



Welcome to

3. Traffic Inspection and Firewalls

Communication and Network Security 2023

Henrik Kramselund he/him han/ham hlk@zencurity.com @kramse

Slides are available as PDF, kramse@Github 

3-Traffic-Inspection-and-Firewalls.tex in the repo security-courses

Goals for today



- Introduce a network tool for isolation, firewalls
- Discuss what they *filter on* – network packets
- See how they relate to VLANs – logical/virtual separation for hosts

Photo by Thomas Galler on Unsplash

Plan for today



Subjects

- Traffic inspection and firewalls
- Generic IP Firewalls stateless filtering vs stateful inspection
- Next Generation firewalls, Deep Packet Inspection
- IEEE 802.1q VLAN
- Common countermeasures in firewalls

Exercises

- Nmap scanning firewalls
- Nmap full scan - strategy
- Nmap reporting

Introduce firewalls

Reading Summary



ANSM chapter 1,2,3 - 73 pages

[https://en.wikipedia.org/wiki/Firewall_\(computing\)](https://en.wikipedia.org/wiki/Firewall_(computing))

<http://www.wilyhacker.com/> Cheswick chapter 2 og 3 PDF, ca 55 pages

Skim chapters from 1st edition:

<http://www.wilyhacker.com/1e/chap03.pdf>

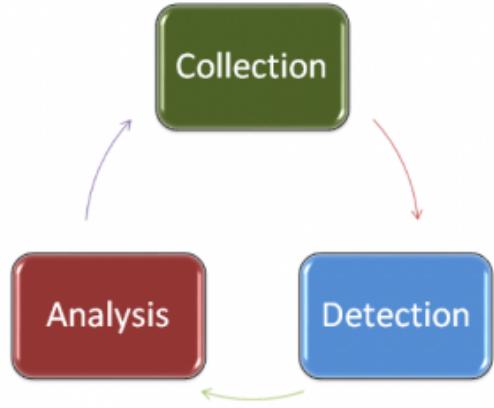
<http://www.wilyhacker.com/1e/chap04.pdf>

The next time you are at your console, review some logs. You might think. . . “I don’t know what to look for”.

Start with what you know, understand, and don’t care about. Discard those. Everything else is of interest.

Semper Vigilans, Mike Poor

Reading Summary, continued



ANSM chapter 1: The Practice of Applied Network Security Monitoring

- Vulnerability-Centric vs. Threat-Centric Defense
- The NSM cycle: collection, detection, and analysis
- Full Content Data, Session Data, Statistical Data, Packet String Data, and Alert Data
- Security Onion is nice, but a bit over the top - quickly gets overloaded

Reading Summary, continued



In computing, a firewall is a network security system that monitors and controls incoming and outgoing network traffic based on predetermined security rules.^[1] A firewall typically establishes a barrier between a trusted internal network and untrusted external network, such as the Internet.^[2]

Source: Wikipedia

[https://en.wikipedia.org/wiki/Firewall_\(computing\)](https://en.wikipedia.org/wiki/Firewall_(computing))

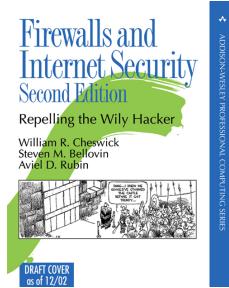
<http://www.wilyhacker.com/>

Cheswick chapter 2 PDF *A Security Review of Protocols: Lower Layers*

- Network layer, packet filters, application level, stateless, stateful

Firewalls are by design a choke point, natural place
to do network security monitoring!

Reading Summary, continued



<http://www.wilyhacker.com/>

Cheswick chapter 3 PDF Security Review: *The Upper Layers*

- How to configure firewalls often boil down to, should we allow protocol X
- If we allow SMB through an internet firewall, we are asking for trouble

Security Onion



Security Onion is a Linux distro for IDS (Intrusion Detection) and NSM (Network Security Monitoring).
<http://securityonion.net>

Nice starting point for researching dashboards/network packets

Baseline Skills



- Threat-Centric Security, NSM, and the NSM Cycle
- TCP/IP Protocols
- Common Application Layer Protocols
- Packet Analysis
- Windows Architecture
- Linux Architecture
- Basic Data Parsing (BASH, Grep, SED, AWK, etc)
- IDS Usage (Snort, Suricata, etc.)
- Indicators of Compromise and IDS Signature Tuning
- Open Source Intelligence Gathering
- Basic Analytic Diagnostic Methods
- Basic Malware Analysis

Source: *Applied Network Security Monitoring Collection, Detection, and Analysis*, Chris Sanders and Jason Smith

Reading Summary, continued



ANSM chapter 2: Planning Data Collection

- The Applied Collection Framework (ACF)
- The ACF involves four distinct phases: Identify threats to your organization, quantify risk, identify relevant data feeds, and refine the useful elements
- Risk Analysis
- Lots of terms used, but only defined later in the book

Reading Summary, continued



ANSM chapter 3: The Sensor Platform

- Full Packet Capture (FPC) Data
- Session Data
- Statistical Data
- Packet String (PSTR) Data
- Log Data
- Sensor Placement, designing etc.

Netflow



- Netflow is getting more important, more data share the same links
- Accounting is important
- Detecting DoS/DDoS and problems is essential
- Netflow sampling is vital information - 123Mbit, but what kind of traffic
- NFSen is an old but free application <http://nfsen.sourceforge.net/>
- Currently also investigating sFlow - hopefully more fine grained
- sFlow, short for "sampled flow", is an industry standard for packet export at Layer 2 of the OSI model, <https://en.wikipedia.org/wiki/SFlow>

Netflow is often from routers, we dont have any here

Also look into Elastiflow! <https://github.com/robcowart/elastiflow>

Collect Network Evidence from the network



Network Flows originated at Cisco

Cisco standard NetFlow version 5 defines a flow as a unidirectional sequence of packets that all share the following 7 values:

- Ingress interface (SNMP ifIndex)
- IP protocol, Source IP address and Destination IP address
- Source port for UDP or TCP, 0 for other protocols
- Destination port for UDP or TCP, type and code for ICMP, or 0 for other protocols
- IP Type of Service

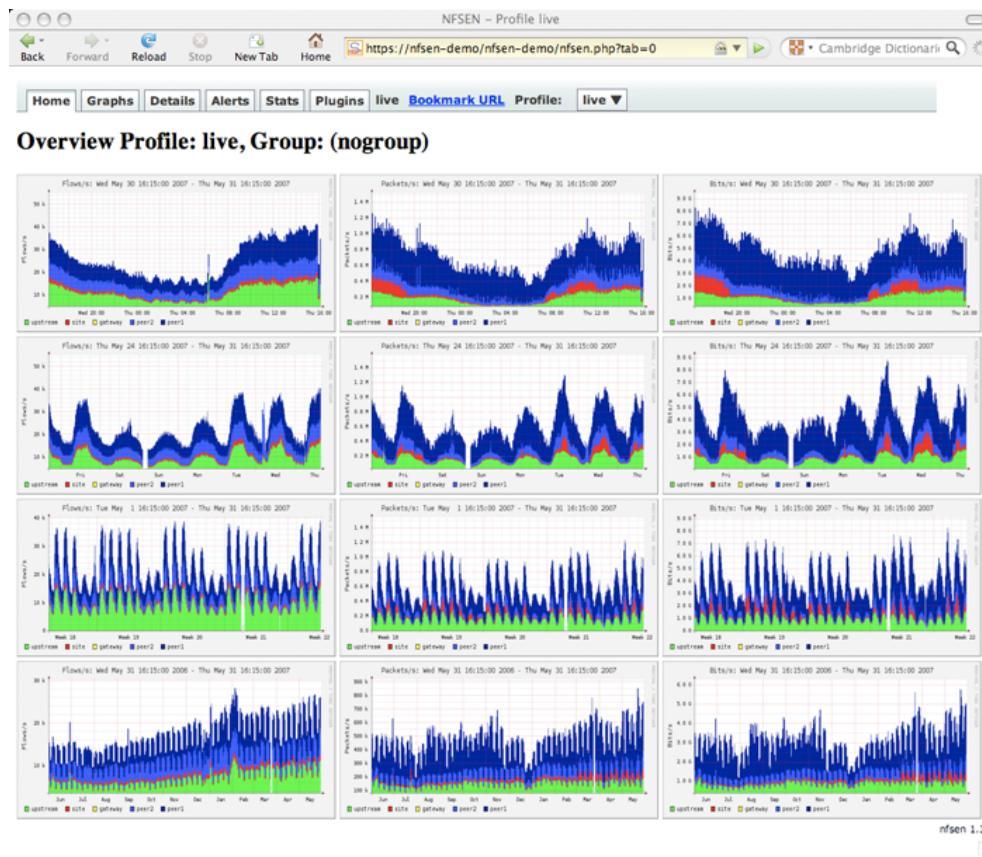
today Netflow version 9 or IPFIX support IPv6, and should be used instead of Netflow v5

Source:

