Welcome to

Network Security Basics

Learn to defend your organisation

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Slides are available as PDF, kramse@Github

network-security-basics.tex in the repo security-courses

Contact information

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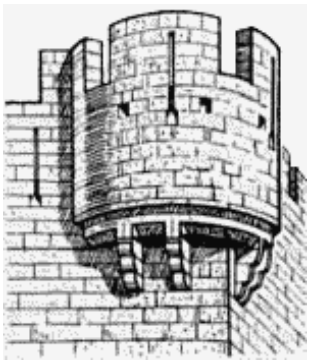
You are welcome to drop me an email

Goals: Network Security Basics



My overall goal

- Introduce networking and related security issues
- Introduce resources, programs, people, authors, documents, sites that further your exploration into network security

Plan for today

A blue-team introduction to Communication and Network Security

- Network information TCP/IP
- Challenges in network security
- The basic tools for countering threats
- Introduce the encryption protocols in use in networks
  Virtual Private Network (VPN) and Transport Layer Services (TLS).
- Network segmentation will be discussed
- How tools like Firewalls, Access Control Lists (ACL) and VLANs can help reduce risk for the network.
- Examples from Zeek Security Monitor for getting information about flows

Duration: 4 hours - with breaks

Keywords: Encryption, TLS, VPN, VLAN IEEE 802.1q, Wifi security, IEEE 802.1x, IKE version 2, IPsec

Time schedule

- 17:00 - 18:15
  Introduction and basics
- 30min break
- 18:45 - 19:30 45min
- 15min break
- 19:45 - 21:00
  break somewhere

About equipment and exercises

- Bringing a laptop is not required, but welcome.
- Exercises booklets are available for many of my courses, see Github
  but it is expected that participants will do any exercises on their own later or at the scheduled hacker days
- The hacker days will be announced in various places
- Events like BornHack are excellent places to arrange hacker days in the network warrior village, or other places

Invite a few friends, make a hacker day and work together!

Course Materials

This material is in multiple parts:

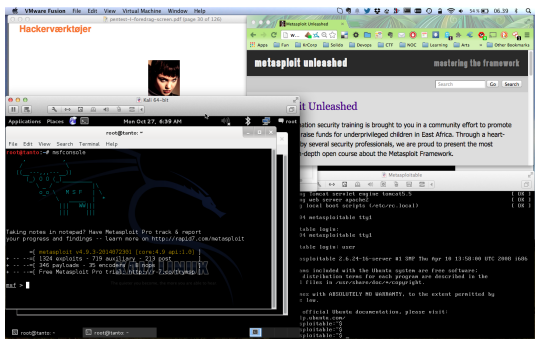
- Slide shows - presentation - this file
- Exercises - PDF files in my repository

Links

- All materials will be released as open source at:
  `https://github.com/kramse/security-courses/`
- Additional resources from the internet linked from lecture plans:
  `https://zencurity.gitbook.io/kea-it-sikkerhed/`

Note: slides and materials will mostly be in english, but presentation language will be danish

Hackerlab Setup



- Hardware: modern laptop CPU with virtualisation
  Dont forget to enable hardware virtualisation in the BIOS
- Software Host OS: Windows, Mac, Linux
- Virtualisation software: VMware, Virtual box, HyperV pick your poison
- Hackersoftware: Kali Virtual Machine `https://www.kali.org/`

Networking Hardware

If you want to do exercises, sniffing data it
will be an advantage to have a wireless USB network card.

- The following are two recommended models:
- TP-link TL-WN722N hardware version 2.0 cheap
- Alfa AWUS036ACH 2.4GHz + 5GHz Dual-Band and high performing
- Often you need to compile drivers yourself, and research a bit
- Get an USB 3.0 1Gbit Ethernet too

Getting an USB card allows you to use the regular one for the main OS, and insert the USB into the virtual machine

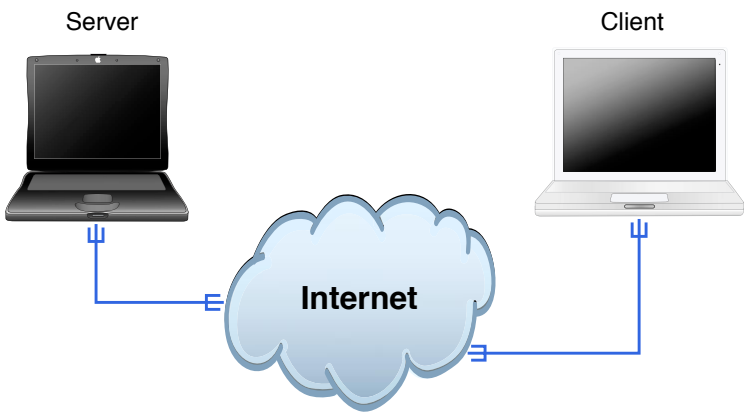
Aftale om test af netværk

Straffelovens paragraf 263 Stk. 2. Med bøde eller fængsel indtil 6 måneder straffes den, som uberettiget skaffer sig adgang til en andens oplysninger eller programmer, der er bestemt til at bruges i et anlæg til elektronisk databehandling.

Hacking kan betyde:

- At man skal betale erstatning til personer eller virksomheder
- At man får konfiskeret sit udstyr af politiet
- At man, hvis man er over 15 år og bliver dømt for hacking, kan få en bøde - eller fængselsstraf i alvorlige tilfælde
- At man, hvis man er over 15 år og bliver dømt for hacking, får en plettet straffeattest. Det kan give problemer, hvis man skal finde et job eller hvis man skal rejse til visse lande, fx USA og Australien
- Frit efter: `http://www.stophacking.dk` lavet af Det Kriminalpræventive Råd
- Frygten for terror har forstærket ovenstående - så lad være!

Internet Today



- Clients and servers, roots in the academic world
- Protocols are old, some more than 20 years
- Very little is encrypted, mostly HTTPS

Internet is based on Open Standards and collaboration!

> We reject kings, presidents, and voting.
> We believe in rough consensus and running code.
> – The IETF credo Dave Clark, 1992.

- Request for comments - RFC – series of documents describing internet standards
- RFC, BCP, FYI, informational
  First ones from 1969
- Never changed but status changed to Obsoleted when a never version or document superseeds it
  (Errata exist and are published though)
- Standards track:
  Proposed Standard $\rightarrow$ Draft Standard $\rightarrow$ Standard
- Open standards gurantee transparency, but not security

What is the Internet

Communication between humans - currently!

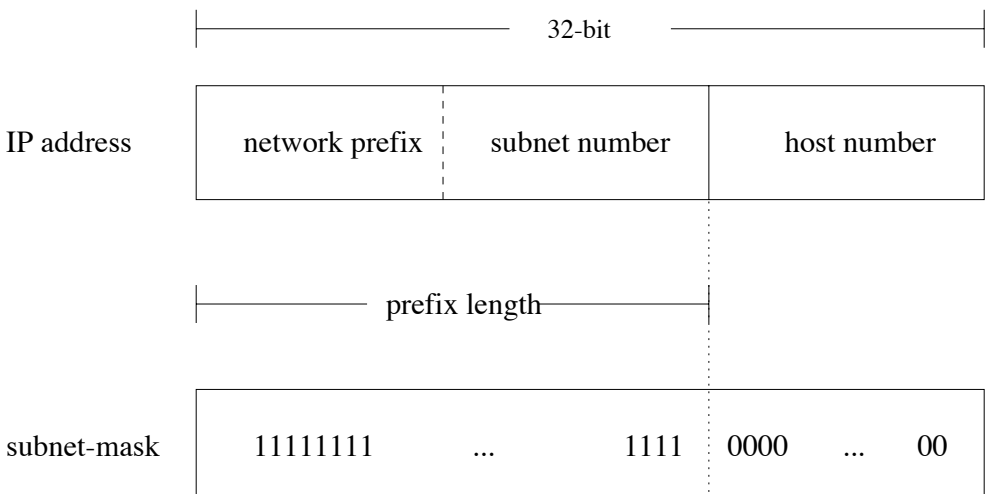
Based on TCP/IP

- best effort
- packet switching (IPv6 calls it packets, not datagram)
- *connection-oriented* TCP
- *connection-less* UDP

RFC-1958:

> A good analogy for the development of the Internet is that of constantly renewing the individual streets and buildings of a city, rather than razing the city and rebuilding it. The architectural principles therefore aim to provide a framework for creating cooperation and standards, as a small "spanning set"of rules that generates a large, varied and evolving space of technology.

Common Address Space



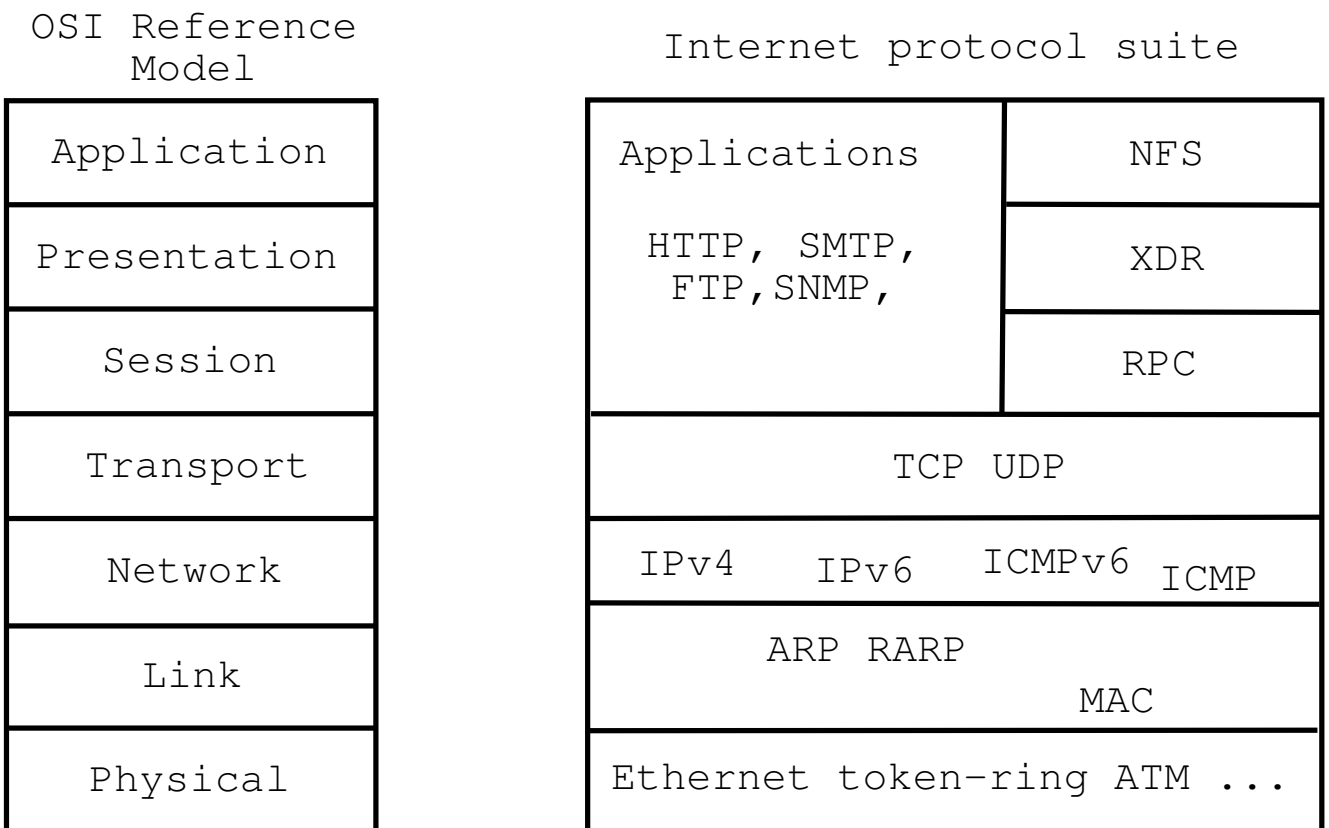
- Internet is defined by the address space, one
- Based on 32-bit addresses, example dotted decimal format 10.0.0.1

CIDR Classless Inter-Domain Routing

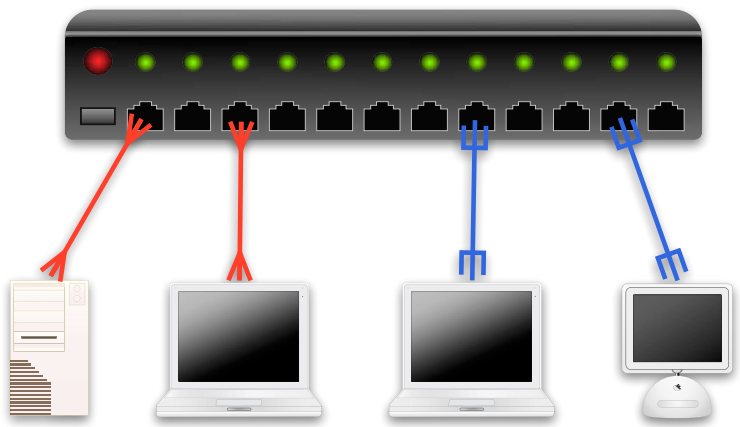
Classful routing		Classless routing CIDR	
4 class C networks	Inherent subnet mask	Supernet	Subnet mask
192.0.8.0	255.255.255.0	192.0.8.0	255.255.252.0
192.0.9.0	255.255.255.0		252d=11111100b
192.0.10.0	255.255.255.0		
192.0.11.0	255.255.255.0	Base network/prefix	
		192.10.8.0/22	

