networkd-wait-online.service
systemd-networkd-wait-online.service - Wait for Network to be Configured
```

Loaded: loaded (/lib/systemd/system/systemd-networkd-wait-online.service; enabled-runtime; vendor preset: disabled)

Active: failed (Result: exit-code) since Thu 2023-05-18 17:10:59 BST; 2min 44s ago

Docs: man:systemd-networkd-wait-online.service(8)

Process: 189 ExecStart=/lib/systemd/systemd-networkd-wait-online (code=exited, status=1/FAILURE)

Main PID: 189 (code=exited, status=1/FAILURE)

CPU: 148ms

Aug 07 14:25:36 6230dea99f07e90f52b5f68b systemd[1]: Starting Wait for Network to be Configured...

May 18 17:10:59 6230dea99f07e90f52b5f68b systemd-networkd-wait-online[189]: Event loop failed: Connection timed out

May 18 17:10:59 6230dea99f07e90f52b5f68b systemd[1]: systemd-networkd-wait-online.service: Main process exited, code=exited, status=1/FAILURE

May 18 17:10:59 6230dea99f07e90f52b5f68b systemd[1]: systemd-networkd-wait-online.service: Failed with result 'exit-code'.

May 18 17:10:59 6230dea99f07e90f52b5f68b systemd[1]: Failed to start Wait for Network to be Configured.

References

<https://netplan.io/examples>

<https://www.freedesktop.org/software/systemd/man/systemd-networkd-wait-online.service.html>

OSPF

OSPF Cost

cost = reference bandwidth / configured bandwidth of interface in kbps

reference bandwidth = 100,000 kbps

Interface speed	OSPF Cost
100 Mbps	1
10 Mbps	10
6 Mbps	17
5 Mbps	20
4 Mbps	25
3 Mbps	33
2 Mbps	50
1.5 Mbps	67
1 Mbps	100
768 Kbps	130
512 Kbps	195
384 Kbps	260
256 Kbps	391
128 Kbps	781
64 Kbps	1563

Ruckus / Brocade

Links

<https://robrobstation.com/2017/07/17/ruckus-icx7150-c12p-initial-configuration/>

The Most Common OpenSSL Commands

General OpenSSL Commands

These commands allow you to generate CSRs, Certificates, Private Keys and do other miscellaneous tasks.

Generate a new private key and Certificate Signing Request

```
openssl req -out CSR.csr -new -newkey rsa:2048 -nodes -keyout privateKey.key
```

Generate a self-signed certificate (see [How to Create and Install an Apache Self Signed Certificate](#) for more info)

```
openssl req -x509 -sha256 -nodes -days 365 -newkey rsa:2048 -keyout privateKey.key -out certificate.crt
```

Generate a certificate signing request (CSR) for an existing private key

```
openssl req -out CSR.csr -key privateKey.key -new
```

Generate a certificate signing request based on an existing certificate

```
openssl x509 -x509toreq -in certificate.crt -out CSR.csr -signkey privateKey.key
```

Remove a passphrase from a private key

```
openssl rsa -in privateKey.pem -out newPrivateKey.pem
```

Checking Using OpenSSL

If you need to check the information within a Certificate, CSR or Private Key, use these commands. You can also check CSRs and check certificates using our [online tools](#).

Check a Certificate Signing Request (CSR)

```
openssl req -text -noout -verify -in CSR.csr
```

Check a private key

```
openssl rsa -in privateKey.key -check
```

Check a certificate

```
openssl x509 -in certificate.crt -text -noout
```

Check a PKCS#12 file (.pfx or .p12)

```
openssl pkcs12 -info -in keyStore.p12
```

Debugging Using OpenSSL

If you are receiving an error that the private doesn't match the certificate or that a certificate that you installed to a site is not trusted, try one of these commands. If you are trying to verify that an SSL certificate is installed correctly, be sure to check out the [SSL Checker](#).

Check an MD5 hash of the public key to ensure that it matches with what is in a CSR or private key