<https://en.wikipedia.org/wiki/NetFlow>

https://en.wikipedia.org/wiki/IP_Flow_Information_Export

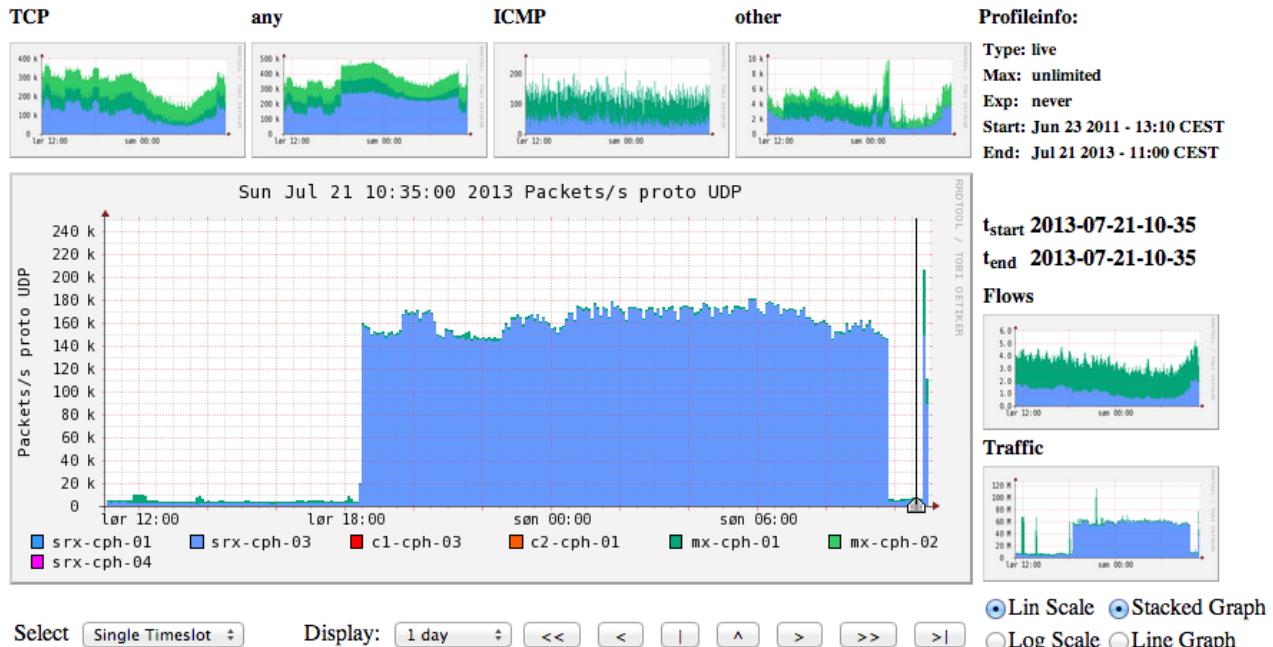
Netflow using NFSEN



Netflow NFSen



Profile: live



An extra 100k packets per second from this netflow source (source is a router)

Netflow processing from the web interface



NFSEN - Profile live May 31 2007 - 04:40

Back Forward Reload Stop New Tab Home https://nfsen-demo/nfsen-demo/nfsen.php?processing Cambridge Dictionary

peer2 3.3 k/s 76.2 k/s 66.9 k/s 7.0 k/s 621.0 /s 1.7 k/s 484.6 Mb/s 459.9 Mb/s 12.5 Mb/s 437.3 kb/s 11.7 Mb/s
gateway 1.0 /s 651.0 /s 600.8 /s 46.6 /s 0 /s 3.7 /s 6.2 Mb/s 6.1 Mb/s 36.4 kb/s 0 b/s 4.4 kb/s
site 467.1 /s 8.9 k/s 6.1 k/s 2.0 k/s 181.7 /s 613.3 /s 38.8 Mb/s 28.3 Mb/s 7.4 Mb/s 104.0 kb/s 2.9 Mb/s
upstream 6.4 k/s 94.2 k/s 84.3 k/s 8.2 k/s 896.4 /s 766.7 /s 588.4 Mb/s 568.2 Mb/s 16.7 Mb/s 685.1 kb/s 2.8 Mb/s

All | None Display: Sum Rate

Netflow Processing

Source: peer1 Filter:

peer1 peer2 gateway site upstream

All Sources and <none>

Options:

List Flows Stat TopN
Top: 10
Stat: Flow Records order by flows
proto
srcPort
dstPort
srcIP
dstIP
Aggregate
Limit: Packets > 0
Output: line / IPv6 long

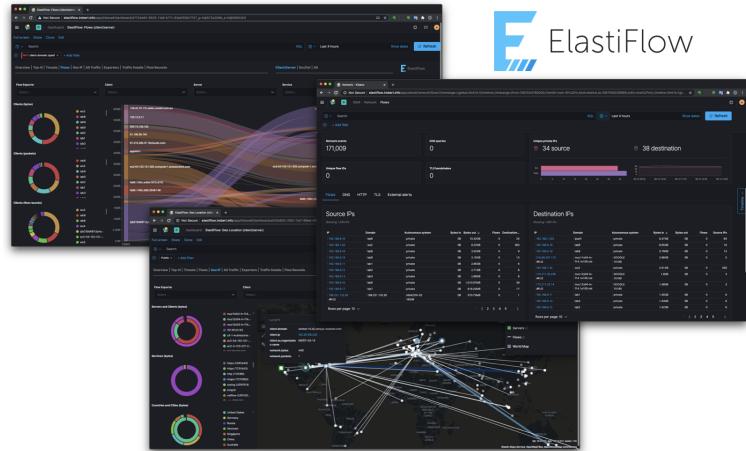
Clear Form process

** nfdump -M /netflow0/nfsen-demo/profile-data/live/peer1:peer2:gateway:site:upstream -T -r 2007/05/31/04:nfcapd.200705310440
nfdump filter:
any
Aggregated flows 2797250
Top 10 flows ordered by flows:
Date flow start Duration Proto Src IP Addr:Port Dst IP Addr:Port Packets Bytes Flows
2007-05-31 04:39:54.045 299.034 UDP 116.147.95.88:1110 -> 188.142.64.162:27014 68 5508 68
2007-05-31 04:39:56.282 298.174 UDP 116.147.249.27:1478 -> 188.142.64.163:27014 67 5427 67
2007-05-31 04:39:57.530 298.206 UDP 117.196.44.62:1031 -> 188.142.64.166:27014 67 5427 67
2007-05-31 04:39:57.819 298.112 UDP 117.196.75.134:1146 -> 188.142.64.167:27014 67 5427 67
2007-05-31 04:39:53.187 297.216 UDP 61.191.235.132:4121 -> 60.9.138.37:4121 62 3720 62
2007-05-31 04:39:53.234 303.588 UDP 60.9.138.37:2121 -> 118.25.93.95:2121 61 3660 61
2007-05-31 04:39:58.921 298.977 UDP 60.9.138.37:2121 -> 121.135.4.186:2121 61 3660 61
2007-05-31 04:39:54.329 303.585 UDP 120.150.194.76:2121 -> 60.9.138.37:2121 61 3660 61
2007-05-31 04:39:53.916 300.734 UDP 60.9.138.37:2121 -> 125.167.25.128:2121 61 3660 61
2007-05-31 04:39:57.946 300.353 UDP 60.9.138.36:2121 -> 121.135.4.186:2121 61 3660 61

IP addresses anonymized
Summary: total flows: 4616424, total bytes: 156.6 G, total packets: 172.6 M, avg bps: 644.8 M, avg pps: 90946, avg bpp: 929
Time: 2007-05-31 04:44:55 - 2007-05-31 04:44:55
Total flows processed: 4616424, skipped: 0, Bytes read: 240064932
Sys: 6.184s flows/second: 746464.4 Wall: 6.185s flows/second: 746361.3

Bringing the power of the command line forward

ElastiFlow – Elasticsearch based



ElastiFlow™ provides network flow data collection and visualization using the Elastic Stack (Elasticsearch, Logstash and Kibana). It supports Netflow v5/v9, sFlow and IPFIX flow types (1.x versions support only Netflow v5/v9).

Source: Picture and text from <https://github.com/robcowart/elastiflow>

How to get started



How to get started searching for security events?

Collect basic data from your devices and networks

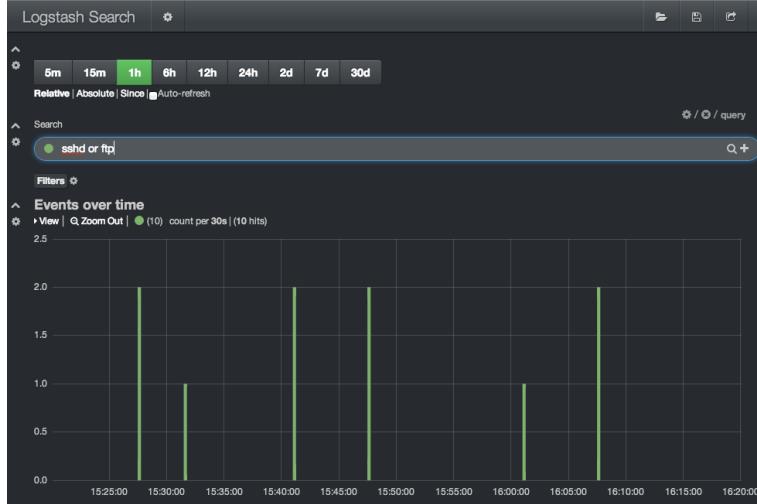
- Netflow data from routers
- Session data from firewalls
- Logging from applications: email, web, proxy systems

Centralize!