- Subnet mask originally inferred by the class
- Started to allocate multiple C-class networks - save remaining B-class
  Resulted in routing table explosion
- A subnet mask today is a row of 1-bit
- 10.0.0.0/24 means the network 10.0.0.0 with subnet mask 255.255.255.0
- Supernet, supernetting

OSI and Internet models



A switch



Today we use switches, Don't buy a hub, not even for experimenting or sniffing

A switch can receive and send data on multiple ports at the same time

Performance only limited by the backplane and switching chips

Can also often route with the same speed

MAC address

```
00-03-93    (hex)        Apple Computer, Inc.
000393      (base 16)    Apple Computer, Inc.
                         20650 Valley Green Dr.
                         Cupertino CA 95014
                         UNITED STATES
```

Network technologies use a layer 2 hardware address

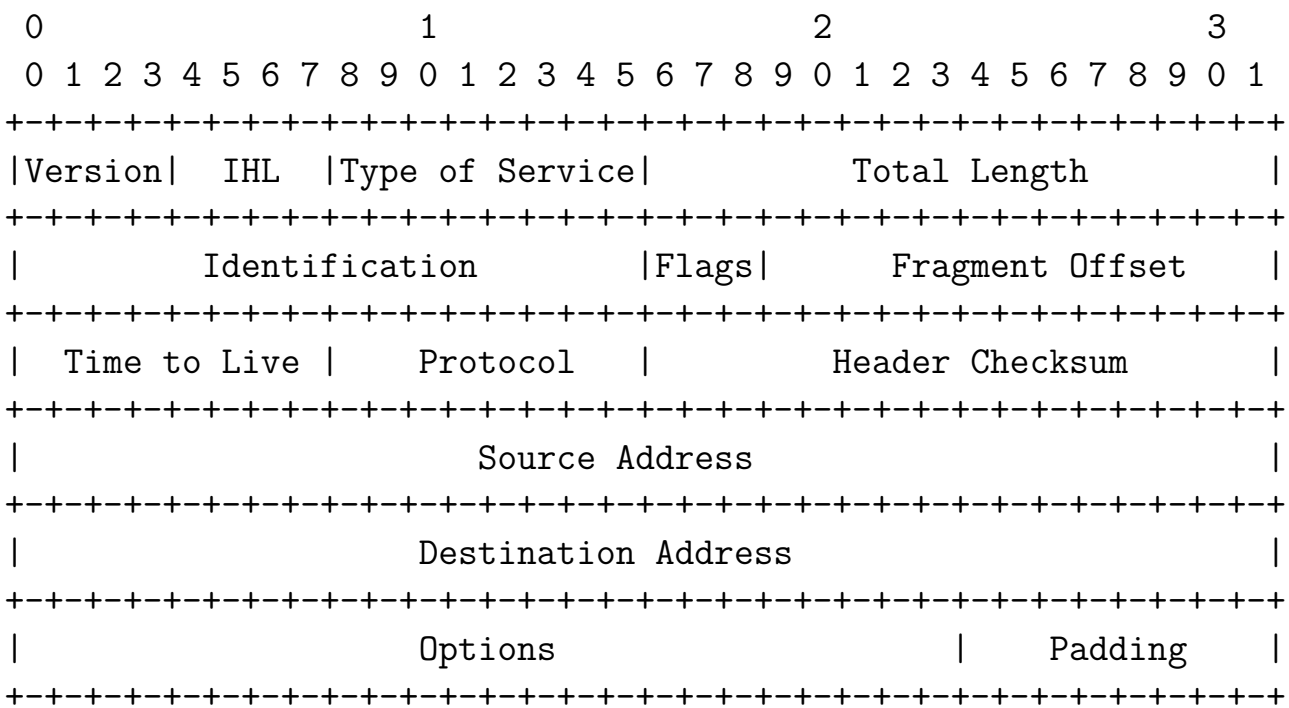
Typically using 48-bit MAC addresses known from Ethernet MAC-48/EUI-48

First half is assigned to companies – Organizationally Unique Identifier (OUI)

Using the OUI you can see which producer and roughly when a network chip was produced

`http://standards.ieee.org/regauth/oui/index.shtml`

IPv4 packets – header - RFC-791



Example Internet Datagram Header

Basic test tools TCP - Telnet and OpenSSL

Telnet used for terminal connections over TCP, but is clear-text

Telnet can be used for testing connections to many older protocols which uses text commands

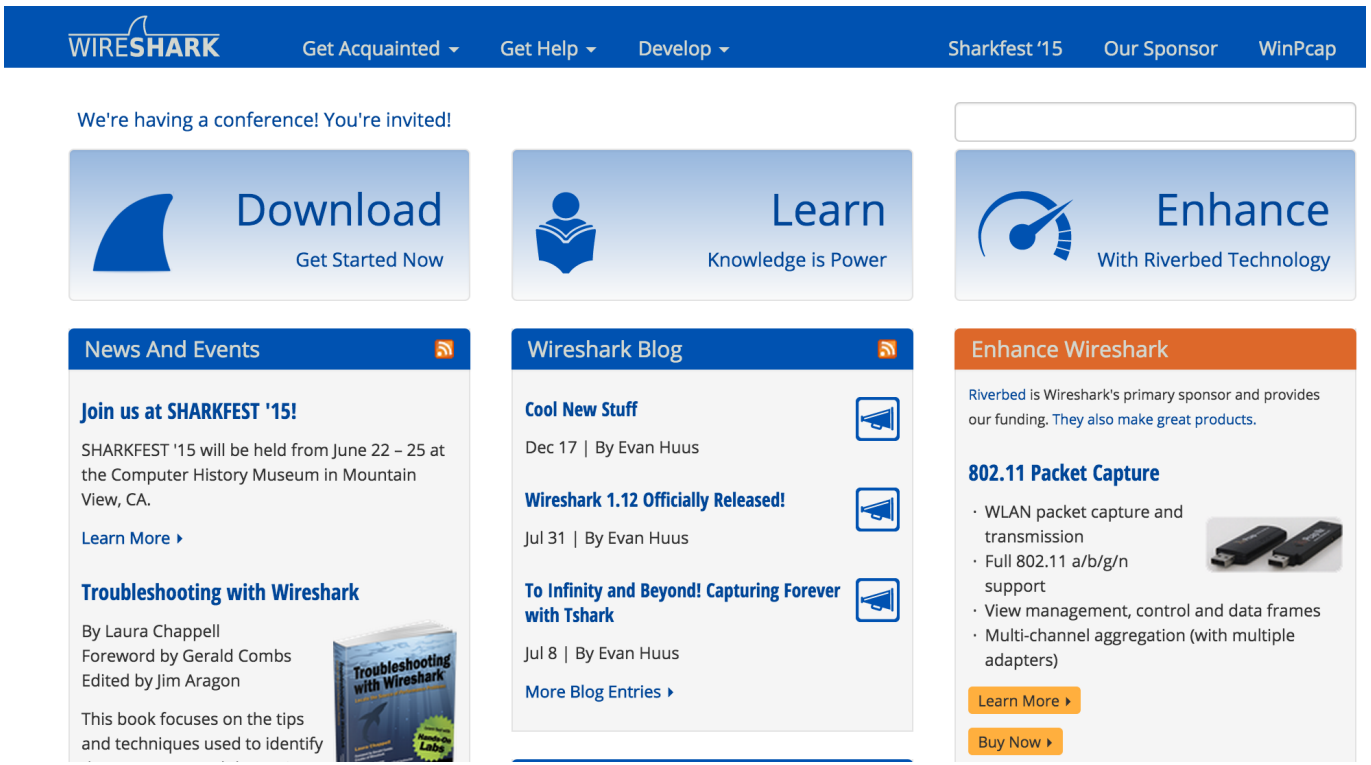
- `telnet mail.kramse.dk 25` create connection to port 25/tcp
- `telnet www.kramse.dk 80` create connection to port 80/tcp

Encrypted connections often use TLS and can be tested using OpenSSL command line tool `openssl`

- `openssl s_client -host www.kramse.dk -port 443`
  create connection to port 443/tcp with TLS
- `openssl s_client -host mail.kramse.dk -port 993`
  create connection to port 993/tcp with TLS

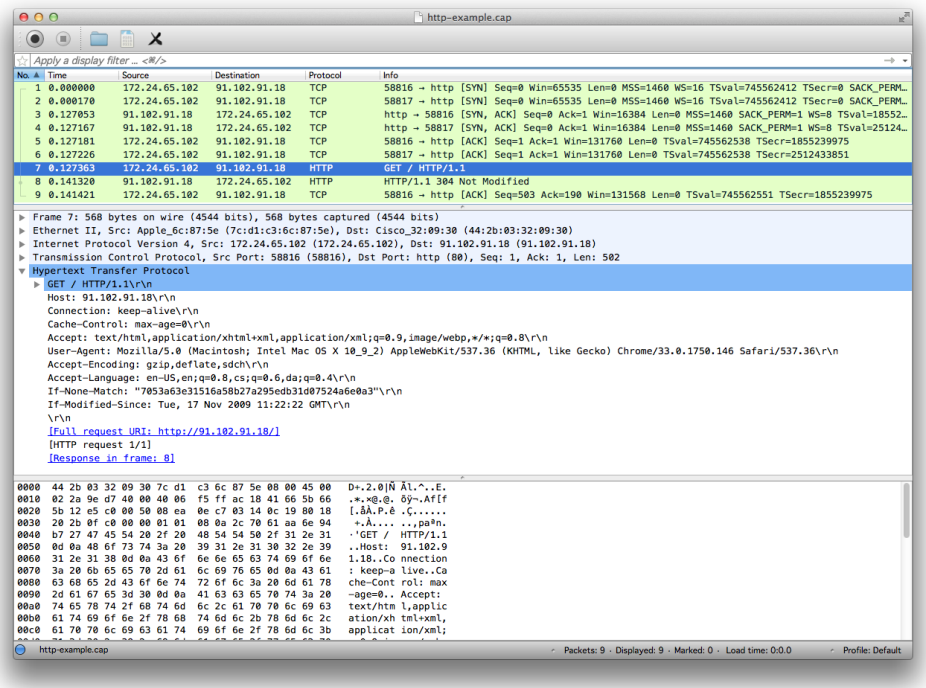
Using OpenSSL in client-mode allows the use of the same commands like Telnet after connection

Wireshark - graphical network sniffer



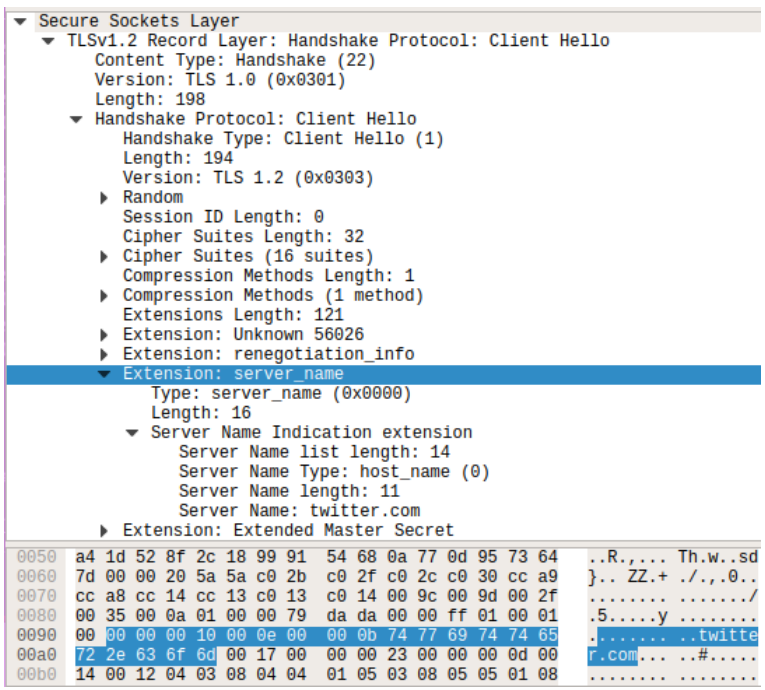
http://www.wireshark.org

Using Wireshark



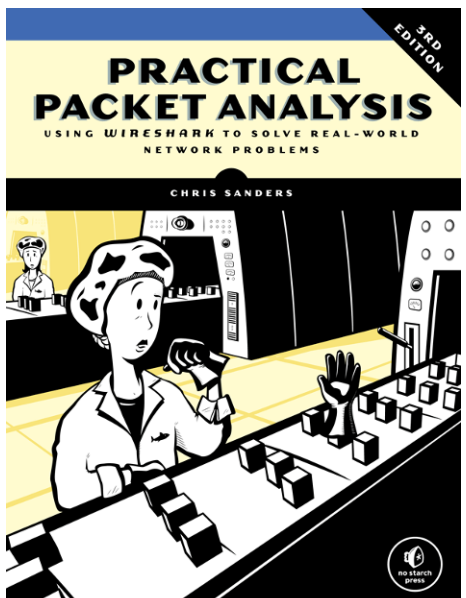
Capture - Options, select a network interface

Detailed view of network traffic with Wireshark



Notice also the filtering possibilities, capture and view

Book: Practical Packet Analysis (PPA)



Practical Packet Analysis, Using Wireshark to Solve Real-World Network Problems by Chris Sanders, 3rd Edition April 2017, 368 pp. ISBN-13: 978-1-59327-802-1

`https://nostarch.com/packetanalysis3`

Note About Hardware IPv4 checksum offloading

IPv4 checksum must be calculated for every packet received

IPv4 checksum must be calculated for every packet sent

Usually on a router the Time To Live is decremented, to need re-calculation

Let an ASIC chip on the network card do the work!