```
openssl x509 -noout -modulus -in certificate.crt | openssl md5  
openssl rsa -noout -modulus -in privateKey.key | openssl md5  
openssl req -noout -modulus -in CSR.csr | openssl md5
```

Check an SSL connection. All the certificates (including Intermediates) should be displayed

```
openssl s_client -connect www.paypal.com:443
```

Converting Using OpenSSL

These commands allow you to convert certificates and keys to different formats to make them compatible with specific types of servers or software. For example, you can convert a normal PEM file that would work with Apache to a PFX (PKCS#12) file and use it with Tomcat or IIS. Use our [SSL Converter](#) to convert certificates without messing with OpenSSL.

Convert a DER file (.crt .cer .der) to PEM

```
openssl x509 -inform der -in certificate.cer -out certificate.pem
```

Convert a PEM file to DER

```
openssl x509 -outform der -in certificate.pem -out certificate.der
```

Convert a PKCS#12 file (.pfx .p12) containing a private key and certificates to PEM

```
openssl pkcs12 -in keyStore.pfx -out keyStore.pem -nodes
```

You can add -nocerts to only output the private key or add -nokeys to only output the certificates.

Convert a PEM certificate file and a private key to PKCS#12 (.pfx .p12)

```
openssl pkcs12 -export -out certificate.pfx -inkey privateKey.key -in certificate.crt -certfile CACert.crt
```

[Source](#)

Wireshark

Capture Filters

MAC address OUI

[Source](#)

```
# haven't figured this capture filter out yet... display filter is easy...
```

bootp and dhcp

[Source](#)

```
port 67 or port 68
```

Name resolution protocols

DNS

Cisco Discovery Protocol

```
udp port 53
```

mDNS

multicast DNS

```
udp port 5353
```

LLMNR

Link-local multicast name resolution


```
udp port 5355
```

All together now

```
udp port 53 or udp port 5353 or udp port 5355
```

Network discovery protocols

An easy way to view discovery protocol traffic from a laptop is by using Wireshark and the capture filters below for CDP, LLDP and MNDP. Use the appropriate capture filter for the type of device you're trying to gather information about, or use all three of them in the same capture filter.

CDP

Cisco Discovery Protocol

```
ether host 01:00:0c:cc:cc:cc and ether[16:4] = 0x0300000C and ether[20:2] == 0x2000
```

LLDP

Link Layer Discovery Protocol

```
ether proto 0x88cc
```

MNDP

Mikrotik Discovery Protocol

```
udp dst port 5678 and udp src port 5678
```

CDP/LLDP/MNDP

All three of the above capture filters in one:

```
(ether host 01:00:0c:cc:cc:cc and ether[16:4] = 0x0300000C and ether[20:2] == 0x2000) or (ether proto 0x88cc) or (udp dst port 5678 and udp src port 5678)
```

Capturing on an interval in Linux

The command below will capture all traffic to/from 8.8.8.8. A new capture file will be created every 600 seconds (10 minutes).

```
dumpcap -b duration:600 -f "host 8.8.8.8" -w capture-google
```

Mikrotik Packet Capture Streaming

To accept only TZSP traffic, Capture Filter like this can be used:

```
udp port 37008
```

Note that TZSP can be sent on any UDP port you set it to, so adjust the above capture as needed.

Using tshark

Interface List

This is typically needed when running tshark on Windows.

```
tshark -D  
tshark -i <interface_id>
```

Capture Filter

```
# capture only udp dns packets  
tshark -f "udp port 53"
```

Saving Packets

```
# save packets (doesn't display packets)  
tshark -f "udp port 37008" -w captured.pcap  
  
# save and display packets  
tshark -f "udp port 37008" -w captured.pcap -P  
  
# save and display packets with LOTS of detail  
tshark -f "udp port 37008" -w captured.pcap -P -O dns -V
```

Automatic stop

Options are duration:[seconds], filesize:[KB], and files:[n].