Process data

- Top 10: interesting due to high frequency, occurs often, brute-force attacks
- *ignore*
- Bottom 10: least-frequent messages are interesting

View data efficiently

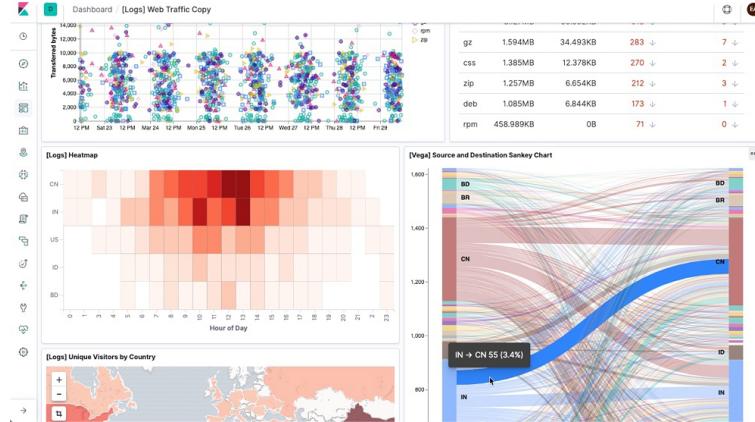


View data by digging into it easily - must be fast

Logstash and Kibana are just examples, but use indexing to make it fast!

Other popular examples include Graylog and Grafana

Big Data tools: Elasticsearch



Elasticsearch is an open source distributed, RESTful search and analytics engine capable of solving a growing number of use cases.

<https://www.elastic.co>

We are all Devops now, even security people!

Kibana



Highly recommended for a lot of data visualisation

Non-programmers can create, save, and share dashboards

Source: <https://www.elastic.co/products/kibana>

Ansible configuration management

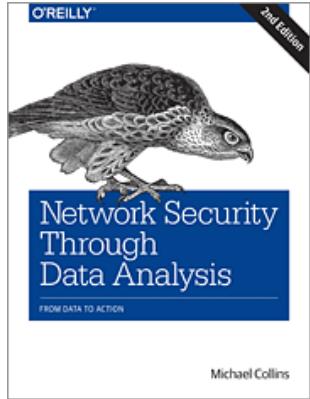


```
- apt: name= item state=latest
  with_items:
    - unzip
    - elasticsearch
    - logstash
    - redis-server
    - nginx
- lineinfile: "dest=/etc/elasticsearch/elasticsearch.yml state=present
  regexp='script.disable_dynamic: true' line='script.disable_dynamic: true'"
- lineinfile: "dest=/etc/elasticsearch/elasticsearch.yml state=present
  regexp='network.host: localhost' line='network.host: localhost'"
```

only requires SSH+python <http://www.ansible.com>

I have a set of files that can install a mostly complete Elastic stack on Debian:
<https://github.com/kramse/kramse-labs/tree/master/suricatazeek>

Network Security Through Data Analysis

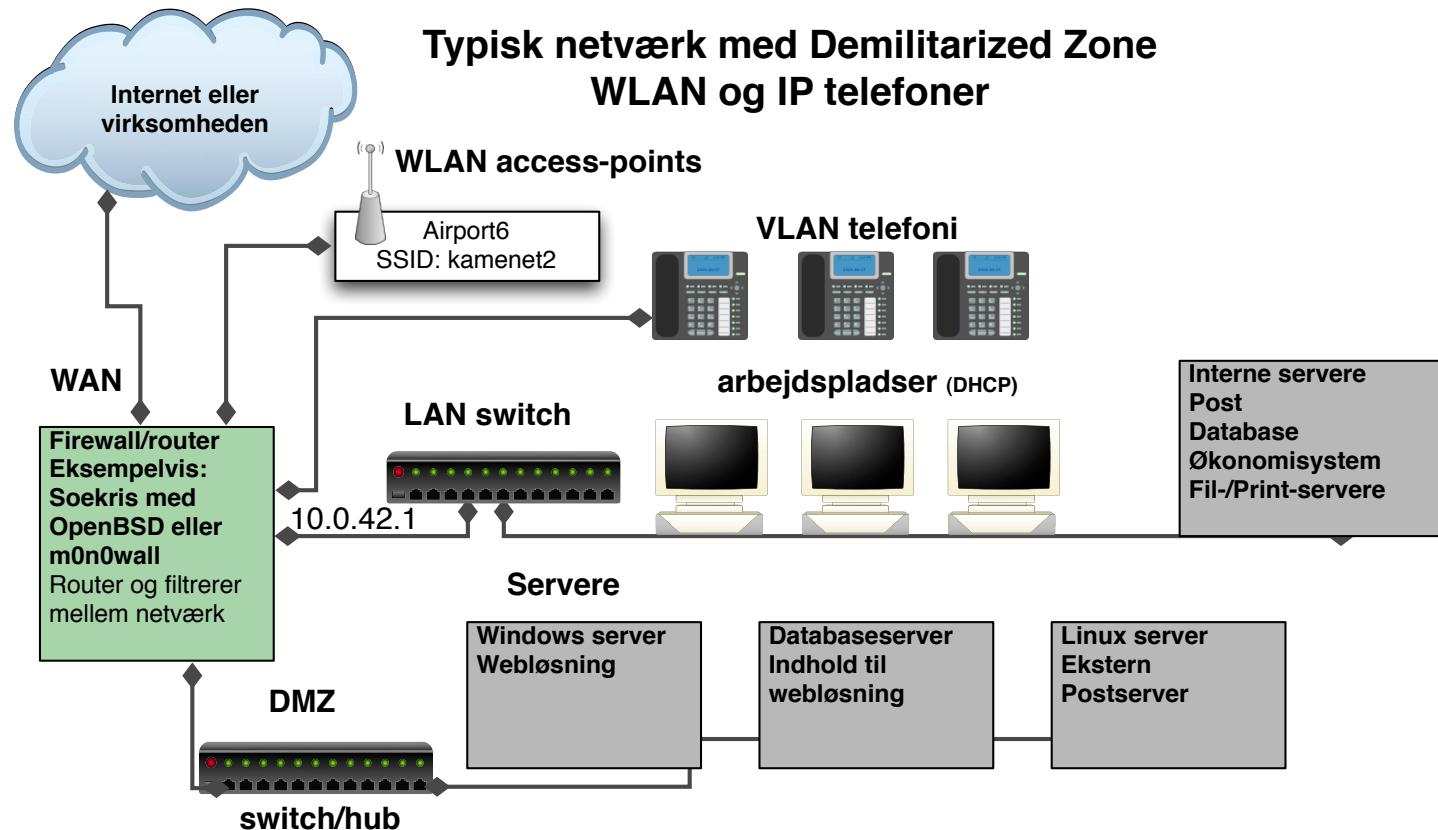


Low page count, but high value! Recommended.

Network Security through Data Analysis, 2nd Edition By Michael S Collins Publisher: O'Reilly Media 2015-05-01:
Second release, 348 Pages

New Release Date: August 2017

Unified communications



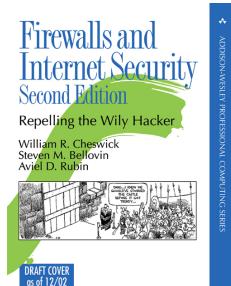
Generic IP Firewalls



En firewall er noget som **blokerer** traffik på Internet

En firewall er noget som **tillader** traffik på Internet

Firewall historik

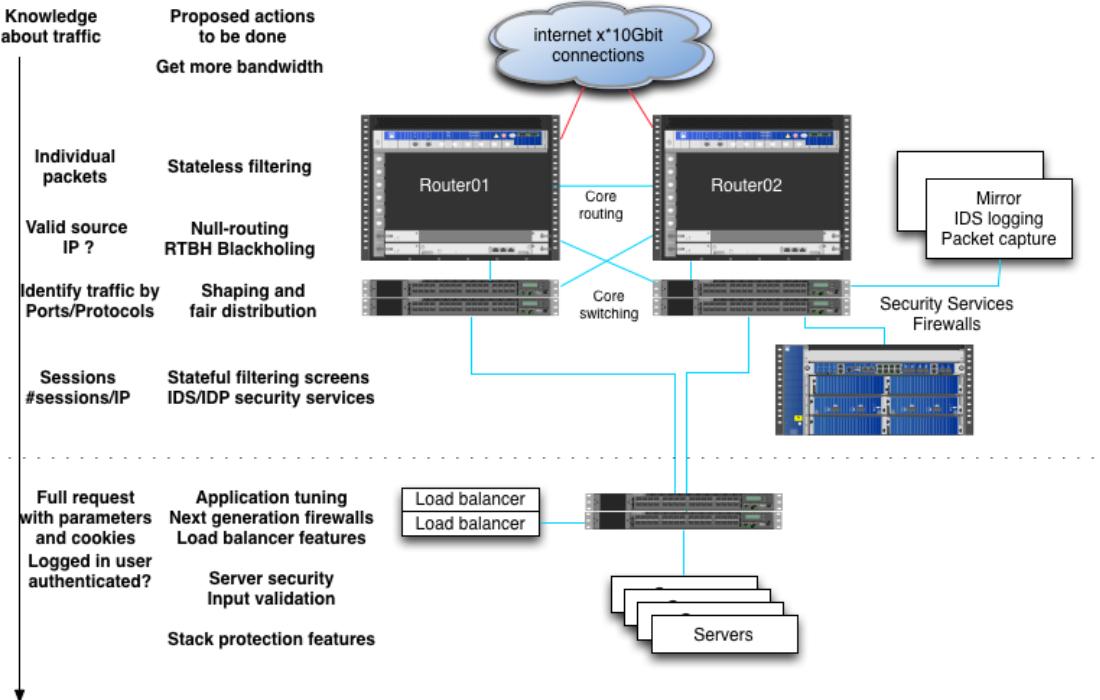


Firewalls har været kendt siden starten af 90'erne

Første bog *Firewalls and Internet Security* udkom i 1994 men kan stadig anbefales, læs den på <http://www.wilyhacker.com/>

2003 kom den i anden udgave *Firewalls and Internet Security* William R. Cheswick, Steven M. Bellovin, Aviel D. Rubin, Addison-Wesley, 2nd edition

Firewall er ikke alene



Forsvaret er som altid - flere lag af sikkerhed!