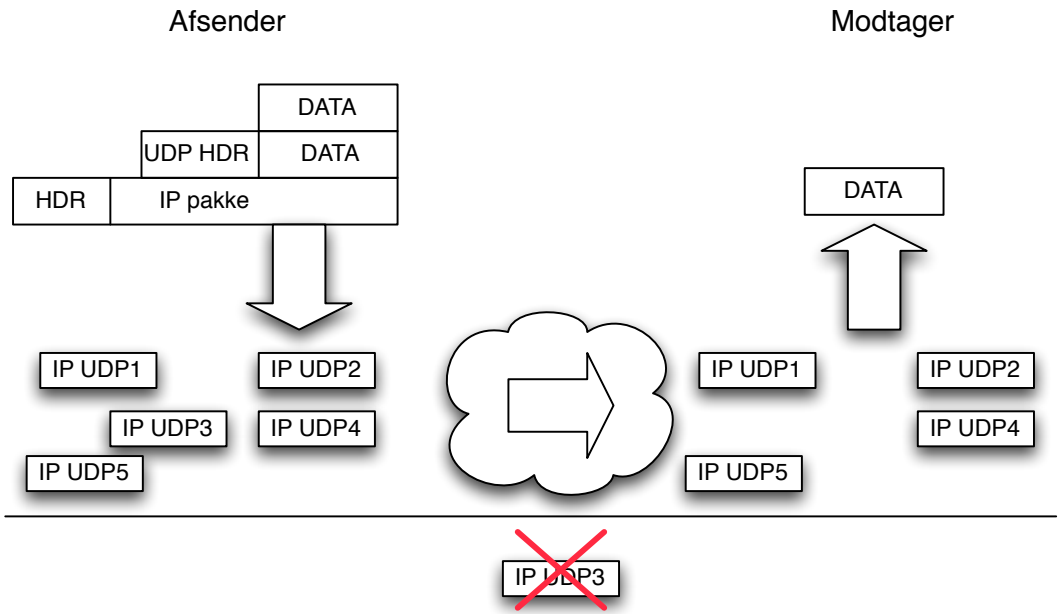
Most server network chips today support this and more

Benefit for performance, but beware when using security tools

If every packet in wireshark has wrong checksum, its the network card doing it

Can be turned off, when doing security work

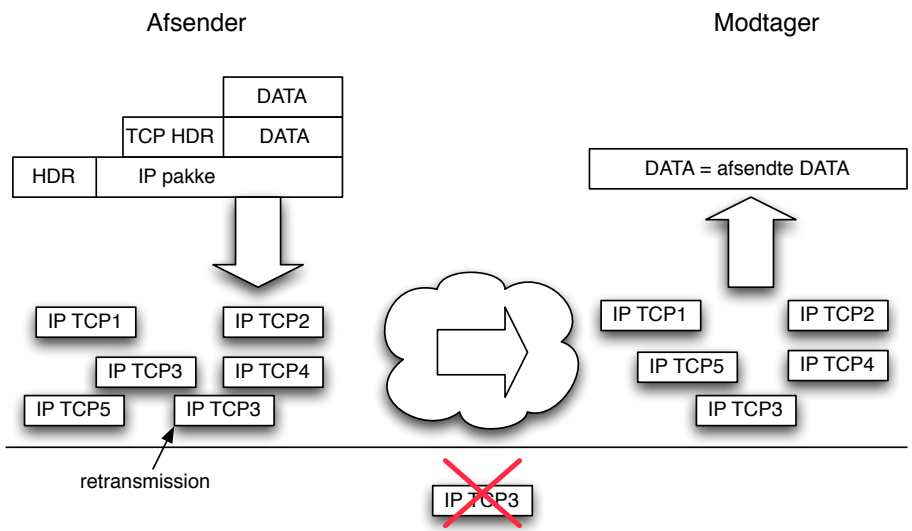
UDP User Datagram Protocol



Connection-less RFC-768, *connection-less*

Used for Domain Name Service (DNS)

TCP Transmission Control Protocol

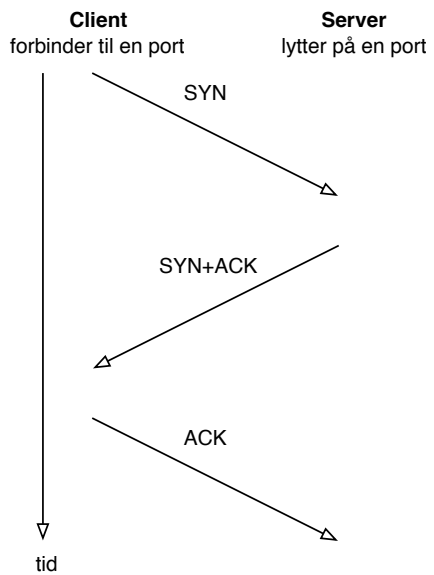


Connection oriented RFC-791 September 1981, *connection-oriented*

Either data delivered in correct order, no data missing, checksum or an error is reported

Used for HTTP and others

TCP three way handshake



- Session setup is used in some protocols
- Other protocols like HTTP/2 can perform request in the first packet

Well-known port numbers

IANA maintains a list of magical numbers in TCP/IP

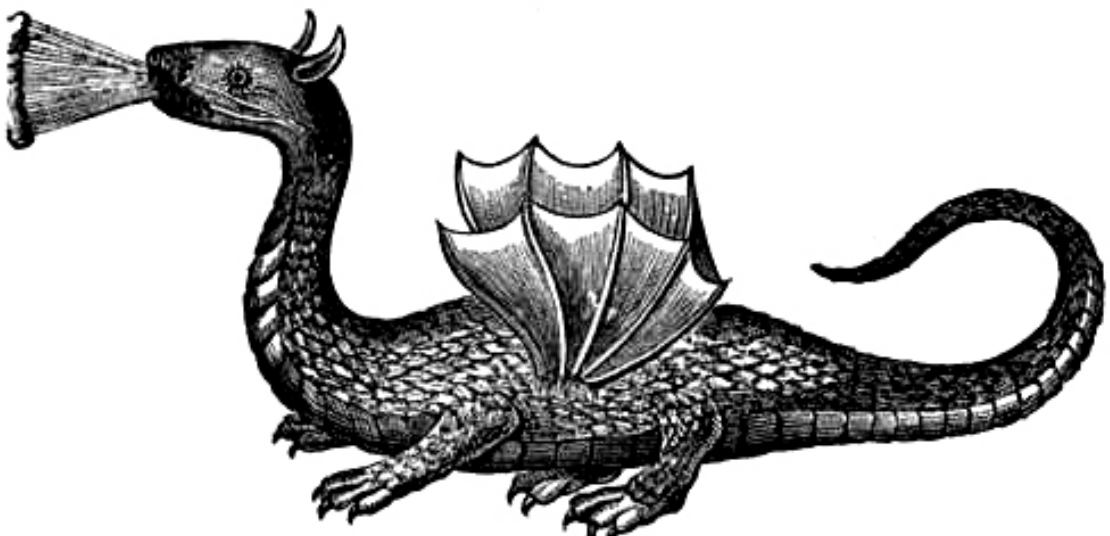
Lists of protocl numbers, port numers etc.

A few notable examples:

- Port 25/tcp Simple Mail Transfer Protocol (SMTP)
- Port 53/udp and 53/tcp Domain Name System (DNS)
- Port 80/tcp Hyper Text Transfer Protocol (HTTP)
- Port 443/tcp HTTP over TLS/SSL (HTTPS)

Source: `http://www.iana.org`

Challenges in network security



Internet here be dragons

Security problems in the TCP/IP Suite

The paper "Security Problems in the TCP/IP Protocol Suite" was originally pub- lished in Computer Communication Review, Vol. 19, No. 2, in April, 1989

Problems described in the original:

- sequence number spoofing
- source address spoofing
- routing attacks,
- authentication attacks

Should have been fixed by now!

TCP sequence number prediction

2. TCP SEQUENCE NUMBER PREDICTION

One of the more fascinating security holes was first described by Morris [7] . Briefly, he used TCP sequence number prediction to construct a TCP packet sequence without ever receiving any responses from the server. This allowed him to spoof a trusted host on a local network.

Previously access was granted by the source IP address you connected from, address based authentication. Not a realiable or secure authentication mechanism

Difficult on modern operating systems, hmmm Internet of Things?

We still use filters to allow people to access a port/service, but they must provide real authentication – password, code, certificate

Routing attacks

Routing problems described in the original from 1989:

- IP Source routing attacks - provide a route for packets
  Not very usable in the original form, see VXLAN and MPLS instead
- Routing Information Protocol Attacks
  The Routing Information Protocol [15] (RIP) - RIP is dead, outdated
- BGPv4 used today, and continously have major issues, patches on patches and bad configurations

Check other low level attacks from `https://github.com/tomac/yersinia`

So we still have problems on all layers

Solutions to TCP sequence problems

> The JSOF research lab has discovered a series of zero-day vulnerabilities in a widely used low-level TCP/IP software library developed by Treck, Inc. The 19 vulnerabilities, given the name Ripple20, affect hundreds of millions of devices (or more) and include multiple remote code execution vulnerabilities.

Source: `https://www.jsof-tech.com/ripple20/`

Solutions:

- Use RANDOM TCP sequence numbers, Win/Mac OS X/Linux - DO
- IoT does not, and have lots of problems, quote above is one example

Routing and BGP Solutions

- Filtrering, ingress / egress:
  "reject external packets that claim to be from the local net"
- See also Reverse Path forwarding `https://en.wikipedia.org/wiki/Reverse-path_forwarding`
- Routers and routing protocols must be more skeptical
  Routing filters implemented everywhere, auth on routing protocols OSPF/BGP etc.
- Has been recommended for some years, but not done in all organisations
- BGP routing Resource Public Key Infrastructure RPKI
- BCP38 is RFC2827: *Network Ingress Filtering: Defeating Denial of Service Attacks which employ IP Source Address Spoofing*
  `http://www.bcp38.info/`
- *Mutually Agreed Norms for Routing Security*, `https://www.manrs.org/`

DNS problems

5.3 The Domain Name System

The Domain Name System (DNS) [32][33] provides for a distributed database mapping host names to IP addresses. An intruder who interferes with the proper operation of the DNS can mount a variety of attacks, including denial of service and password collection. There are a number of vulnerabilities.

Source: *Security Problems in the TCP/IP Protocol Suite*, S.M. Bellovin
`https://www.cs.columbia.edu/~smb/papers/ipext.pdf`

We have a lot of the same problems in DNS today

Plus some more caused by middle-boxes, NAT, DNS size, DNS inspection

- DNS must allow both UDP and TCP port 53
- Your DNS servers must have updated software, see DNS flag days https://dnsflagday.net/ after which kludges will be REMOVED!
- Use DNSSEC, DANE etc. Presentation for another day!

SNMP problems

5.5 Simple Network Management Protocol

The Simple Network Management Protocol (SNMP) [37] has recently been defined to aid in network management. Clearly, access to such a resource must be heavily protected. The RFC states this, but also allows for a null authentication service; this is a bad idea. **Even a "read-only" mode is dangerous;** it may expose the target host to netstat-type attacks if the particular Management Information Base (MIB) [38] used includes sequence numbers. (The current standardized version does not; however, the MIB is explicitly declared to be extensible.)

Source: *Security Problems in the TCP/IP Protocol Suite*, S.M. Bellovin
`https://www.cs.columbia.edu/~smb/papers/ipext.pdf`

True - still there, still useful, still dangerous – use SNMPv3!

local networks

6.1 Vulnerability of the Local Network

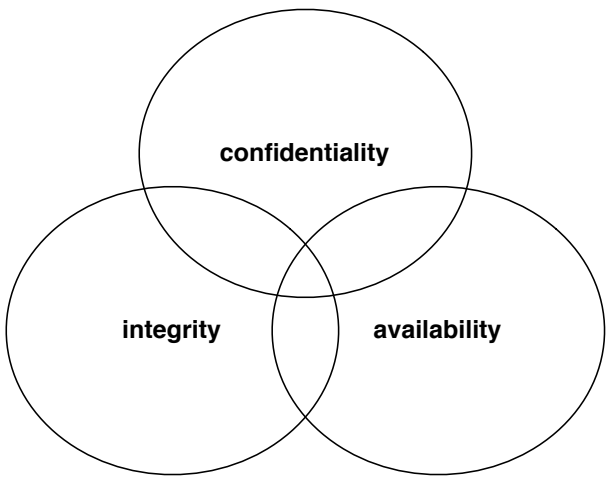
Some local-area networks, notably the Ethernet networks, are extremely vulnerable to eavesdropping and host-spoofing. If such networks are used, physical access must be strictly controlled. It is also unwise to trust any hosts on such networks if any machine on the network is accessible to untrusted personnel, unless authentication servers are used. If the local network uses the Address Resolution Protocol (ARP) [42] more subtle forms of host-spoofing are possible. In particular, it becomes trivial to intercept, modify, and forward packets, rather than just taking over the host's role or simply spying on all traffic.

Today we can send MPLS or VXLAN spoofed packets across the internet/layer 3 and inject ARP behind firewalls, in some cloud infrastructure cases ...