```
tshark -a duration:60  
tshark -a filesize:1000
```

Ring Buffer Capture

```
tshark -b duration:3600 -b filesize:1000 -b files:24 -w ring_buffer.pcap  
tshark -b duration:86400 -b filesize:1000 -b files:30 -w ring_buffer.pcap
```

Practical examples

```
# TZSP stream capture on specific interface  
tshark -f "udp port 37008" -i 5  
  
# TZSP stream capture on alternate udp port, uses decode as feature  
tshark -f "udp port 37091" -d udp.port==37091,tzsp
```

Finding listening ports on any operating system

ss - the new netstat

```
# show number listening process  
ss -nlp | grep -e ^tcp -e ^tcp6 -e ^udp -e ^udp6
```

Output

```
udp UNCONN 0 0 127.0.0.53%lo:53 0.0.0.0:* users:(("systemd-  
resolve",pid=1985,fd=13))  
udp UNCONN 0 0 10.32.57.255:137 0.0.0.0:*  
users:(("nmbd",pid=2033,fd=16))  
udp UNCONN 0 0 10.32.57.3:137 0.0.0.0:*  
users:(("nmbd",pid=2033,fd=15))  
udp UNCONN 0 0 0.0.0.0:137 0.0.0.0:* users:(("nmbd",pid=2033,fd=13))  
udp UNCONN 0 0 10.32.57.255:138 0.0.0.0:*  
users:(("nmbd",pid=2033,fd=18))  
udp UNCONN 0 0 10.32.57.3:138 0.0.0.0:*  
users:(("nmbd",pid=2033,fd=17))  
udp UNCONN 0 0 0.0.0.0:138 0.0.0.0:* users:(("nmbd",pid=2033,fd=14))  
udp UNCONN 0 0 0.0.0.0:44900 0.0.0.0:* users:(("avahi-  
daemon",pid=2020,fd=14))  
udp UNCONN 0 0 0.0.0.0:5353 0.0.0.0:* users:(("avahi-  
daemon",pid=2020,fd=12))  
udp UNCONN 0 0 [::]:33933 [::]:* users:(("avahi-  
daemon",pid=2020,fd=15))  
udp UNCONN 0 0 [::]:5353 [::]:* users:(("avahi-  
daemon",pid=2020,fd=13))
```

tcp	LISTEN	0	4096	127.0.0.53%lo:53	0.0.0.0:*	users:(("systemd- resolve",pid=1985,fd=14))
tcp	LISTEN	0	128	0.0.0.0:22	0.0.0.0:*	users:(("sshd",pid=2231,fd=3))
tcp	LISTEN	0	10	127.0.0.1:25	0.0.0.0:*	users:(("sendmail- mta",pid=2872,fd=4))
tcp	LISTEN	0	50	0.0.0.0:445	0.0.0.0:*	users:(("smbd",pid=2438,fd=46))
tcp	LISTEN	0	16	127.0.0.1:3493	0.0.0.0:*	users:(("upsd",pid=2410,fd=4))
tcp	LISTEN	0	80	127.0.0.1:3306	0.0.0.0:*	users:(("mariadb",pid=2367,fd=28))
tcp	LISTEN	0	10	127.0.0.1:587	0.0.0.0:*	users:(("sendmail- mta",pid=2872,fd=5))
tcp	LISTEN	0	50	0.0.0.0:139	0.0.0.0:*	users:(("smbd",pid=2438,fd=47))
tcp	LISTEN	0	128	:::22	:::*	users:(("sshd",pid=2231,fd=4))
tcp	LISTEN	0	50	:::445	:::*	users:(("smbd",pid=2438,fd=44))
tcp	LISTEN	0	16	:::1:3493	:::*	users:(("upsd",pid=2410,fd=5))
tcp	LISTEN	0	50	:::139	:::*	users:(("smbd",pid=2438,fd=45))

#end

Microsoft netsh trace

Basic

Start the trace:

```
netsh trace start capture=yes Ethernet.Type=IPv4
```

Stop the trace:

```
netsh trace stop
```

Files will be created in %AppData%\Local\Temp\NetTraces

View ETL in Microsoft Network Monitor 3.4

If you load the ETL in Microsoft Network Monitor 3.4, you will see the following error in the packet display:

MicrosoftWindowsNDISPacketCapture: Windows stub parser: Requires full Common parsers. See the "How Do I Change Parser Set Options(Version 3.3 or before) or Configure Parser Profile (Version 3.4)" help topic for tips on loading these parser sets.

To fix this you need to change the active Parser Profile. Click the Parser Profiles button on the top right of the screen, click Network Monitor Profiles, and then click Windows to set it as the active profile.

Details

```
C:\>netsh trace start help
```

start

Starts tracing.

Usage: trace start [sessionname=<sessionname>]
[[scenario=]<scenario1,scenario2>]
[[globalKeywords=]keywords] [[globalLevel=]level]
[[capture=]yes|no] [[capturetype=]physical|vmswitch|both]
[[report=]yes|no|disabled] [[persistent=]yes|no]
[[traceFile=]path\filename] [[maxSize=]filemaxsize]
[[fileMode=]single|circular|append] [[overwrite=]yes|no]
[[correlation=]yes|no|disabled] [capturefilters]
[[provider=]providerIdOrName] [[keywords=]keywordMaskOrSet]
[[level=]level] [bufferSize=<bufferSize>]
[[[provider=]provider2IdOrName] [[providerFilter=]yes|no]]
[[keywords=]keyword2MaskOrSet] [[perfMerge=]yes|no]
[[level=]level2] ...

Defaults:

capture=no (specifies whether packet capture is enabled
in addition to trace events)
capturetype=physical (specifies whether packet capture needs to be
enabled for physical network adapters only, virtual switch
only, or both physical network adapters and virtual switch)
report=no (specifies whether a complementing report will be generated
along with the trace file)
persistent=no (specifies whether the tracing session continues
across reboots, and is on until netsh trace stop is issued)
maxSize=250 MB (specifies the maximum trace file size, 0=no maximum)
bufferSize=512 (specifies trace buffer size in KB, min 4, max 16384)
fileMode=circular
overwrite=yes (specifies whether an existing trace output file will
be overwritten)
correlation=disabled (specifies whether related events will be

correlated and grouped together)

perfMerge=yes (specifies whether performance metadata is merged into trace)

traceFile=%LOCALAPPDATA%\Temp\NetTraces\[sessionname]NetTrace.etl (specifies location of the output file)

providerFilter=no (specifies whether provider filter is enabled)

sessionname="" (specifies a name for the trace session so that simultaneous traces can be collected.

Provider keywords default to all and level to 255 unless otherwise specified.

For example:

```
netsh trace start scenario=InternetClient capture=yes
```

Starts tracing for the InternetClient scenario and dependent providers with packet capture enabled for physical network adapters only. Tracing will stop when the "netsh trace stop" command is issued or when the system reboots. Default location and name will be used for the output file. If an old file exists, it will be overwritten.

```
netsh trace start provider=microsoft-windows-wlan-autoconfig  
keywords=state,ut:authentication
```

Starts tracing for the microsoft-windows-wlan-autoconfig provider. Tracing will stop when the "netsh trace stop" command is issued or when the system reboots. Default location and name will be used for the output file. If an old file exists, it will be overwritten. Only events with keyword 'state' or 'ut:authentication' will be logged.

netsh trace show provider command can be used to display supported keywords and levels.

Capture Filters:

Capture filters are only supported when capture is explicitly enabled with capture=yes. Use 'netsh trace show CaptureFilterHelp' to display a list of supported capture filters and their usage.

Provider Filters:

Provider filters are supported by multiple providers and are enabled with providerFilter=Yes after every provider.

Use 'netsh trace show ProviderFilterHelp' to display a list of supported provider filters for each provider and their usage.

capturefilterhelp