Firewallrollen idag

Idag skal en firewall være med til at:

- Forhindre angribere i at komme ind
- Forhindre angribere i at sende traffik ud
- Forhindre virus og orme i at sprede sig i netværk
- Indgå i en samlet løsning med ISP, routere, firewalls, switchede strukturer, intrusion detectionsystemer samt andre dele af infrastrukturen

Det kræver overblik!



Basalt set et netværksfilter - det yderste fæstningsværk

Indholder typisk:

- Grafisk brugergrænseflade til konfiguration - er det en fordel?
- TCP/IP filtermuligheder - pakernes afsender, modtager, retning ind/ud, porte, protokol, ...
- både IPv4 og IPv6
- foruddefinerede regler/eksempler - er det godt hvis det er nemt at tilføje/åbne en usikker protokol?
- typisk NAT funktionalitet indbygget
- typisk mulighed for nogle serverfunktioner: kan agere DHCP-server, DNS caching server og lignende

En router med Access Control Lists - kaldes ofte netværksfilter, mens en dedikeret maskine kaldes firewall



Sample rules from OpenBSD PF

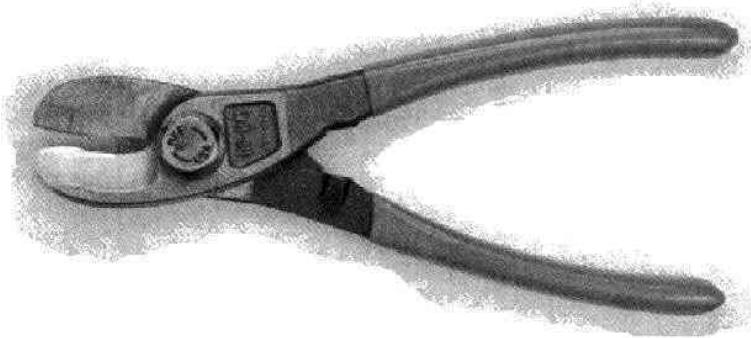
```
# hosts and networks
router="217.157.20.129"
webserver="217.157.20.131"
homenet=" 192.168.1.0/24, 1.2.3.4/24 "
wlan="10.0.42.0/24"
wireless=wi0
set skip lo0
# things not used
spoofed=" 127.0.0.0/8, 172.16.0.0/12, 10.0.0.0/16, 255.255.255.255/32 "

# default block anything
block in all
# egress and ingress filtering - disallow spoofing, and drop spoofed
block in quick from $spoofed to any
block out quick from any to $spoofed

pass in on $wireless proto tcp from { $wlan $homenet } to any port = 22
pass in on $wireless proto tcp from any to $webserver port = 80

pass out
```

netdesign - med firewalls



- Hvor skal en firewall placeres for at gøre størst nytte?
- Hvad er forudsætningen for at en firewall virker?
At der er konfigureret et sæt fornuftige regler!
- Hvor kommer reglerne fra? Sikkerhedspolitikken!

Kilde: Billede oprindeligt fra <http://www.ranum.com/pubs/a1fwall/> The ULTIMATELY Secure Firewall (link er dødt)



Packet filtering

0	1	2	3
0 1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0 1	
-----	-----	-----	-----
Version IHL Type of Service		Total Length	
-----	-----	-----	-----
Identification	Flags	Fragment Offset	
-----	-----	-----	-----
Time to Live Protocol		Header Checksum	
-----	-----	-----	-----
Source Address			
-----	-----	-----	-----
Destination Address			
-----	-----	-----	-----
Options	Padding		
-----	-----	-----	-----

Packet filtering er firewalls der filtrerer på IP niveau
Idag inkluderer de fleste stateful inspection



Kommercielle firewalls

- Checkpoint Firewall-1 <http://www.checkpoint.com>
- Cisco ASA , Meraki, Firepower<http://www.cisco.com>
- Fortinet <https://www.fortinet.com/>
- Juniper SRX <http://www.juniper.net>
- Palo Alto <https://www.paloaltonetworks.com/>
- Big-IP F5 <https://www.f5.com>

Ovenstående er dem som jeg oftest ser ude hos mine kunder i Danmark



Open source baserede firewalls

- Linux firewalls IP tables, use command line tool ufw Uncomplicated Firewall!
- Firewall GUIs ovenpå Linux - mange! nogle er kommercielle produkter
- OpenBSD PF <http://www.openbsd.org>
- FreeBSD IPFW og IPFW2 <http://www.freebsd.org>
- Mac OS X benytter OpenBSD PF
- FreeBSD inkluderer også OpenBSD PF
- <https://opnsense.org/>

NB: kun eksempler og dem jeg selv har brugt



Hardware eller software

Man hører indimellem begrebet *hardware firewall*

Det er dog et faktum at en firewall består af:

- Netværkskort - som er hardware
- Filtreringssoftware - som er *software!*

Det giver ikke mening at kalde en ASA 5501 en hardware firewall
og en APU2C4 med OpenBSD for en software firewall!

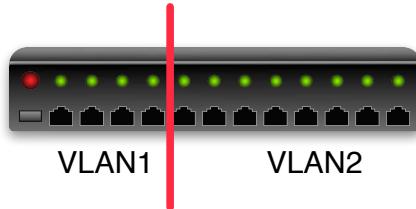
Man kan til gengæld godt argumentere for at en dedikeret firewall som en separat enhed kan give bedre sikkerhed

Det er også fint at tale om host-firewalls, altså at servere og laptops har firewall slået til

Together with Firewalls - VLAN Virtual LAN



Portbased VLAN



Nogle switcher tillader at man opdeler portene

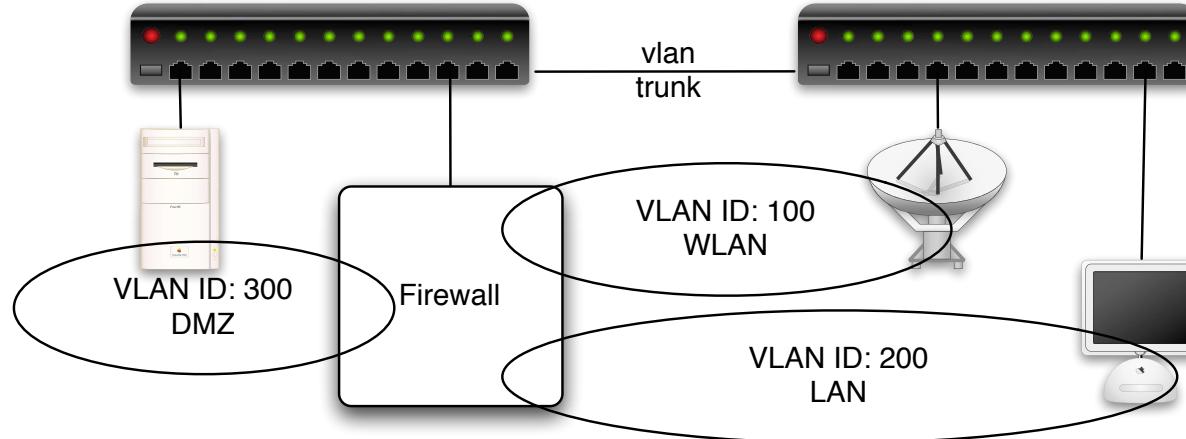
Denne opdeling kaldes VLAN og portbaseret er det mest simple

Port 1-4 er et LAN

De resterende er et andet LAN

Data skal omkring en firewall eller en router for at krydse fra VLAN1 til VLAN2

IEEE 802.1q – virtual LAN



Med 802.1q tillades VLAN tagging på Ethernet niveau

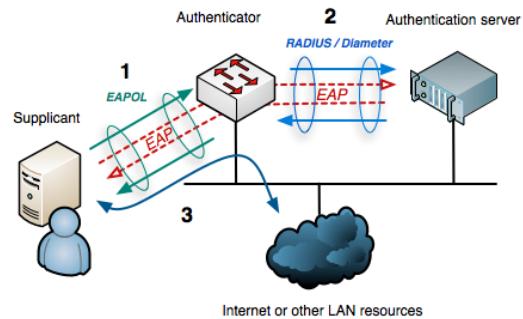
Data skal omkring en firewall eller en router for at krydse fra VLAN1 til VLAN2