`https://github.com/kramse/security-courses/tree/master/presentations/network/vxlan-troopers19`

A Look Back at "Security Problems in the TCP/IP Protocol Suite" about 1989 + 31 years = 2020 – wow

Confidentiality Integrity Availability



We want to protect something

Confidentiality - data holdes hemmelige

Integrity - data ændres ikke uautoriseret

Availability - data og systemet er tilgængelige når de skal bruges

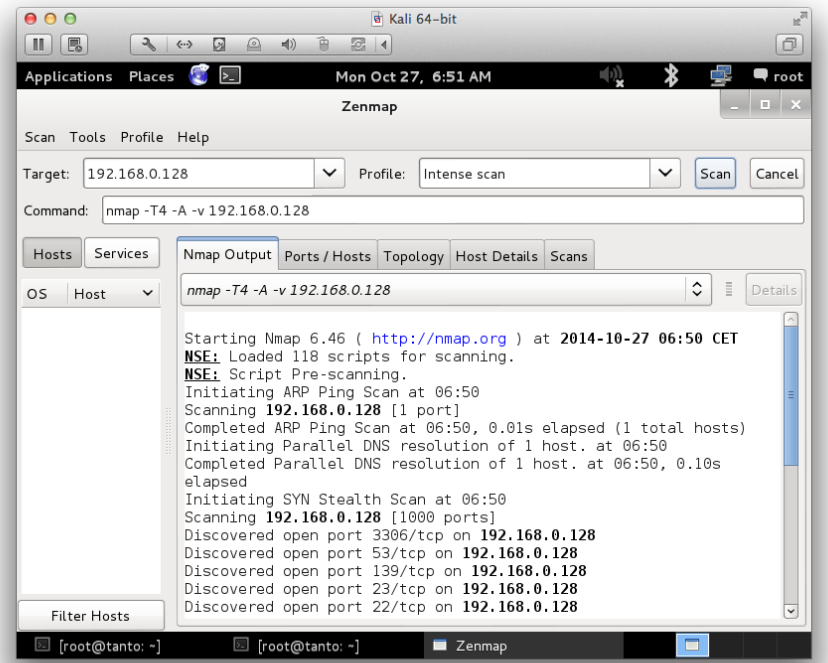
The basic tools for countering threats

- Networks have end-points and conversations on multiple layers
- Wireshark is advanced, try right-clicking different places
- Name resolution includes low level MAC addresses, and IP - names
- More than 1000 dissectors, but beware some have security issues!

- TShark and Tcpdump, I often use: `tcpdump -nei eth0`
  `tshark -z expert -r download-slow.pcapng`
- Remote packet dumps, `tcpdump -i eth0 -w packets.pcap`
- Story: tcpdump was originally written in 1988 by Van Jacobson, Sally Floyd, Vern Paxson and Steven McCanne who were, at the time, working in the Lawrence Berkeley Laboratory Network Research Group
  `https://en.wikipedia.org/wiki/Tcpdump`

Great network security comes from knowing networks!

Portscan using Zenmap GUI



Zenmap is included in the Nmap binary RPM package `https://nmap.org`

All attacks have signatures, some more noisy than others

Table 12-1: Common Passive Fingerprinting Values

Protocol header	Field	Default value	Platform
IP	Initial time to live	64	NMap, BSD, OS X, Linux
		128	Novell, Windows
		255	Cisco IOS, Palm OS, Solaris
IP	Don't fragment flag	Set	BSD, OS X, Linux, Novell, Windows, Palm OS, Solaris
		Not set	Nmap, Cisco IOS
TCP	Maximum segment size	0	Nmap
		1440–1460	Windows, Novell
		1460	BSD, OS X, Linux, Solaris

(continued)

Systems can also be fingerprinted on various levels

Discover, filter, harden, reduce attack surfaces

Know your network!

FTP File Transfer Protocol

File Transfer Protocol – file transfer

FTP send the data, including username and pasword in cleartext messages
USER username og
PASS your-not-so-secret-password

Some varianets can use TLS, but IMHO better to use HTTPS or SCP/SFTP over Secure Shell protocol

please kill FTP when you see it!

Person in the middle attacks

- ARP spoofing, ICMP redirects, the classics
- Used to be called Man in The Middle MiTM
- ICMP redirect
- ARP spoofing
- Wireless listening and spoofing higher levels like airpwn-ng `https://github.com/ICSec/airpwn-ng`
- Usually aimed at unencrypted protocols
- Yes, you can do ARP spoofing on a switched network
- Yes, segment your network to avoid it – use IEEE 802.1q VLANs

Network Security Threats

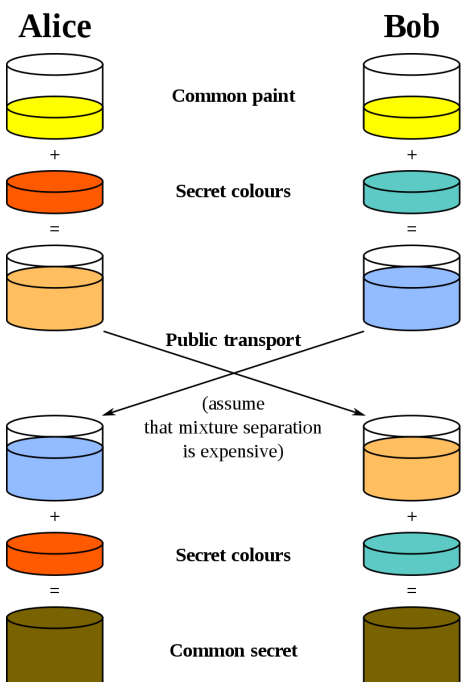
Low level and Network Layer Attacks

- "Yersinia is a network tool designed to take advantage of some weakeness in different network protocols. It pretends to be a solid framework for analyzing and testing the deployed networks and systems."
  evil l2 tools - STP, CDP, DTP, DHCP, HSRP, IEEE 802.1Q, IEEE 802.1X, ISL, VTP
  `https://github.com/tomac/yersinia`
- IP based creating strange fragments, overlapping, missing, SMALLL with fragroute/fragrouter
- LAND - same destination and source address
- THC-IPV6 - attacking the IPV6 protocol suite

Note: Evil repeats itself, like doing ARP poisoning across MPLS or VXLAN

Attackers are very creative!

Use the encryption protocols in networks



Picture from `https://en.wikipedia.org/wiki/Diffie%E2%80%93Hellman_key_exchange`

Cryptography

Cryptography or cryptology is the practice and study of techniques for secure communication

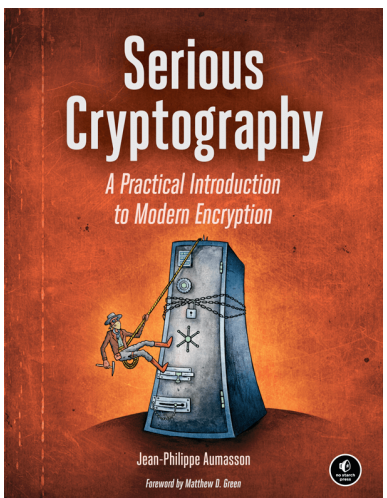
Modern cryptography is heavily based on mathematical theory and computer science practice; cryptographic algorithms are designed around computational hardness assumptions, making such algorithms hard to break in practice by any adversary

Symmetric-key cryptography refers to encryption methods in which both the sender and receiver share the same key, to ensure confidentiality, example algorithm AES

Public-key cryptography (like RSA) uses two related keys, a key pair of a public key and a private key. This allows for easier key exchanges, and can provide confidentiality, and methods for signatures and other services

Source: `https://en.wikipedia.org/wiki/Cryptography`

Serious Cryptography



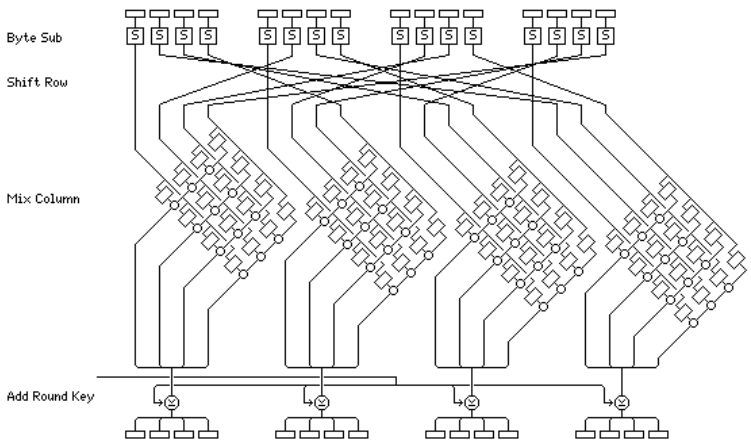
Serious Cryptography A Practical Introduction to Modern Encryption by Jean-Philippe Aumasson November 2017, 312 pp. ISBN-13: 978-1-59327-826-7 `https://nostarch.com/seriouscrypto`

RSA

> RSA (Rivest–Shamir–Adleman) is one of the first public-key cryptosystems and is widely used for secure data transmission. ... In RSA, this asymmetry is based on the practical difficulty of the factorization of the product of two large prime numbers, the "factoring problem". The acronym RSA is made of the initial letters of the surnames of Ron Rivest, Adi Shamir, and Leonard Adleman, who first publicly described the algorithm in 1978.

- Key sizes 1,024 to 4,096 bit typical
- Quote from: `https://en.wikipedia.org/wiki/RSA_(cryptosystem)`

AES Advanced Encryption Standard



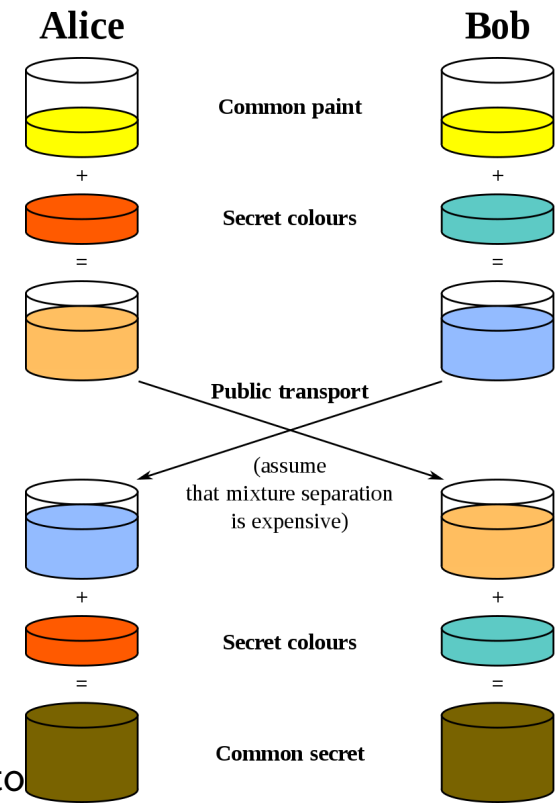
- The official Rijndael web site displays this image to promote understanding of the Rijndael round transformation [8].
- Key sizes 128,192,256 bit typical
- Some extensions in cryptosystems exist: XTS-AES-256 really is 2 instances of AES-128 and 384 is two instances of AES-192 and 512 is two instances of AES-256
- `https://en.wikipedia.org/wiki/Advanced_Encryption_Standard`

Elliptic Curve

> Elliptic-curve cryptography (ECC) is an approach to public-key cryptography based on the algebraic structure of elliptic curves over finite fields. ECC requires smaller keys compared to non-EC cryptography (based on plain Galois fields) to provide equivalent security.[1]

- Today we also use elliptic curve math for encryption `https://en.wikipedia.org/wiki/Elliptic-curve_cryptography`
- A lot of what we do is based on the works by Dan J. Bernstein `https://cr.yp.to/` with others
- Example curve Curve25519 `https://en.wikipedia.org/wiki/Curve25519`:
  Also in 2018, RFC 8446 was published as the new Transport Layer Security v1.3 standard. It requires mandatory support for X25519, Ed25519, X448, and Ed448 algorithms.[24]

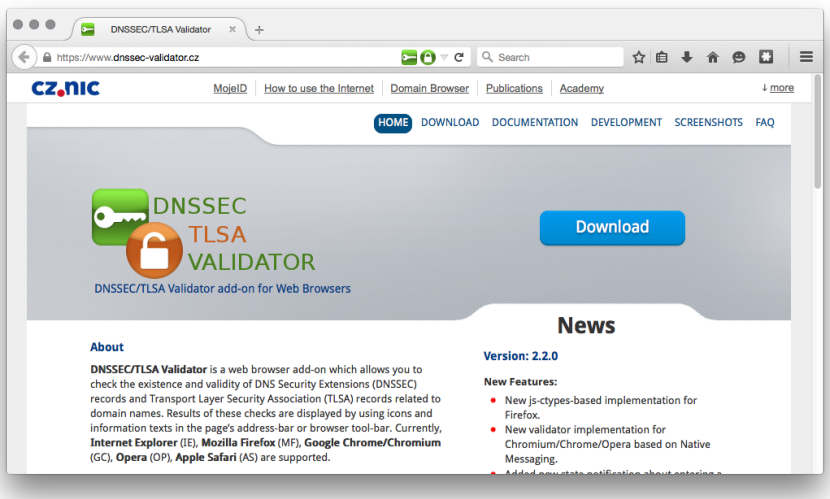
Encryption on the web – Diffie Helman exchange



> Diffie–Hellman key exchange (DH)[nb 1] is a method of securely exchanging cryptographic keys over a public channel and was one of the first public-key protocols as originally conceptualized by Ralph Merkle and named after Whitfield Diffie and Martin Hellman.[1][2] DH is one of the earliest practical examples of public key exchange implemented within the field of cryptography. ... The scheme was first published by Whitfield Diffie and Martin Hellman in 1976

- Quote from: `https://en.wikipedia.org/wiki/Diffie-Hellman_key_exchange`
- This is used as part of Transport Layer Security (TLS)
- Stanford professor Dan Boneh and Victor Shoup are creating a graduate course crypto book `https://toc.cryptobook.us/`

DNSSEC get started now



"TLSA records store hashes of remote server TLS/SSL certificates. The authenticity of a TLS/SSL certificate for a do
by DANE protocol (RFC 6698). DNSSEC and TLSA validation results are displayer by using several icons."