```
C:\>netsh trace show capturefilterhelp
```

Capture Filters:

Capture filters are only supported when capture is explicitly enabled with capture=yes. Supported capture filters are:

CaptureInterface=<interface name or GUID>

Enables packet capture for the specified interface name or GUID. Use 'netsh trace show interfaces' to list available interfaces.

e.g. CaptureInterface={716A7812-4AEE-4545-9D00-C10EFD223551}

e.g. CaptureInterface={!{716A7812-4AEE-4545-9D00-C10EFD223551}}

e.g. CaptureInterface="Local Area Connection"

Ethernet.Address=<MAC address>

Matches the specified filter against both source and destination MAC addresses.

e.g. Ethernet.Address=00-0D-56-1F-73-64

Ethernet.SourceAddress=<MAC address>

Matches the specified filter against source MAC addresses.

e.g. Ethernet.SourceAddress=00-0D-56-1F-73-64

Ethernet.DestinationAddress=<MAC address>

Matches the specified filter against destination MAC addresses.

e.g. Ethernet.DestinationAddress=00-0D-56-1F-73-64

Ethernet.Type=<ethertype>

Matches the specified filter against the MAC ethertype.

e.g. Ethernet.Type=IPv4

e.g. Ethernet.Type=NOT(0x86DD)

e.g. Ethernet.Type=(IPv4,IPv6)

Wifi.Type=<Management|Data>

Matches the specified filter against the Wifi type. Allowed values are 'Management' and 'Data'. If not specified, the Wifi.Type filter is not applied.

Note: This capture filter does not support ranges, lists or negation.

e.g. Wifi.Type=Management

Protocol=<protocol>

Matches the specified filter against the IP protocol.

e.g. Protocol=6

e.g. Protocol=!(TCP,UDP)

e.g. Protocol=(4-10)

IPv4.Address=<IPv4 address>

Matches the specified filter against both source and destination IPv4 addresses.

e.g. IPv4.Address=157.59.136.1

e.g. IPv4.Address=!(157.59.136.1)

e.g. IPv4.Address=(157.59.136.1,157.59.136.11)

IPv4.SourceAddress=<IPv4 address>

Matches the specified filter against source IPv4 addresses.

e.g. IPv4.SourceAddress=157.59.136.1

IPv4.DestinationAddress=<IPv4 address>

Matches the specified filter against destination IPv4 addresses.

e.g. IPv4.DestinationAddress=157.59.136.1

IPv6.Address=<IPv6 address>

Matches the specified filter against both source and destination IPv6 addresses.

e.g. IPv6.Address=fe80::5038:3c4:35de:f4c3\%8

e.g. IPv6.Address=!(fe80::5038:3c4:35de:f4c3\%8)

IPv6.SourceAddress=<IPv6 address>

Matches the specified filter against source IPv6 addresses.

e.g. `IPv6.SourceAddress=fe80::5038:3c4:35de:f4c3\%8`

`IPv6.DestinationAddress=<IPv6 address>`

Matches the specified filter against destination IPv6 addresses.

e.g. `IPv6.DestinationAddress=fe80::5038:3c4:35de:f4c3\%8`

`CustomMac=<type(offset,value)>`

Matches the specified filter against the value at the specified offset starting with the MAC header.

Note: This capture filter does not support ranges, lists or negation.

e.g. `CustomMac=UINT8(0x1,0x23)`

e.g. `CustomMac=ASCIISTRING(3,test)`

e.g. `CustomMac=UNICODESTRING(2,test)`

`CustomIp=<type(offset,value)>`

Matches the specified filter against the value at the specified offset starting with the IP header.

Note: This capture filter does not support ranges, lists or negation.

e.g. `CustomIp=UINT16(4,0x3201)`

e.g. `CustomIp=UINT32(0x2,18932)`

`CaptureMultiLayer=<yes|no>`

Enables multi-layer packet capture.

Note: This capture filter does not support ranges, lists or negation.

`PacketTruncateBytes=<value>`

Captures only the the specified number of bytes of each packet.

Note: This capture filter does not support ranges, lists or negation.

e.g. `PacketTruncateBytes=40`

Note:

Multiple filters may be used together. However the same filter may not be repeated.

e.g. `'netsh trace start capture=yes Ethernet.Type=IPv4`

`IPv4.Address=157.59.136.1'`

Filters need to be explicitly stated when required. If a filter is not specified, it is treated as "don't-care".

e.g. `'netsh trace start capture=yes IPv4.SourceAddress=157.59.136.1'`

This will capture IPv4 packets only from 157.59.136.1, and it

will also capture packets with non-IPv4 Ethernet Types, since the Ethernet.Type filter is not explicitly specified.

e.g. 'netsh trace start capture=yes IPv4.SourceAddress=157.59.136.1 Ethernet.Type=IPv4'

This will capture IPv4 packets only from 157.59.136.1. Packets with other Ethernet Types will be discarded since an explicit filter has been specified.

Capture filters support ranges, lists and negation (unless stated otherwise).

e.g. Range: 'netsh trace start capture=yes Ethernet.Type=IPv4 Protocol=(4-10)'

This will capture IPv4 packets with protocols between 4 and 10 inclusive.

e.g. List: 'netsh trace start capture=yes Ethernet.Type=(IPv4,IPv6)'

This will capture only IPv4 and IPv6 packets.

e.g. Negation: 'netsh trace start capture=yes Ethernet.Type=!IPv4'

This will capture all non-IPv4 packets.

Negation may be combined with lists in some cases.

e.g. 'netsh trace start capture=yes Ethernet.Type=!(IPv4,IPv6)'

This will capture all non-IPv4 and non-IPv6 packets.

'NOT' can be used instead of '!' to indicate negation. This requires parentheses to be present around the values to be negated.

e.g. 'netsh trace start capture=yes Ethernet.Type=NOT(IPv4)'

Scenarios