VLAN trunking giver mulighed for at dele VLANs ud på flere switches

Network Access Control – Connecting clients more securely



IEEE 802.1x Port Based Network Access Control



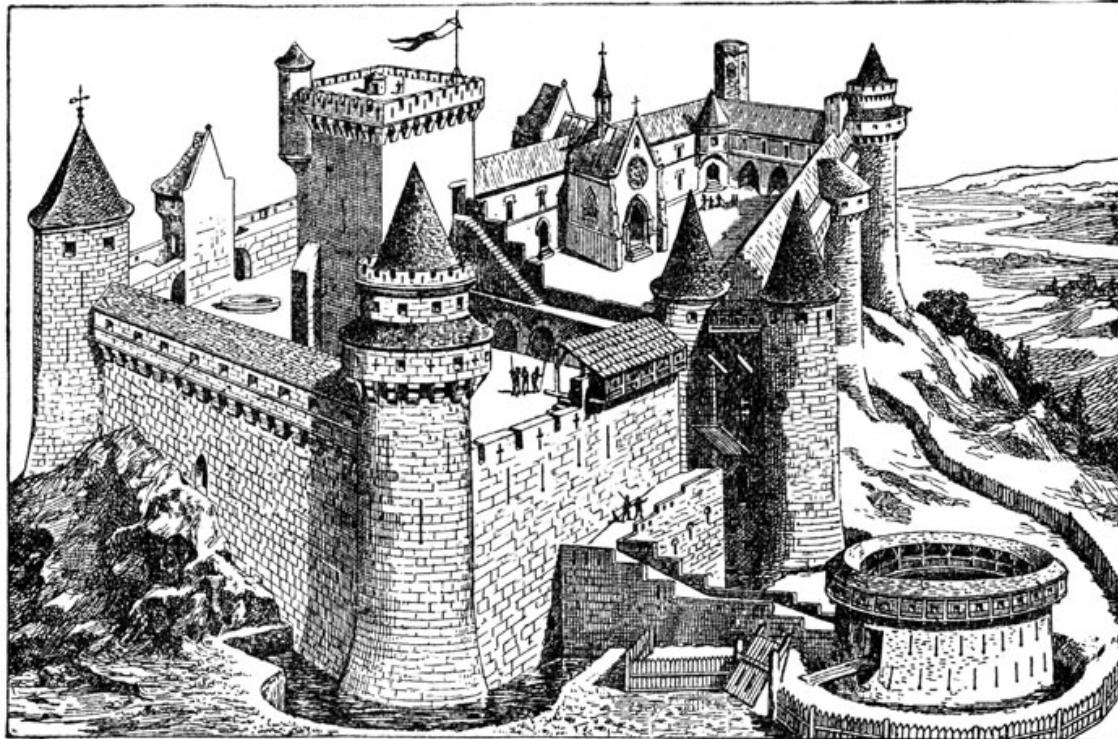
Denne protokol sikrer at man valideres før der gives adgang til porten

Når systemet skal have adgang til porten afleveres brugernavn og kodeord/certifikat

Typisk benyttes RADIUS og 802.1x integrerer således mod både LDAP og Active Directory

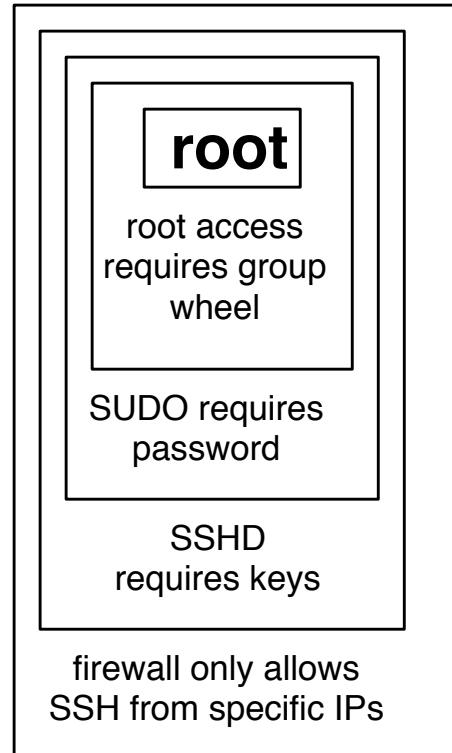
Bruges til Wi-Fi netværk, og kan derfor også nemmere bruges til kablede netværk nu

Defense in depth



Picture originally from: <http://karenswhimsy.com/public-domain-images>

Defense in depth - layered security

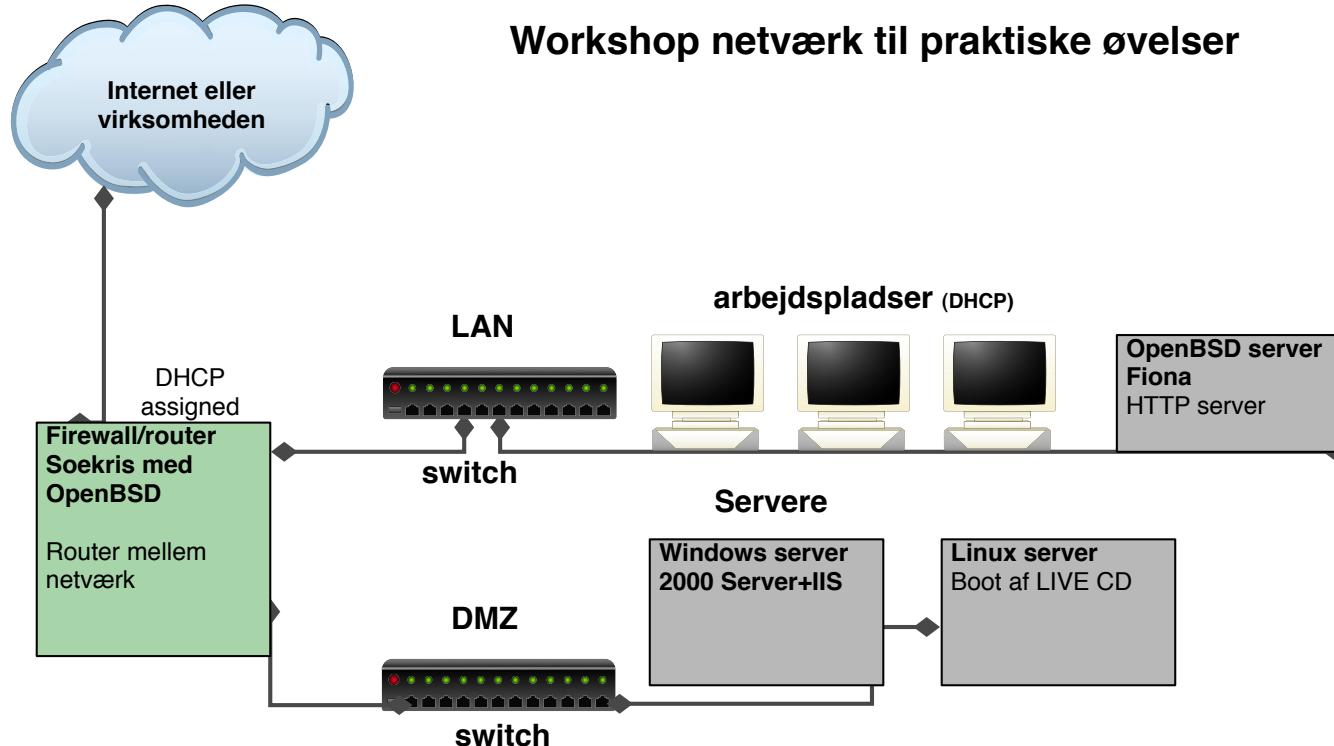


Multiple layers of security! Isolation!

Small networks



Workshop netværk til praktiske øvelser



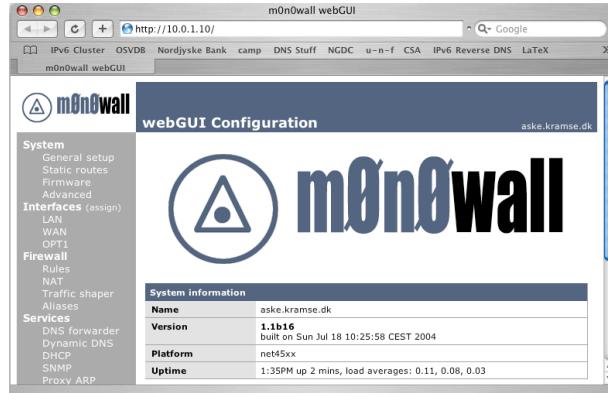
Exercise



Now lets do the exercise

i Configure SSH keys for more secure access

which is number **27** in the exercise PDF.



Firewall bygget på FreeBSD med grafisk web interface – nu outdated

Idag erstattet af pfSense <https://www.pfsense.org/>
og OPNsense <https://opnsense.org/>

De nye versioner bruges i produktion i danske firmaer, og kan anbefales hvis man vil prøve en firewall

Firewall koncepter



Rækkefølgen af regler betyder noget!

- To typer af firewalls: First match - når en regel matcher, gør det som angives block/pass Last match - marker pakken hvis den matcher, til sidst afgøres block/pass

Det er ekstremt vigtigt at vide hvilken type firewall man bruger!