DNSSEC and DANE

"Objective:

Specify mechanisms and techniques that allow Internet applications to establish cryptographically secured communications by using information distributed through DNSSEC for discovering and authenticating public keys which are associated with a service located at a domain name."

DNS-based Authentication of Named Entities (dane)

Email security 2020 – Goals

- SPF Sender Policy Framework

  `https://en.wikipedia.org/wiki/Sender_Policy_Framework`
- DKIM DomainKeys Identified Mail

  `https://en.wikipedia.org/wiki/DomainKeys_Identified_Mail`
- DMARC Domain-based Message Authentication, Reporting and Conformance

  `https://en.wikipedia.org/wiki/DMARC`
- DANE DNS-based Authentication of Named Entities

  `https://en.wikipedia.org/wiki/DNS-based_Authentication_of_Named_Entities`

SMTP TLS

> The STARTTLS command for IMAP and POP3 is defined in RFC 2595, for SMTP in RFC 3207, for XMPP in RFC 6120 and for NNTP in RFC 4642. For IRC, the IRCv3 Working Group has defined the STARTTLS extension. FTP uses the command "AUTH TLS"defined in RFC 4217 and LDAP defines a protocol extension OID in RFC 2830. HTTP uses upgrade he ader.

SMTP was extended with support for Transport Layer Security TLS

Also called **Opportunistic TLS**, where the quote is also from:
`https://en.wikipedia.org/wiki/Opportunistic_TLS`

Now we have MTA Strict Transport Security (MTA-STS) RFC 8461
so we can announce that we only accept encrypted email!

sslscan check your web and mail server settings

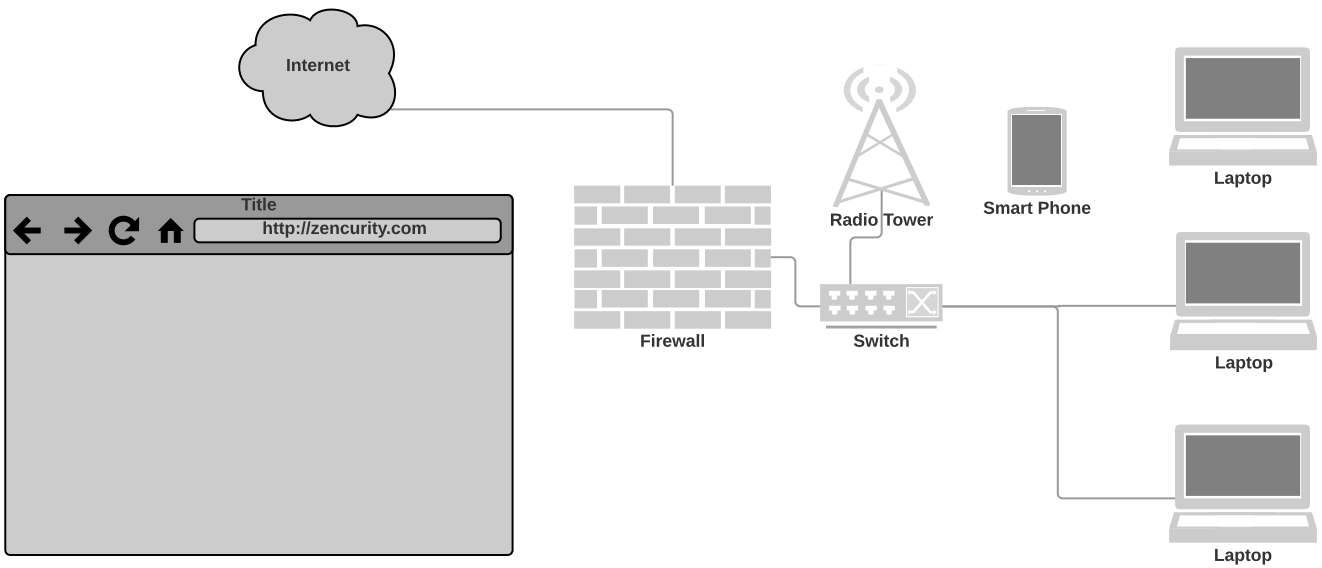
```
root@kali:~# sslscan --ssl2 web.kramse.dk
Version: 1.10.5-static OpenSSL 1.0.2e-dev xx XXX xxxx

Testing SSL server web.kramse.dk on port 443
...
  SSL Certificate:
Signature Algorithm: sha256WithRSAEncryption
RSA Key Strength:    2048
Subject:  *.kramse.dk
Altnames: DNS:*.kramse.dk, DNS:kramse.dk
Issuer:   AlphaSSL CA - SHA256 - G2
```

Source: Originally sslscan from http://www.titania.co.uk but use the version on Kali Linux

SSLscan can check your own sites by IP plus SMTP and some other services!

PS From now on its TLS! Not SSL anymore, any SSLv2, SSLv3 is old and vulnerable

Your Privacy



- Your data travels far
- Often crossing borders, virtually and literally

Data found in Network data

Lets take an example, DNS

Domain Name System DNS breadcrumbs

- Your company domain, mailservers, vpn servers
- Applications you use, checking for updates, sending back data
- Web sites you visit

Advice show your users,ask them to participate in a experiment

Maybe use VPN more - or always!

DNS over TLS vs DNS over HTTPS - DNS encryption

- Protocols exist that encrypt DNS data
- Today we have competing standards:
- *Specification for DNS over Transport Layer Security (TLS)* (DoT), RFC7858 MAY 2016
  `https://en.wikipedia.org/wiki/DNS_over_TLS`
- *DNS Queries over HTTPS (DoH)* RFC8484
- How to cofigure DoT
  `https://dnsprivacy.org/wiki/display/DP/DNS+Privacy+Clients`

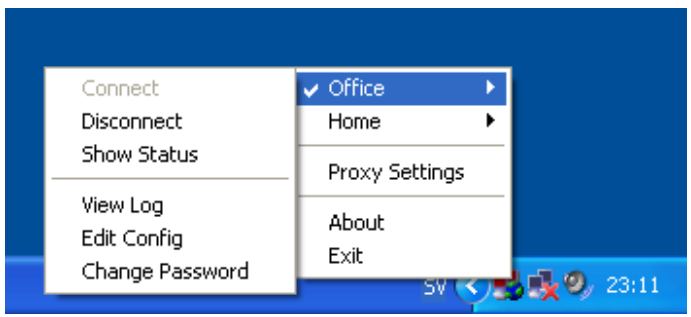
Virtual Private Network (VPN)

VPNs are everywhere, but could be better!

https://en.wikipedia.org/wiki/Virtual_private_network
https://kb.juniper.net/InfoCenter/index?page=content&id=KB11104
IPSec VPN between JUNOS and Cisco IOS
Skim:
https://en.wikipedia.org/wiki/Multiprotocol_Label_Switching
https://en.wikipedia.org/wiki/OpenVPN
https://en.wikipedia.org/wiki/IPsec
https://en.wikipedia.org/wiki/DirectAccess
https://www.wireguard.com/papers/wireguard.pdf

Example references. Note MPLS is NOT encrypting data!

VPN



Virtual Private Networks are useful - or even required when travelling

VPN `http://en.wikipedia.org/wiki/Virtual_private_network`

SSL/TLS VPN - Multiple incompatible vendors: OpenVPN, Cisco, Juniper, F5 Big IP

IETF IPsec does work cross-vendors - sometimes, and is also increasingly becoming blocked or unusable due to NAT :-(

Recommended starting point OpenVPN - free and open, clients for "anything"

VPN without encryption

> Multiprotocol Label Switching (MPLS) is a routing technique in telecommunications networks that directs data from one node to the next based on short path labels rather than long network addresses, thus avoiding complex lookups in a routing table and speeding traffic flows.[
> ... MPLS works by prefixing packets with an MPLS header, containing one or more labels.

Source:

`https://en.wikipedia.org/wiki/Multiprotocol_Label_Switching`

- The term VPN is also used in cases without encryption
- MPLS allows multiple customers to use the same IP prefixes, like 10/8
- MPLS is used in many provider networks
- Another example is Generic Routing Encapsulation (GRE), which is often then protected with IPsec
- People today also uses Virtual Extensible LAN (VXLAN) for cloud computing

Linux Wireguard VPN

> WireGuard is a secure network tunnel, operating at layer 3, implemented as a kernel virtual network interface for Linux, which aims to replace both IPsec for most use cases, as well as popular user space and/or TLS-based solutions like OpenVPN, while being more secure, more performant, and easier to use.

Description from `https://www.wireguard.com/papers/wireguard.pdf`

- Going to be interesting!
- single round trip key exchange, based on NoiseIK
- Short pre-shared static keys—Curve25519
- strong perfect forward secrecy
- Transport speed is accomplished using ChaCha20Poly1305 authenticated-encryption
- encapsulation of packets in UDP
- WireGuard can be simply implemented for Linux in less than 4,000 lines of code, making it easily audited and verified

IPsec – the older VPN suite

Secure data in transit – provide integrity and confidentiality

RFC-2401 Security Architecture for the Internet Protocol

RFC-2402 IP Authentication Header (AH)

RFC-2406 IP Encapsulating Security Payload (ESP)

RFC-2409 The Internet Key Exchange (IKE) - dynamisk keying

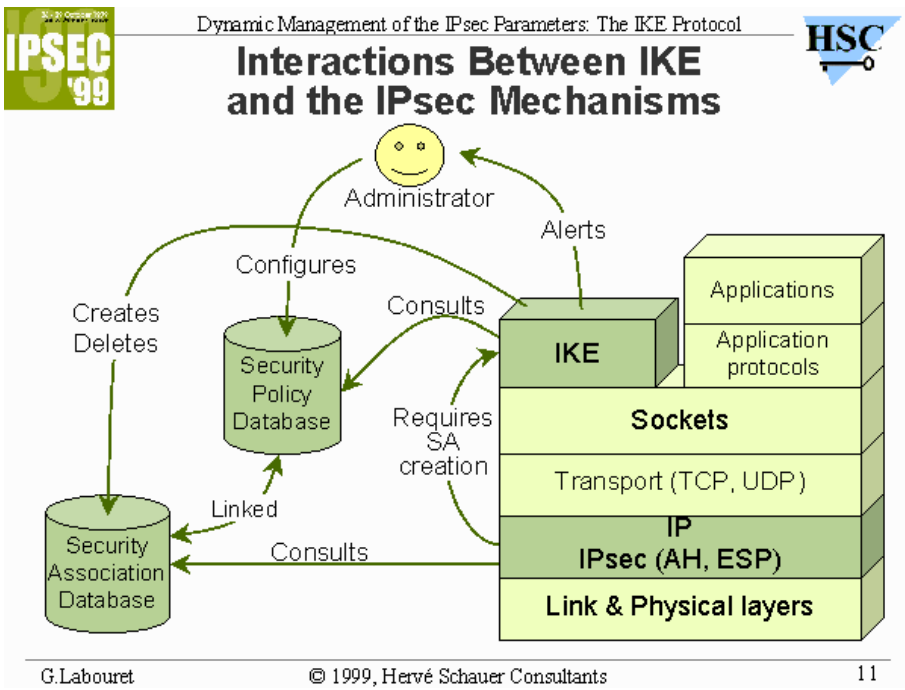
... IP Security (IPsec) and Internet Key Exchange (IKE) Document Roadmap
`https://tools.ietf.org/html/rfc6071`

Both for IPv4 and IPv6

MANDATORY in IPv6! - et krav hvis man implementerer fuld IPv6 support

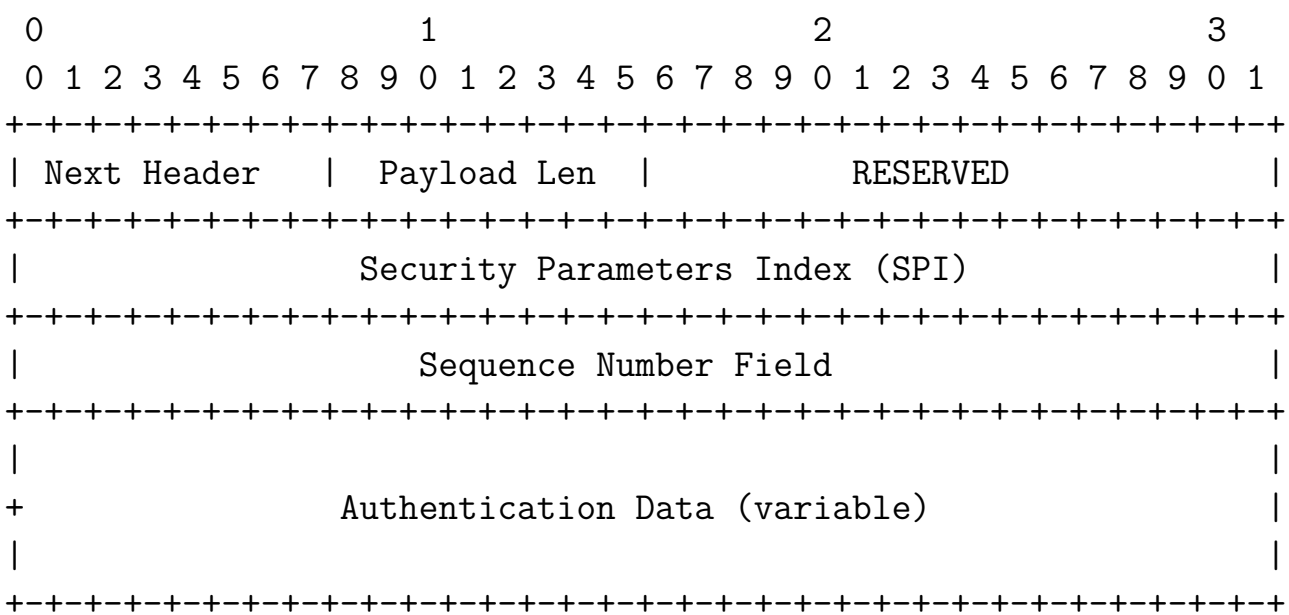
IKEscan can help scan for some IKE porte/implementations –
`http://www.nta-monitor.com/ike-scan/index.htm`

IPsec er ikke simpelt!