```
C:\>netsh trace show scenarios
```

Available scenarios (24):

AddressAcquisition : Troubleshoot address acquisition related issues

AddressAcquisitionServer : Troubleshoot address acquisition server related issues

DirectAccess : Troubleshoot DirectAccess related issues

DirectAccessServer :

FileSharing : Troubleshoot common file and printer sharing problems

ICS : Troubleshoot internet connection sharing related issues

InternetClient : Troubleshoot web connectivity issues

InternetServer	: Troubleshoot server-side web connectivity issues
L2SEC	: Troubleshoot layer 2 authentication related issues
LAN	: Troubleshoot wired LAN related issues
Layer2	: Troubleshoot layer 2 connectivity related issues
MBN	: Troubleshoot mobile broadband related issues
NDIS	: Troubleshoot network adapter related issues
NetConnection	: Troubleshoot network connection related issues
NetworkSnapshot	: Collect the current network state of the system
P2P-Grouping	: Troubleshoot Peer-to-Peer Grouping related issues
P2P-PNRP	: Troubleshoot Peer Name Resolution Protocol (PNRP) related issues
RemoteAssistance	: Troubleshoot Windows Remote Assistance related issues
Virtualization	:
VPNServer	: Troubleshoot VPN related issues
WCN	: Troubleshoot Windows Connect Now related issues
WFP-IPsec	: Troubleshoot Windows Filtering Platform and IPsec related issues
WLAN	: Troubleshoot wireless LAN related issues
XboxMultiplayer	: Troubleshoot Xbox Live Multiplayer connectivity-related issues

-end

Port Mirror / Monitor

Ubiquiti EdgeSwitch

```
monitor session 1 destination interface 0/10
monitor session 1 source interface 0/1
monitor session 1 source interface 0/2
monitor session 1 source interface 0/3
monitor session 1 source interface 0/4
monitor session 1 source interface 0/5
monitor session 1 source interface 0/6
monitor session 1 source interface 0/7
monitor session 1 source interface 0/8
monitor session 1 source interface 0/11
monitor session 1 source interface 0/12
monitor session 1 source interface 0/13
monitor session 1 source interface 0/14
monitor session 1 source interface 0/15
monitor session 1 source interface 0/16
monitor session 1 mode
```