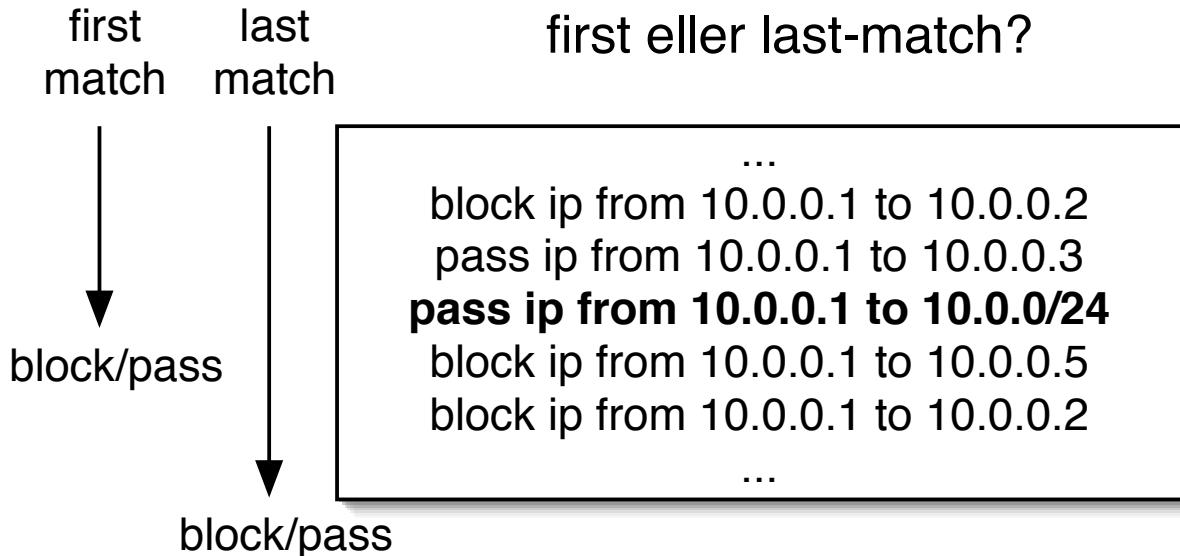
OpenBSD PF er last match

FreeBSD IPFW er first match

Linux iptables/netfilter er last match



First or Last match firewall?



Med dette regelsæt vil en first-match firewall blokere pakker fra 10.0.0.1 til 10.0.0.2 - men tillade alt andet fra 10.0.0.1 til 10.0.0/24

Med dette regelsæt vil en last-match firewall blokere pakker fra 10.0.0.1 til 10.0.0.2, **10.0.0.1 til 10.0.0.5**, **10.0.0.1 til 10.0.0.2** - men ellers tillade alt andet fra 10.0.0.1 til 10.0.0/24

First match - IPFW



```
00100 16389 1551541 allow ip from any to any via lo0
00200      0          0 deny log ip from any to 127.0.0.0/8
00300      0          0 check-state
...
65435     36        5697 deny log ip from any to any
65535     865       54964 allow ip from any to any
```

Den sidste regel nås aldrig!

Last match - OpenBSD PF



```
ext_if="ext0"
int_if="int0"

block in
pass out keep state

pass quick on { lo $int_if }

# Tillad forbindelser ind på port 80=http og port 53=domain
# på IP-adressen for eksterne netkort ($ext_if) syntaksen
pass in on $ext_if proto tcp to ($ext_if) port http keep state
pass in on $ext_if proto { tcp, udp } to ($ext_if) port domain keep state
```

Pakkerne markeres med block eller pass indtil sidste regel
nøgleordet *quick* afslutter match - god til store regelsæt



Linux iptables/netfilter eksempel

```
# Firewall configuration written by system-config-securitylevel
# Manual customization of this file is not recommended.

*filter
:INPUT ACCEPT [0:0]
:FORWARD ACCEPT [0:0]
:OUTPUT ACCEPT [0:0]
:RH-Firewall-1-INPUT - [0:0]
-A INPUT -j RH-Firewall-1-INPUT
-A FORWARD -j RH-Firewall-1-INPUT
-A RH-Firewall-1-INPUT -i lo -j ACCEPT
-A RH-Firewall-1-INPUT -p icmp --icmp-type any -j ACCEPT
-A RH-Firewall-1-INPUT -p 50 -j ACCEPT
-A RH-Firewall-1-INPUT -p 51 -j ACCEPT
-A RH-Firewall-1-INPUT -p udp --dport 5353 -d 224.0.0.251 -j ACCEPT
-A RH-Firewall-1-INPUT -p udp -m udp --dport 631 -j ACCEPT
-A RH-Firewall-1-INPUT -m state --state ESTABLISHED,RELATED -j ACCEPT
-A RH-Firewall-1-INPUT -m state --state NEW -m tcp -p tcp --dport 443 -j ACCEPT
-A RH-Firewall-1-INPUT -m state --state NEW -m tcp -p tcp --dport 22 -j ACCEPT
-A RH-Firewall-1-INPUT -j REJECT --reject-with icmp-host-prohibited
COMMIT
```

NB: husk at aktivere IP forwarding, evt. skifte default policy fra ACCEPT til DROP

Anbefaler UFW Uncomplicated Firewall



```
root@debian01:~# ufw allow 22/tcp
Rules updated
Rules updated (v6)
root@debian01:~# ufw enable
Command may disrupt existing ssh connections. Proceed with operation (y|n)? y
Firewall is active and enabled on system startup
root@debian01:~# ufw status numbered
Status: active
```

To	Action	From
--	-----	-----
[1] 22/tcp	ALLOW IN	Anywhere
[2] 22/tcp (v6)	ALLOW IN	Anywhere (v6)

Langt nemmere at bruge

Exercise



Now lets do the exercise

Enable firewall - 15min

which is number **6** in the exercise PDF.

Firewalls og ICMP



```
ipfw add allow icmp from any to any icmptypes 3,4,11,12
```

Ovenstående er IPFW syntaks for at tillade de interessante ICMP beskeder igennem
Tillad ICMP types:

- 3 Destination Unreachable
- 4 Source Quench Message
- 11 Time Exceeded
- 12 Parameter Problem Message



Firewall konfiguration

Den bedste firewall konfiguration starter med:

- Papir og blyant
- En fornuftig adressestruktur

Brug dernæst en firewall med GUI første gang!

Husk dernæst:

- En firewall skal passes
- En firewall skal opdateres
- Systemerne bagved skal hærdes!



Blokér indefra og ud

Der er porte og services som altid bør blokeres

Det kan være kendte sårbare services

- Windows SMB filesharing - ikke til brug på Internet!
- UNIX NFS - ikke til brug på Internet!

Kendte problemer som minimum

Den generelle anbefaling er at starte med et regelsæt der blokerer ALT og derefter åbner man for services man vil tillade.

Exercise



Now lets do the exercise

⚠ Perform nmap service scan 10 min

which is number **28** in the exercise PDF.

Exercise

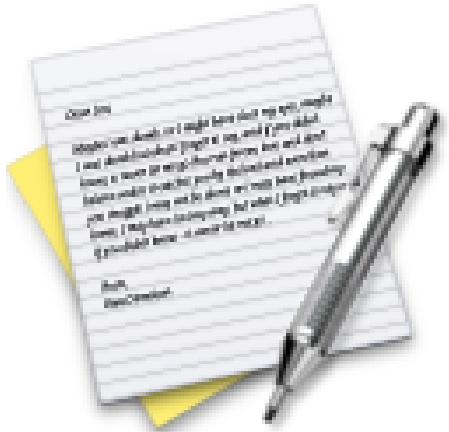


Now lets do the exercise

⚠ SSH scanners - 15min

which is number **29** in the exercise PDF.

Exercise



Now lets do the exercise

⚠️ Nmap full scan - strategy 15 min

which is number **30** in the exercise PDF.

Exercise



Now lets do the exercise

i Reporting HTML 15 min

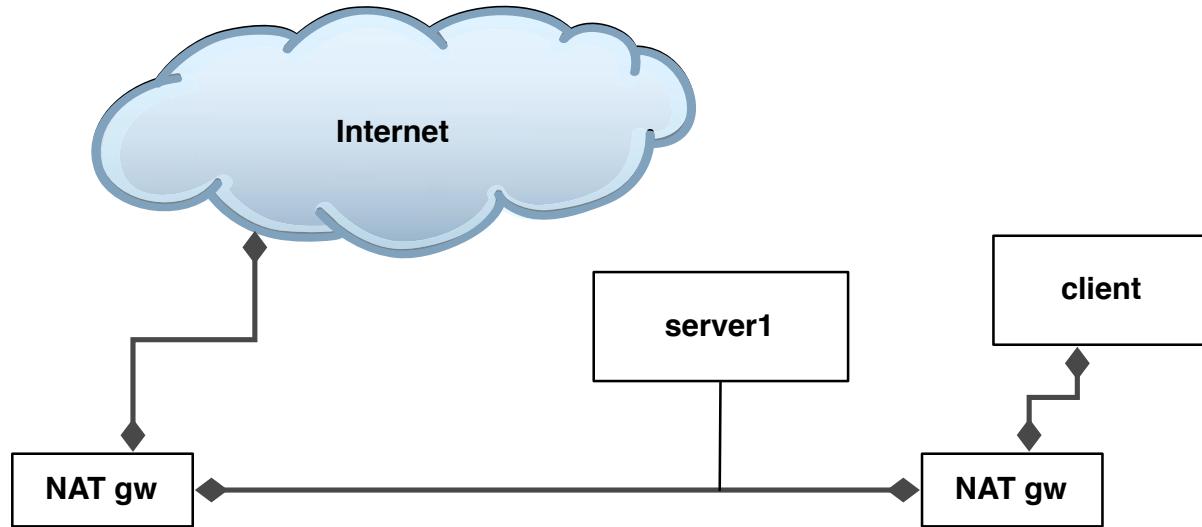
which is number **31** in the exercise PDF.