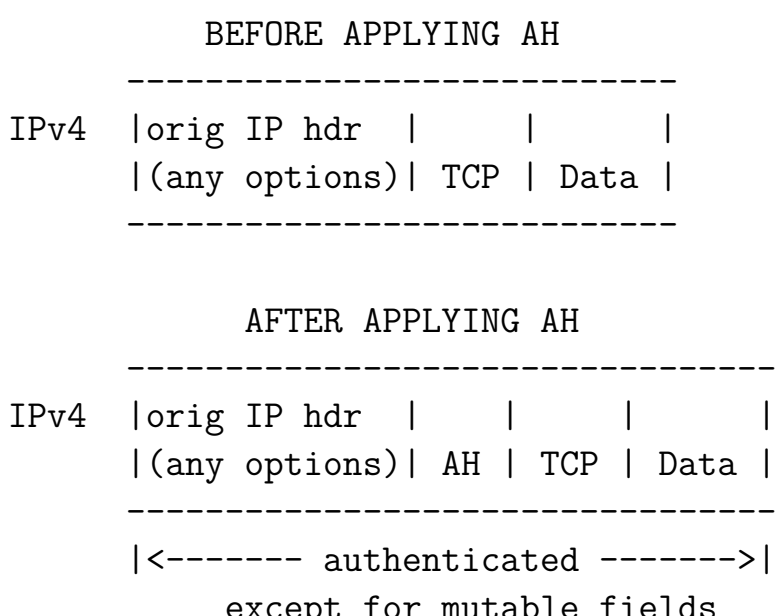
Kilde: `http://www.hsc.fr/presentations/ike/`

RFC-2402 IP Authentication Header AH

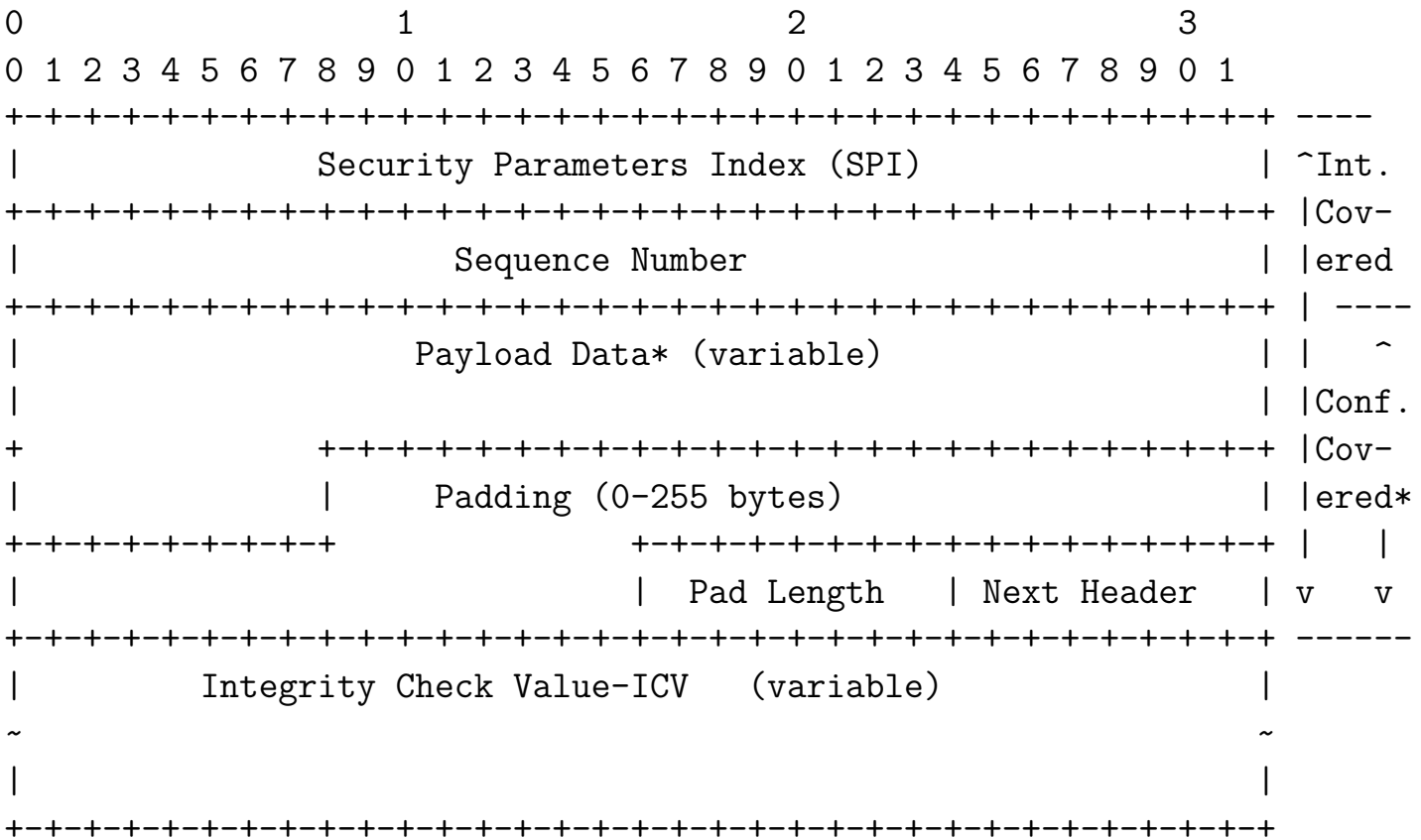


RFC-2402 IP Authentication Header AH

Indpakning - pakkerne før og efter Authentication Header:

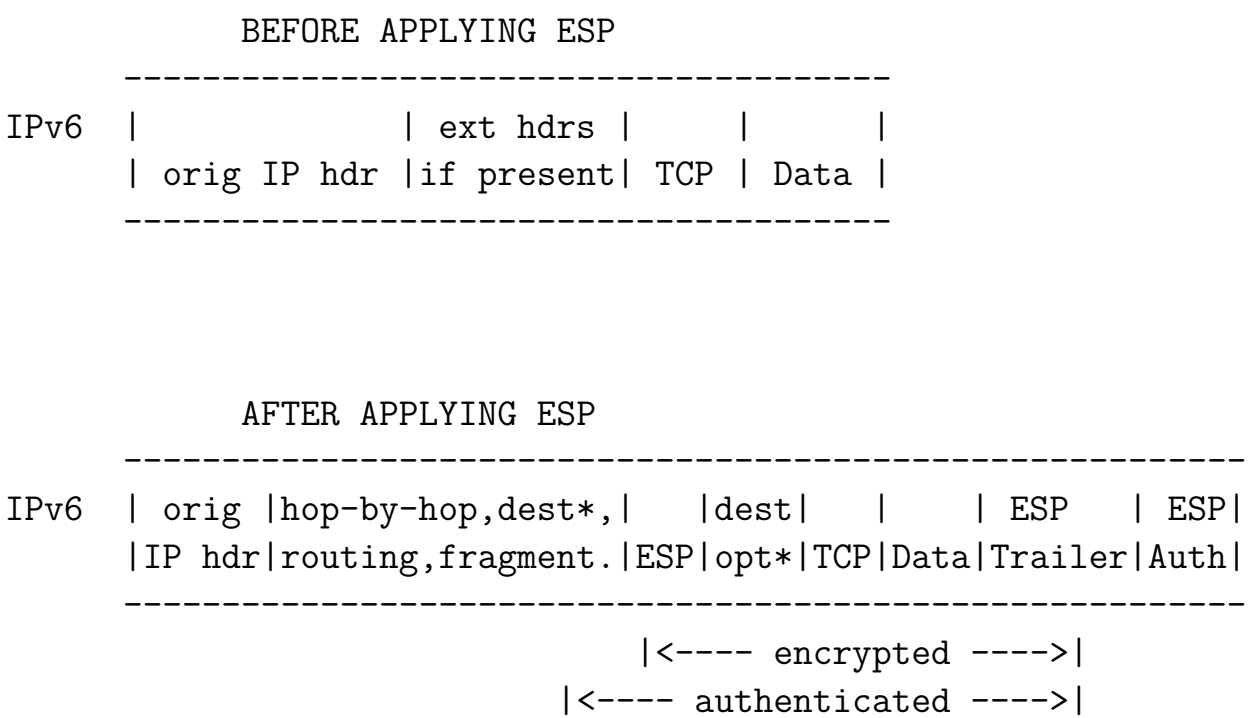


RFC-2406 IP Encapsulating Security Payload ESP

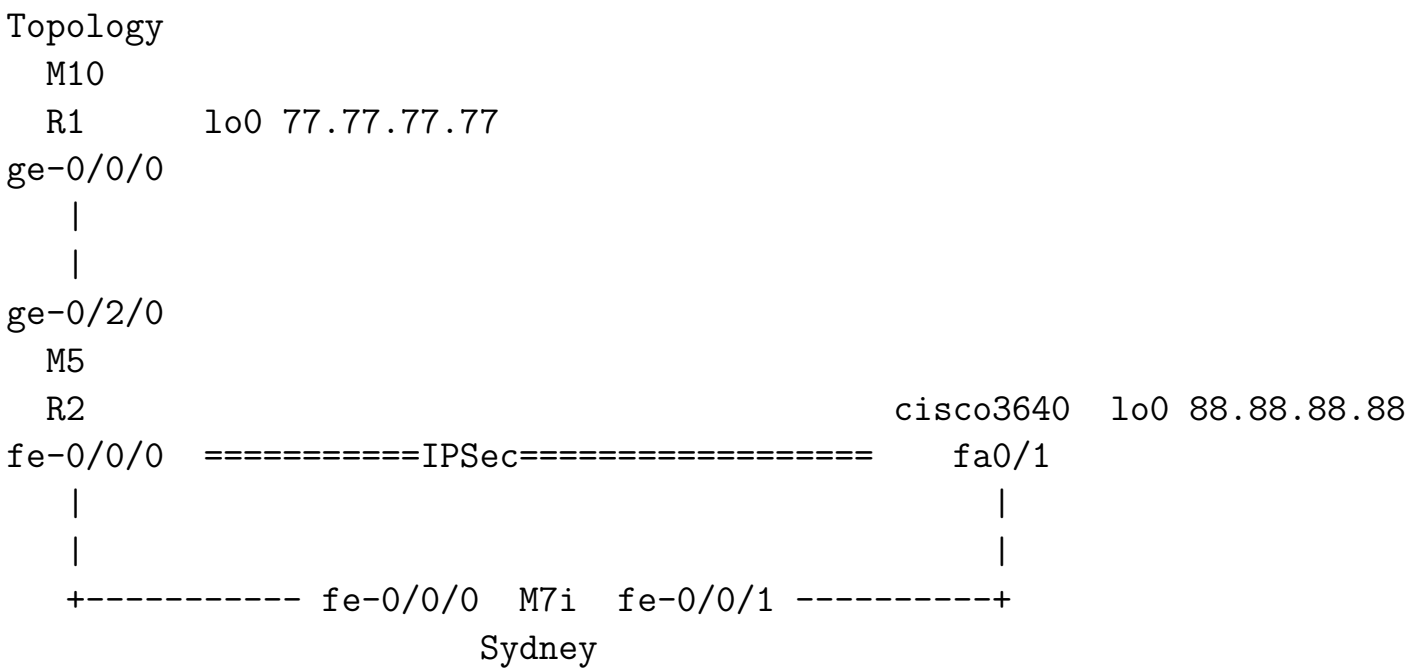


RFC-2406 IP Encapsulating Security Payload ESP

Pakkerne før og efter:



IPSec VPN between JUNOS and Cisco IOS



Source: https://kb.juniper.net/InfoCenter/index?page=content&id=KB11104

Cisco IOS crypto setup

```
cisco3640#sh run
crypto isakmp policy 10
 authentication pre-share
 group 2
 lifetime 3600
crypto isakmp key key123 address 11.0.0.1
!
!
crypto ipsec transform-set ts esp-3des esp-sha-hmac
crypto ipsec transform-set ts-man esp-des esp-md5-hmac
!
crypto map dyn 10 ipsec-isakmp
 set peer 11.0.0.1
 set transform-set ts
 match address 120
```

Not recommended settings! See later! People still use these examples!

Layer 2 Tunneling Protocol L2TP

Description from `https://en.wikipedia.org/wiki/Layer_2_Tunneling_Protocol`

> The entire L2TP packet, including payload and L2TP header, is sent within a User Datagram Protocol (UDP) datagram. A virtue of transmission over UDP (rather than TCP; c.f. SSTP) is that it avoids the "TCP meltdown problem".[3][4] It is common to carry PPP sessions within an L2TP tunnel. L2TP does not provide confidentiality or strong authentication by itself. IPsec is often used to secure L2TP packets by providing confidentiality, authentication and integrity. The combination of these two protocols is generally known as L2TP/IPsec (discussed below).

Often used when crossing NAT, which everyone does ...

Configuration example for Cisco:

`https://www.cisco.com/c/en/us/support/docs/security-vpn/ipsec-negotiation-ike-protocols/14122-24.html`

OpenBSD L2TP IPsec

`https://www.exoscale.com/syslog/building-an-ipsec-gateway-with-openbsd/`

IPsec IKE-SCAN

Scan IPs for VPN endpoints with ike-scan:

```
root@kali:~# ike-scan 91.102.91.30
Starting ike-scan 1.9 with 1 hosts
(http://www.nta-monitor.com/tools/ike-scan/)
91.102.91.30 Notify message 14 (NO-PROPOSAL-CHOSEN)
HDR=(CKY-R=f0d6043badb2b7bc, msgid=f97a7508)

Ending ike-scan 1.9: 1 hosts scanned in 1.238 seconds (0.81 hosts/sec).
0 returned handshake; 1 returned notify
```

Source:

`http://www.nta-monitor.com/tools-resources/security-tools/ike-scan`

crack IKE psk?

`http://ikecrack.sourceforge.net/`

`https://www.trustwave.com/Resources/SpiderLabs-Blog/Cracking-IKE-Mission-Improbable-(Part-1)/`

Forward Secrecy

In cryptography, forward secrecy (FS), also known as perfect forward secrecy (PFS), is a feature of specific key agreement protocols that gives assurances that session keys will not be compromised even if the private key of the server is compromised.[1] Forward secrecy protects past sessions against future compromises of secret keys or passwords.[2] By generating a unique session key for every session a user initiates, the compromise of a single session key will not affect any data other than that exchanged in the specific session protected by that particular key.

Source: `https://en.wikipedia.org/wiki/Forward_secrecy`

Recommendations for VPN

Use the following guidelines when configuring Internet Key Exchange (IKE) in VPN technologies:
Avoid IKE Groups 1, 2, and 5.
Use IKE Group 15 or 16 and employ 3072-bit and 4096-bit DH, respectively.
When possible, use IKE Group 19 or 20. They are the 256-bit and
384-bit ECDH groups, respectively.
Use AES for encryption.

Paper: `https://www.cisco.com/c/en/us/about/security-center/next-generation-cryptography.html`

- Certificates/keys - like TLS long and roll new ones from time to time
- Algorithms DES/3DES bye bye, update both encryption and authentication/integrity protection algorithms
- DH-Group - +15 thanks, highed most likely better, check what you have available
- Check both your remote client VPN and site-2-site VPN solutions
- Switch to IKE version 2
- Make it a habit to check regularly

Wi-Fi Security

Subjects

- Wifi standarder IEEE 802.11
- Authentication Protocols RADIUS, PAP, CHAP, EAP
- Port Based Network Access Control IEEE 802.1x
- Security problems in wireless protocols
- Security problems in wireless encryption
- Hacking wireless networks

Exercises you can do later:

- Wifi scanning, aka wardriving
- WPA hacking with a short password
  See for examples: `http://aircrack-ng.org/doku.php?id=cracking_wpa`

Wifi standards IEEE 802.11

802.11 is the work group in IEEE

Most well-known within this group:

- 802.11b 11Mbps versionen
- 802.11g 54Mbps versionen
- 802.11n faster
- **802.11i Security enhancements Robust Security Network RSN**

New names soon:
Wi-Fi 6 to identify devices that support 802.11ax technology
Wi-Fi 5 to identify devices that support 802.11ac technology
Wi-Fi 4 to identify devices that support 802.11n technology

Source: `http://grouper.ieee.org/groups/802/11/index.html`

IEEE 802.11 Security fast forward

In 2001, a group from the University of California, Berkeley presented a paper describing weaknesses in the 802.11 Wired Equivalent Privacy (WEP) security mechanism defined in the original standard; they were followed by **Fluhrer, Mantin, and Shamir's** paper titled "Weaknesses in the Key Scheduling Algorithm of RC4". Not long after, Adam Stubblefield and AT&T publicly announced the first **verification of the attack**. In the attack, they were able to intercept transmissions and gain unauthorized access to wireless networks.

Source: `http://en.wikipedia.org/wiki/IEEE_802.11`

IEEE 802.11 Security fast forward

The IEEE set up a dedicated task group to create a replacement security solution, **802.11i** (previously this work was handled as part of a broader 802.11e effort to enhance the MAC layer). The Wi-Fi Alliance announced an **interim specification called Wi-Fi Protected Access (WPA)** based on a subset of the then current IEEE 802.11i draft. These started to appear in products in **mid-2003**. **IEEE 802.11i (also known as WPA2)** itself was ratified in **June 2004**, and uses government strength encryption in the **Advanced Encryption Standard AES,** instead of RC4, which was used in WEP. The modern recommended encryption for the home/consumer space is **WPA2 (AES Pre-Shared Key) and for the Enterprise space is WPA2 along with a RADIUS authentication server** (or another type of authentication server) and a strong authentication method such as EAP-TLS.

Source: `http://en.wikipedia.org/wiki/IEEE_802.11`

IEEE 802.11 Security fast forward

In January 2005, the IEEE set up yet another task group "w"to protect management and broadcast frames, which previously were sent unsecured. Its standard was published in 2009.[24]

In **December 2011**, a security flaw was revealed that affects wireless routers with the **optional Wi-Fi Protected Setup (WPS)** feature. While WPS is not a part of 802.11, **the flaw allows a remote attacker to recover the WPS PIN and, with it, the router's 802.11i password in a few hours**.

WPS WTF?! - det er som om folk bevidst saboterer wireless sikkerhed!

Source: `http://en.wikipedia.org/wiki/IEEE_802.11`

Encrypt where?

> It is not clear that the link layer is the right one for security. In a coffeeshop, the security association is terminated by the store: is there any reason you should trust the shopkeeper? Perhaps link-layer security makes some sense in a home, where you control both the access point and the wireless machines. However, we prefer end-to-end security at the network layer or in the applications.

Source: Cheswick-chap2.pdf Firewalls and Internet Security: Repelling the Wily Hacker , Second Edition, William R. Cheswick, Steven M. Bellovin, and Aviel D. Rubin

Individual Authentication

Replace the single secret code used in WEP/WPA PSK Pre-shared key

Recommend using:

Known VPN technologies or WPA Enterprise

Based on modern algorithms and protocols

Implemented in professional equipment

From trustworthy vendors

Which is maintained and updated regularly

Using individual authentication is preferred
IEEE 802.1x Port Based Network Access Control

Create more VLANs with IEEE 802.1q and use both 1q and 1x on Ethernet!

Authentication Protocols RADIUS, PAP, CHAP, EAP

- Used for verifying credentials, typically username and password
- Extensible Authentication Protocol EAP
  `https://en.wikipedia.org/wiki/Extensible_Authentication_Protocol`
- Challenge-Handshake Authentication Protocol
  `https://en.wikipedia.org/wiki/Challenge-Handshake_Authentication_Protocol`
- Password Authentication Protocol
  `https://en.wikipedia.org/wiki/Password_Authentication_Protocol`
- Remote Authentication Dial In User Service (RADIUS)
  `https://en.wikipedia.org/wiki/RADIUS`

Hint: you can create RADIUS configuration for WPA Enterprise – with any user and password allowed!
`https://github.com/kramse/conference-open-8021x`

Network segmentation – Firewalls

`https://en.wikipedia.org/wiki/Firewall_(computing)`
`http://www.wilyhacker.com/` Cheswick chapter 2 og 3 PDF

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

Firewalls Definition

> 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)`

- Network layer, packet filters, application level, stateless, stateful
- Firewalls are by design a choke point, natural place
  to do network security monitoring!
- Older but still interesting Cheswick chapter 2 PDF *A Security Review of Protocols: Lower Layers*
  `http://www.wilyhacker.com/`

Generic IP Firewalls

A firewall blocks internet trafic

A firewall allows internet trafic

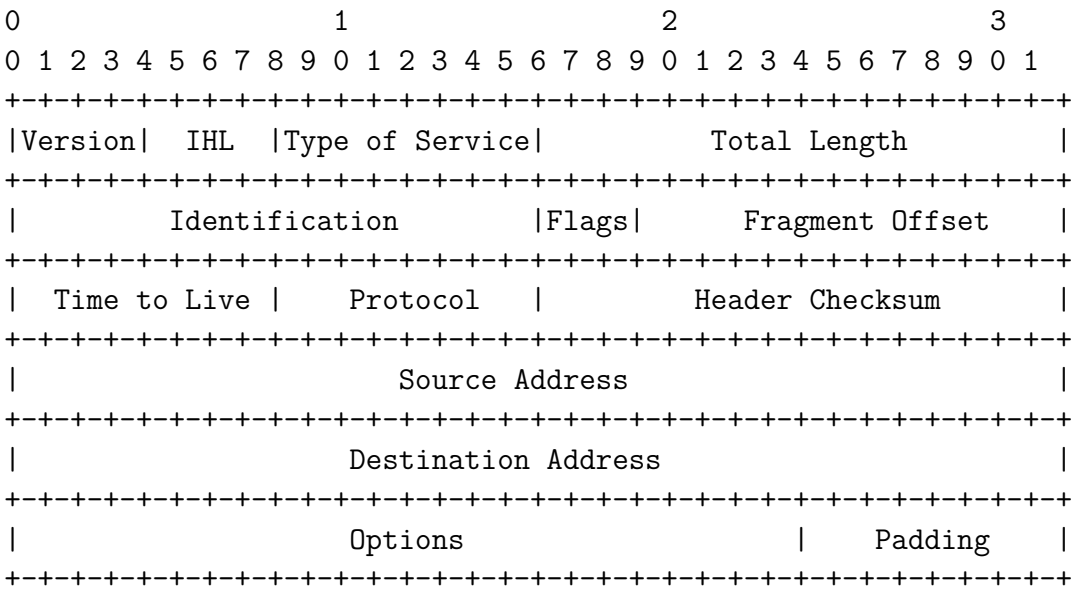
Modern Firewall Infrastructures

Today a firewall infrastructure must:

- Prevents attackers from entering
- Prevent data exfiltration
- Prevent worms, malware, virus from spreading in networks
- Be part of an overall solution with ISP, routers, other firewalls, switched infrastructures, intrusion detection systems and the rest of the infrastructure

Requires a lot

Packet filtering



Packet filtering er firewalls der filtrerer på IP niveau

Idag inkluderer de fleste stateful inspection

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
```

Example firewall products

- Checkpoint Firewall-1 `http://www.checkpoint.com`
- Cisco ASA `http://www.cisco.com`
- Clavister firewalls `http://www.clavister.com`
- Juniper SRX `http://www.juniper.net`
- Palo Alto `https://www.paloaltonetworks.com/`
- Fortinet `https://www.fortinet.com/`

Those listed are the most popular commercial ones I see in Denmark

Open source based firewalls

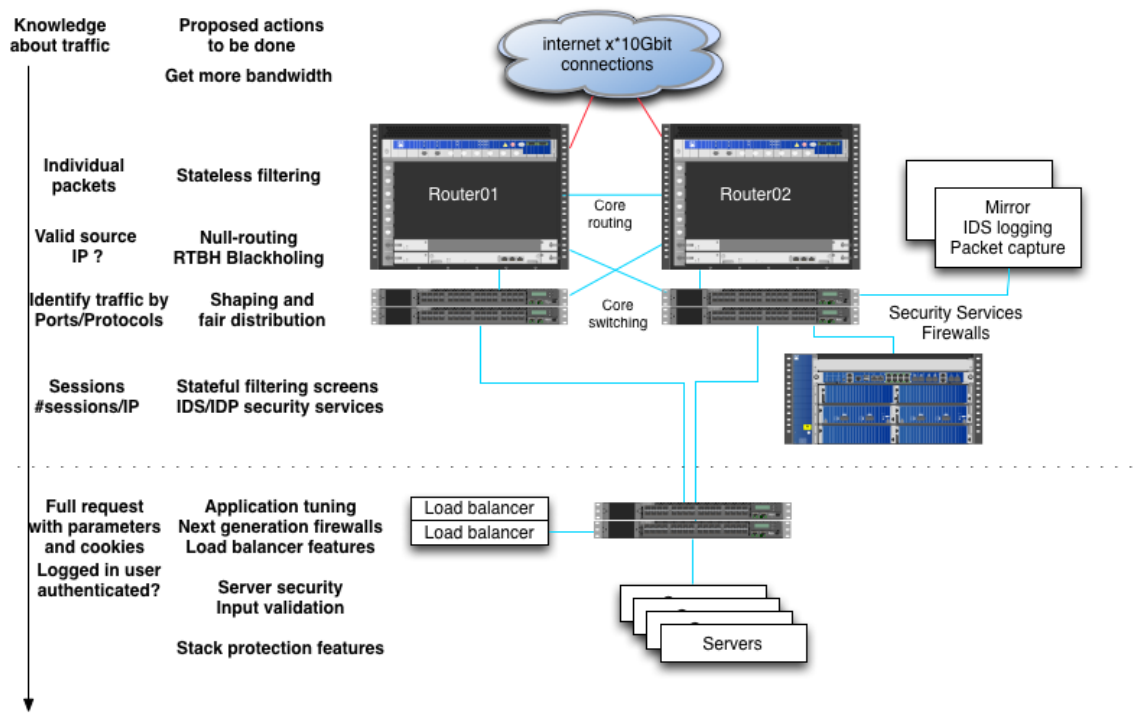
- Linux firewalls IP tables, use command line tool ufw Uncomplicated Firewall!
- Firewall GUIs on top of Linux – lots! Some are also available as commercial ones
- OpenBSD PF `http://www.openbsd.org`
- FreeBSD IPFW og IPFW2 `http://www.freebsd.org`
- Mac OS X uses OpenBSD PF
- FreeBSD has an older version of the OpenBSD PF, should really be renamed now

I recommend and use the 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)
```