Specielle features



- Network Address Translation - NAT
- IPv6 funktionalitet
- Båndbredde håndtering
- VLAN funktionalitet
- Redundante firewalls - pfSync og CARP er eksempler
- IPsec og Andre VPN features
- inspection - diverse muligheder for at lave deep inspection i protokoller
- Eksempelvis DNS inspection
- Nogle firewalls kan inspicere mange protokoller og bruger jævnligt betegnelsen *deep packet inspection* (DPI)

Anti-pattern dobbelt NAT i eget netværk



Det er nødvendigt med NAT for at oversætte traffik der sendes videre ud på internet.

Der er ingen som helst grund til at benytte NAT indenfor eget netværk!

IPsec og Andre VPN features



De fleste firewalls giver mulighed for at lave krypterede tunneler

Nyttigt til fjernkontorer der skal have usikker traffik henover usikre netværk som Internet

Konceptet kaldes Virtual Private Network VPN

IPsec er de facto standarden for VPN og beskrevet i RFC'er

Linux TCP SACK PANIC - CVE-2019-11477 et al



Kernel vulnerabilities, CVE-2019-11477, CVE-2019-11478 and CVE-2019-11479

Executive Summary

Three related flaws were found in the Linux kernel's handling of TCP networking. The most severe vulnerability could allow a remote attacker to trigger a kernel panic in systems running the affected software and, as a result, impact the system's availability.

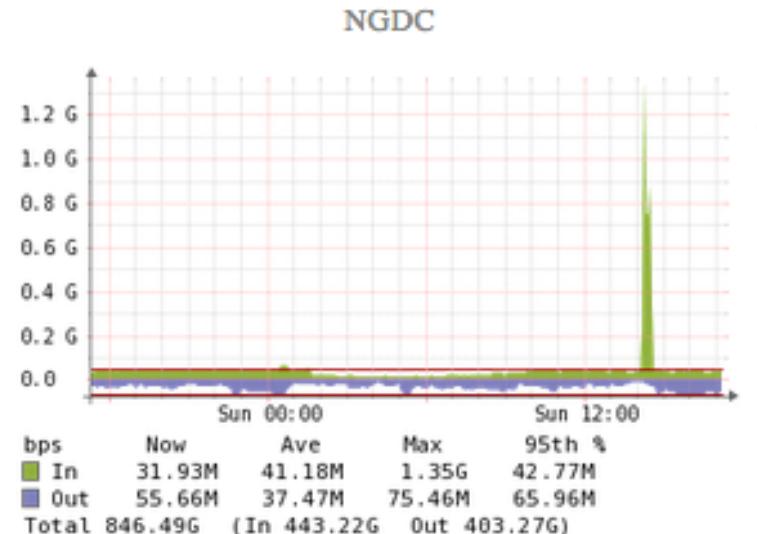
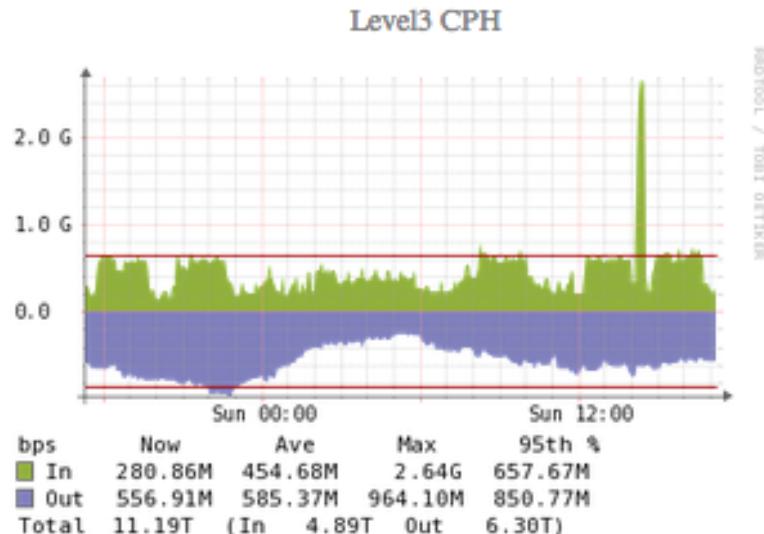
The issues have been assigned multiple CVEs: CVE-2019-11477 is considered an Important severity, whereas CVE-2019-11478 and CVE-2019-11479 are considered a Moderate severity.

The first two are related to the Selective Acknowledgement (SACK) packets combined with Maximum Segment Size (MSS), the third solely with the Maximum Segment Size (MSS).

These issues are corrected either through applying mitigations or kernel patches. Mitigation details and links to RHSA advisories can be found on the RESOLVE tab of this article.

Source: <https://access.redhat.com/security/vulnerabilities/tcpsack>

DDoS traffic before filtering



Only two links shown, at least 3Gbit incoming for this single IP

DDoS traffic after filtering



Link toward server (next level firewall actually) about 350Mbit outgoing

Better to filter stateless before traffic reaches firewall, less work!



Stateless firewall filter throw stuff away

```
hlk@MX-CPH-02> show configuration firewall filter all | no-more
/* This is a sample, better to use BGP flowspec and RTBH */
inactive: term edgeblocker {
    from {
        source-address {
            84.180.xxx.173/32;
...
            87.245.xxx.171/32;
        }
        destination-address {
            91.102.91.16/28;
        }
        protocol [ tcp udp icmp ];
    }
    then {
        count edge-block;
        discard;
    }
}
```

Hint: can also leave out protocol and then it will match all protocols

Stateless firewall filter limit protocols



```
term limit-icmp {  
    from {  
        protocol icmp;  
    }  
    then {  
        policer ICMP-100M;  
        accept;  
    }  
}  
term limit-udp {  
    from {  
        protocol udp;  
    }  
    then {  
        policer UDP-1000M;  
        accept;  
    }  
}
```

Routers also have extensive Class-of-Service (CoS) tools today

Strict filtering for some servers, still stateless!



```
term some-server-allow {  
    from {  
        destination-address {  
            109.238.xx.0/xx;  
        }  
        protocol tcp;  
        destination-port [ 80 443 ];  
    } then accept;  
}  
  
term some-server-block-unneeded {  
    from {  
        destination-address {  
            109.238.xx.0/xx; }  
        protocol-except icmp; }  
    then { count some-server-block; discard;  
    }  
}
```

Wut - no UDP, yes UDP service is not used on these servers

Firewalls - screens, IDS like features



When you know regular traffic you can decide:

```
hlk@srx-kas-05# show security screen ids-option untrust-screen
icmp {
    ping-death;
}
ip {
    source-route-option;
    tear-drop;
}
tcp {    Note: UDP flood setting also exist
    syn-flood {
        alarm-threshold 1024;
        attack-threshold 200;
        source-threshold 1024;
        destination-threshold 2048;
        timeout 20;
    }
    land;
} Always select your own settings YMMV
```

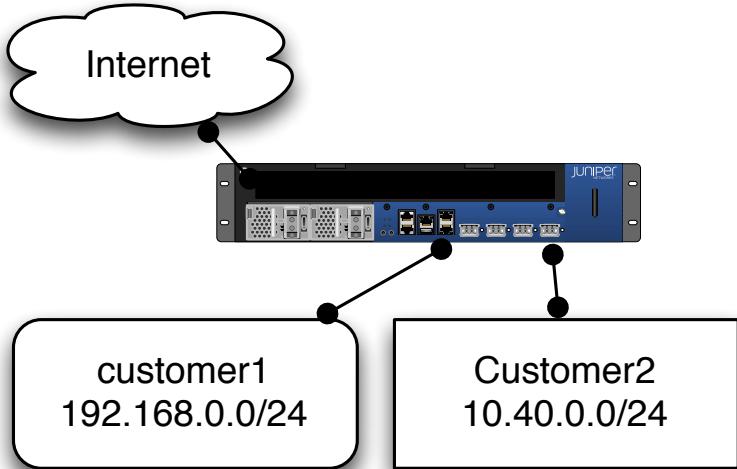


uRPF unicast Reverse Path Forwarding

Reverse path forwarding (RPF) is a technique used in modern routers for the purposes of ensuring loop-free forwarding of multicast packets in multicast routing and to help prevent IP address spoofing in unicast routing.

Source: http://en.wikipedia.org/wiki/Reverse_path_forwarding

Strict vs loose mode RPF



```
user@router# show interfaces
ge-0/0/0 {
    unit 2 {
        family inet {
            rpf-check fail-filter rpf-special-case-dhcp;
            address 192.168.0.254/24;
        }
    }
}
ge-0/0/1 {
    unit 2 {
        family inet {
            rpf-check fail-filter rpf-special-case-dhcp;
            address 10.40.0.254/24;
        }
    }
}
```

Strict mode RPF



Configuring Unicast RPF Strict Mode

In strict mode, unicast RPF checks whether the incoming packet has a source address that matches a prefix in the routing table, **and whether the interface expects to receive a packet with this source address prefix.**

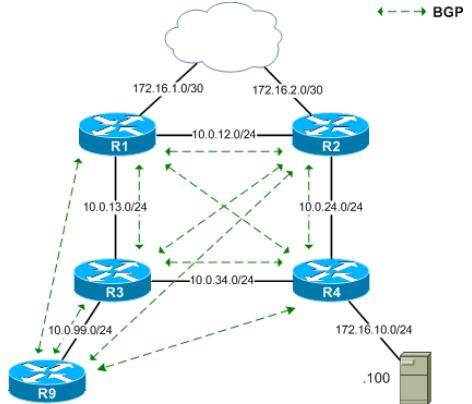
uRPF Junos config with loose mode



```
xe-5/1/1 {  
    description "Transit: Blah (AS65512)";  
    unit 0 {  
        family inet {  
            rpf-check {  
                mode loose;  
            }  
            filter {  
                input all;  
                output all;  
            }  
            address xx.yy.xx.yy/30;  
        }  
        family inet6 {  
            rpf-check {  
                mode loose;  
            }  
            address 2001:xx:yy/126;  
        } } }
```

See also: <http://www.version2.dk/blog/den-danske-internettrafik-og-bgp-49401>

Remotely Triggered Black Hole Configurations



Picture from packetlife.net showing R9 as a standalone "management" router for route injection.

<http://packetlife.net/blog/2009/jul/6/remotely-triggered-black-hole-rtbh-routing/>

<https://ripe65.ripe.net/presentations/285-inex-ripe-routingwg-amsterdam-2012-09-27.pdf> <https://www.inex.ie/rtbh>

Remotely Triggered Black Hole at upstreams



6. Black Hole Server (Optional)

```
#####
#          NOTE          #
# The Cogent Black Hole server will allow customers to announce a /32 route      #
# to Cogent and have all traffic to that network blocked at Cogents backbone.    #
# All peers on the Cogent black hole server require a password and IP address     #
# from your network for Cogent to peer with.                                     #
#####
```

[] Please set up a BGP peer on the Cogent Black Hole server

Black Hole server password:

Black Hole server peer IP:

North American Black Hole Peer: 66.28.8.1

European Black Hole Peer: 130.117.20.1

Source:

http://cogentco.com/files/docs/customer_service/guide/bgpq.sample.txt

Better drop single /32 host than whole network!



Abstract

This document defines a Border Gateway Protocol Network Layer Reachability Information (BGP NLRI) encoding format that can be used to distribute (intra-domain and inter-domain) traffic Flow Specifications for IPv4 unicast and IPv4 BGP/MPLS VPN services. This allows the routing system to propagate information regarding more specific components of the traffic aggregate defined by an IP destination prefix.

It also specifies BGP Extended Community encoding formats, which can be used to propagate Traffic Filtering Actions along with the Flow Specification NLRI. Those Traffic Filtering Actions encode actions a routing system can take if the packet matches the Flow Specification.

Source: *Dissemination of Flow Specification Rules* RFC8955

- Advanced users may also want to investigate BGP Flowspec
- Allows dynamic updating of multiple routers/firewalls/devices using BGP

More information about DDoS testing



More DDoS and testing for DDoS can be found in this presentation:

Simulated DDoS Attacks, Breaking the Firewall Infrastructure Henrik Kramselund Jereminsen

DDoS Attacks have become a daily annoyance for many, and we need to create robust infrastructure. This tutorial will go through a proposed method for testing your own infrastructure using off-the-shelf tools like packet generators hping3 and t50 on Kali Linux.

The goal for the tutorial is to explain: * How to create DDoS attack simulations * My actual experience with doing this - testing banks, etc. * Evaluate how good is this, value proposition for you

Can be found at <https://ripe72.ripe.net/wp-content/uploads/presentations/32-simulated-ddos-ripe.pdf> or
<https://github.com/kramse/security-courses/tree/master/presentations/pentest/simulated-ddos-ripe>

Firewalls og IPv6



Læg mærke til forskellen mellem ARP og ICMPv6

Hvis det er muligt lav een regel der tillader adgang til services uanset protokol

NB: husk at aktivere IP forwarding når I skal lave en firewall



IPv6 neighbor discovery protocol (NDP)

OSI	IPv4	IPv6
Network	IP / ICMP	IPv6 / ICMPv6
Link	ARP	
Physical	Physical	Physical

- ARP bruges kun til IPv4
- NDP erstatter og udvider ARP, se eksempel nedenfor
- ICMPv6 kan samtidig uddele *prefix* til subnet via router advertisement og dermed kan systemer lave egen adresse i dette subnet, inklusiv privacy extension RFC4941 adresser som skifter løbende
- DHCP i IPv6, DHCPv6 findes stadig, men knapt så nødvendig
- **NB: bemærk at ovenstående har stor betydning for firewallregler!**

ARP vs NDP



Example from Mac OS X – BSD derived operating system

```
hlk@bigfoot:basic-ipv6-new$ arp -an
? (10.0.42.1) at 0:0:24:c8:b2:4c on en1 [ethernet]
? (10.0.42.2) at 0:c0:b7:6c:19:b on en1 [ethernet]
hlk@bigfoot:basic-ipv6-new$ ndp -an
Neighbor          Linklayer Address  Netif Expire   St Flgs Prbs
::1                (incomplete)      lo0 permanent R
2001:16d8:fffd2:cf0f:21c:b3ff:fec4:e1b6 0:1c:b3:c4:e1:b6 en1 permanent R
fe80::1%lo0        (incomplete)      lo0 permanent R
fe80::200:24ff:fec8:b24c%en1 0:0:24:c8:b2:4c      en1 8h54m51s S R
fe80::21c:b3ff:fec4:e1b6%en1 0:1c:b3:c4:e1:b6      en1 permanent R
```

Note: Linux systems have moved to the command ip -4 neighbor show and ip -6 neighbor show



OpenBSD PF IPv6 NDP

```
# Macros: define common values, so they can be referenced and changed easily.
int_if=vr0
ext_if=vr2
tunnel_if=gif0
table <homenet6> 2001:16d8:ffd2:cf0f::/64
set skip on lo0
scrub in all
# Filtering: the implicit first two rules are
block in all

# allow ICMPv6 for NDP
# server with configured IP address and router advertisement daemon running
pass in inet6 proto ipv6-icmp all icmp6-type neighbradv keep state
pass out inet6 proto ipv6-icmp all icmp6-type routersol keep state

# client which uses autoconfiguration would use this instead
#pass in inet6 proto ipv6-icmp all icmp6-type routeradv keep state
#pass out inet6 proto ipv6-icmp all icmp6-type neighbrsol keep state

... probably not working AS IS
```



IPv4 + IPv6 serviceeksempel, med tables

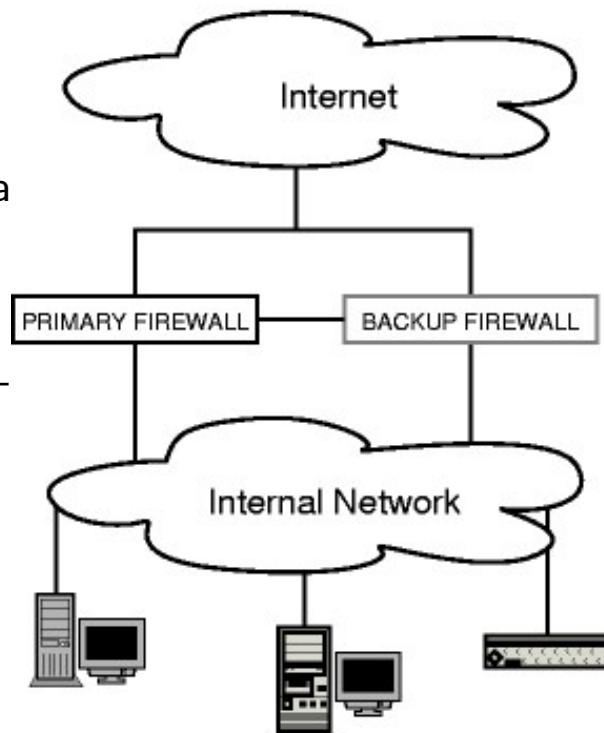
PF har tabeller og simpel regel til PF konfigurationsfilen kan give adgang til både IPv4 og IPv6:

```
table <webservers> { 2001:7b8:3e4:72::20 10.0.72.20 }  
...  
pass in on $ext_if proto tcp to <webserver> port http
```

Redundante firewalls

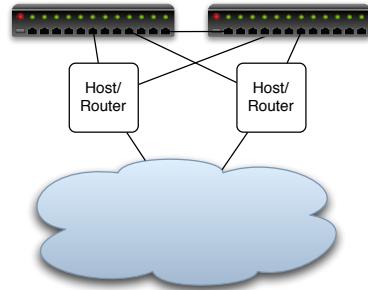


- Mange producenter giver mulighed for redundante firewalls/routere
- Eksempler med fail-over protokoller som: VRRP, CARP, HSRP Cisco, VARP Arista
- OpenBSD Common Address Redundancy Protocol (CARP) - både IPv4 og IPv6 overtagelse af adresse både IPv4 og IPv6
- pfSync - sender opdateringer om firewall states mellem de to systemer, den synchroniserer alt state på PF ind og udgående, inklusiv NAT.





Redundante forbindelser IP-niveau



HSRP Hot Standby Router Protocol, Cisco protokol, RFC-2281

VRRP Virtual Router Redundancy Protocol, IETF RFC-3768, åben standard - ikke fri

CARP Common Address Redundancy Protocol, findes på OpenBSD og FreeBSD

http://en.wikipedia.org/wiki/Common_Address_Redundancy_Protocol

For Next Time



Think about the subjects from this time, write down questions

Check the plan for chapters to read in the books

Visit web sites and download papers if needed

Retry the exercises to get more confident using the tools