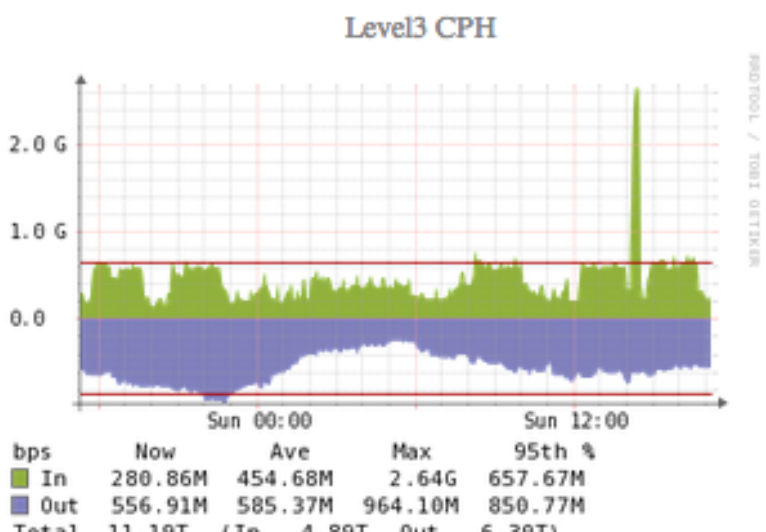
Extremely easy to use

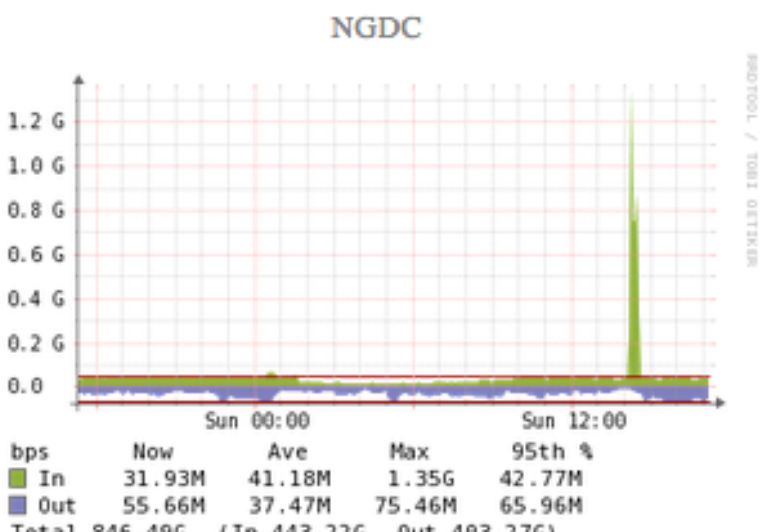
Firewalls are not alone



Use defense in Depth – all layers have features

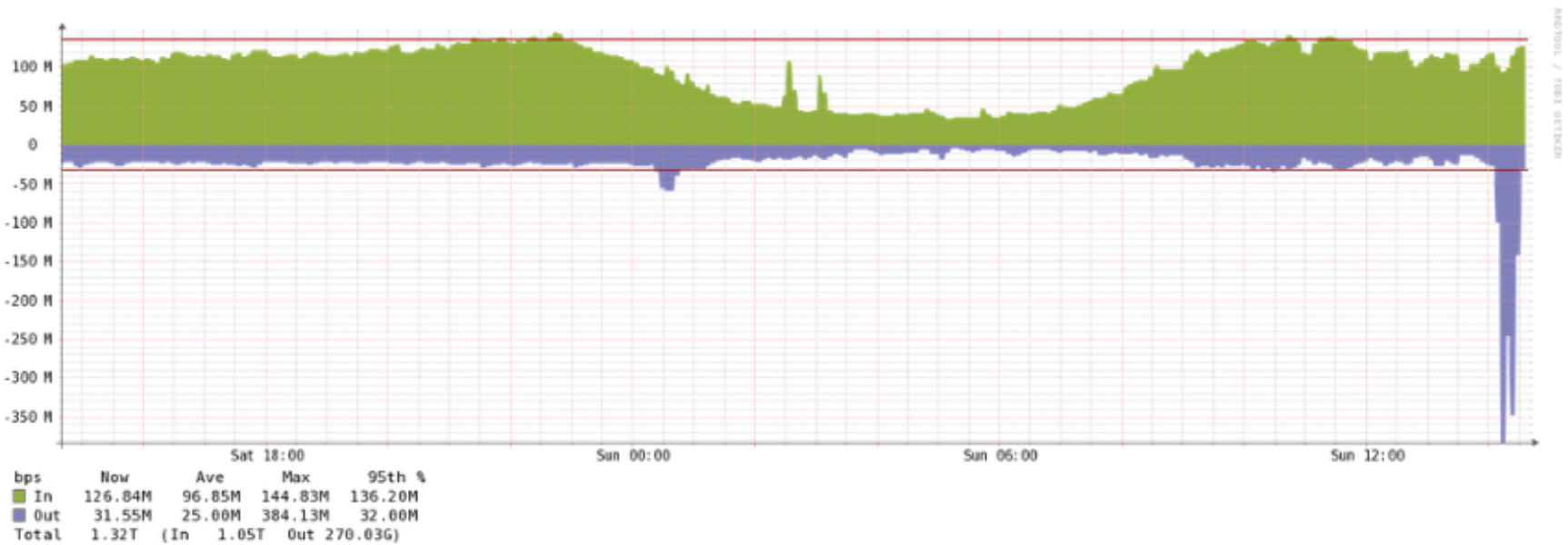
DDoS traffic before filtering





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!

Access Control Lists (ACL)

Stateless firewall filter throw stuff away

```
hlk@MX-CPH-02> show configuration firewall filter all | no-more
/* This is a sample, maybe use BGP flowspec and/or RTBH */
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 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;
    }
}
```

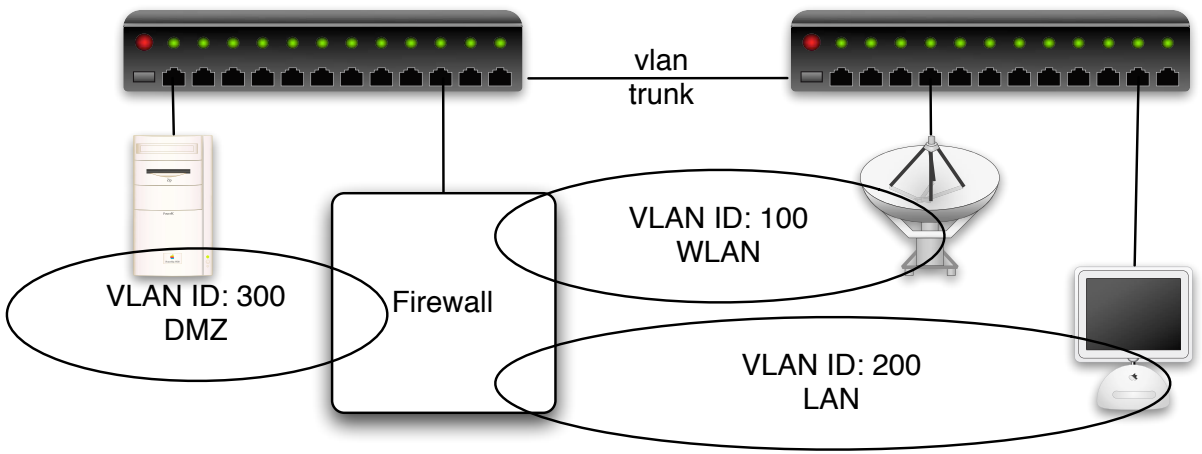
Routers also have extensive Class-of-Service (CoS) tools today

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

IEEE 802.1q



Using IEEE 802.1q VLAN tagging on Ethernet frames

Virtual LAN, to pass from one to another, must use a router/firewall

Allows separation/segmentation and protects traffic from many security issues

Port Security – Rogue DHCP servers

Common problem in networks is people connecting devices with DHCPD servers

In general make sure to segment networks

Start to use port security on switches, including DHCP snooping
`https://en.wikipedia.org/wiki/DHCP_snooping`

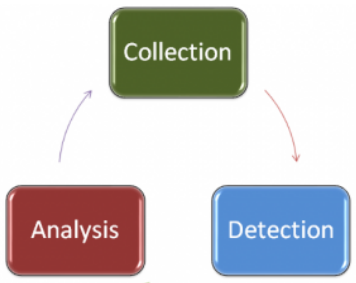
Example port security

```
[edit ethernet-switching-options secure-access-port]
set interface ge-0/0/1 mac-limit 4

set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:80
set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:81
set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:83
set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:85
set interface ge-0/0/2 allowed-mac 00:05:85:3A:82:88
set interface ge-0/0/2 mac-limit 4

set interface ge-0/0/1 persistent-learning
set interface ge-0/0/8 dhcp-trusted
set vlan employee-vlan arp-inspection
set vlan employee-vlan examine-dhcp
set vlan employee-vlan mac-move-limit 5
```

Source: Overview of Port Security, Juniper

https://www.juniper.net/documentation/en_US/junos/topics/example/overview-port-security.html

Most firewalls include some detection today



ANSM chapter 1: The Practice of Applied

- 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

Book referenced is: *Network Security Monitoring Applied Network Security Monitoring Collection, Detection, and Analysis*, 2014 Chris Sanders ISBN: 9780124172081

Indicators of Compromise and Signatures

> An IOC is any piece of information that can be used to objectively describe a network intrusion, expressed in a platform-independent manner. This could include a simple indicator such as the IP address of a command and control (C2) server or a complex set of behaviors that indicate that a mail server is being used as a malicious SMTP relay.
>
> When an IOC is taken and used in a platform-specific language or format, such as a Snort Rule or a Bro-formatted file, it becomes part of a signature. A signature can contain one or more IOCs.

Source: Applied Network Security Monitoring Collection, Detection, and Analysis, 2014 Chris Sanders

- Network Security Monitoring (NSM) - monitoring networks for intrusions, and reacting to those
- networkbased intrusion detection systems (NIDS)
- host based intrusion detection systems (HIDS)
- Example systems are Security Onion `https://securityonion.net/` or SELKS `https://www.stamus-networks.com/open-source/`

Network Sniffing for Security

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.

Applied Network Security Monitoring Collection, Detection, and Analysis, 2014 Chris Sanders ISBN: 9780124172081 - shortened ANSM

Collect Network Evidence from the network – netflow

Netflow is getting more important, more data share the same links

Detecting DoS/DDoS and problems is essential

Netflow sampling is vital information - 123Mbit, but what kind of traffic

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

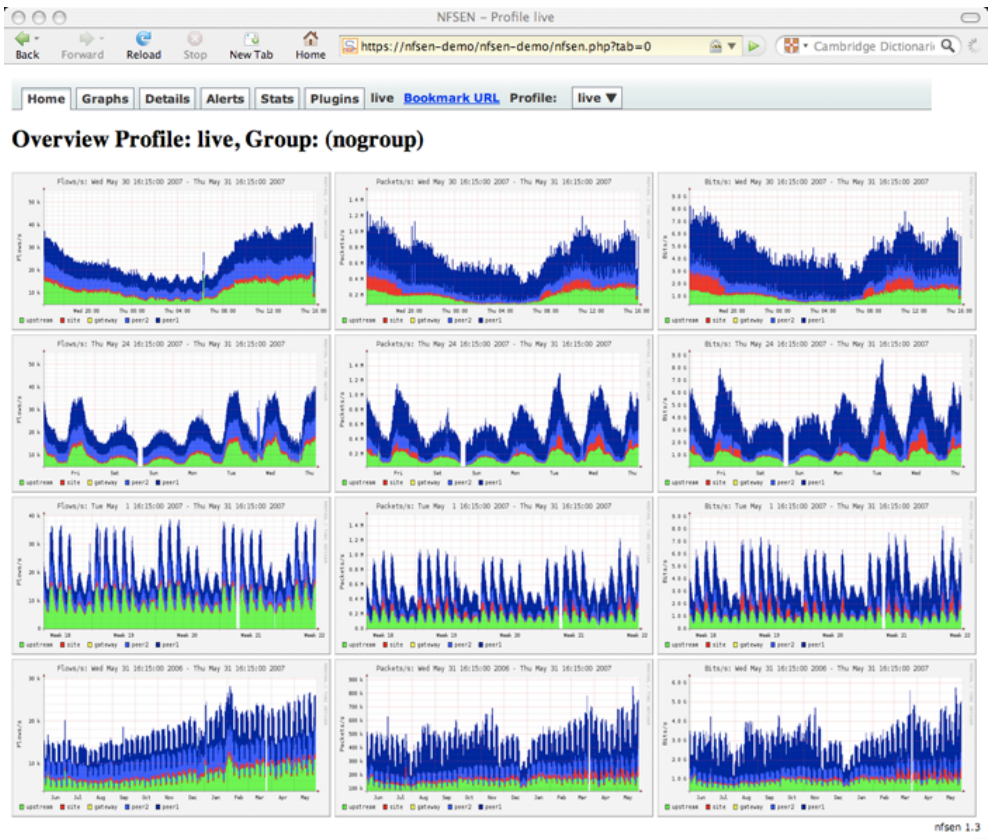
- Ingress interface (SNMP ifIndex), IP protocol, Source IP address and Destination IP address
- Source port for UDP or TCP, 0 for other protocols, IP Type of Service
- Destination port for UDP or TCP, type and code for ICMP, or 0 for other protocols

Today we can use Netflow version 9 or IPFIX with more fields available

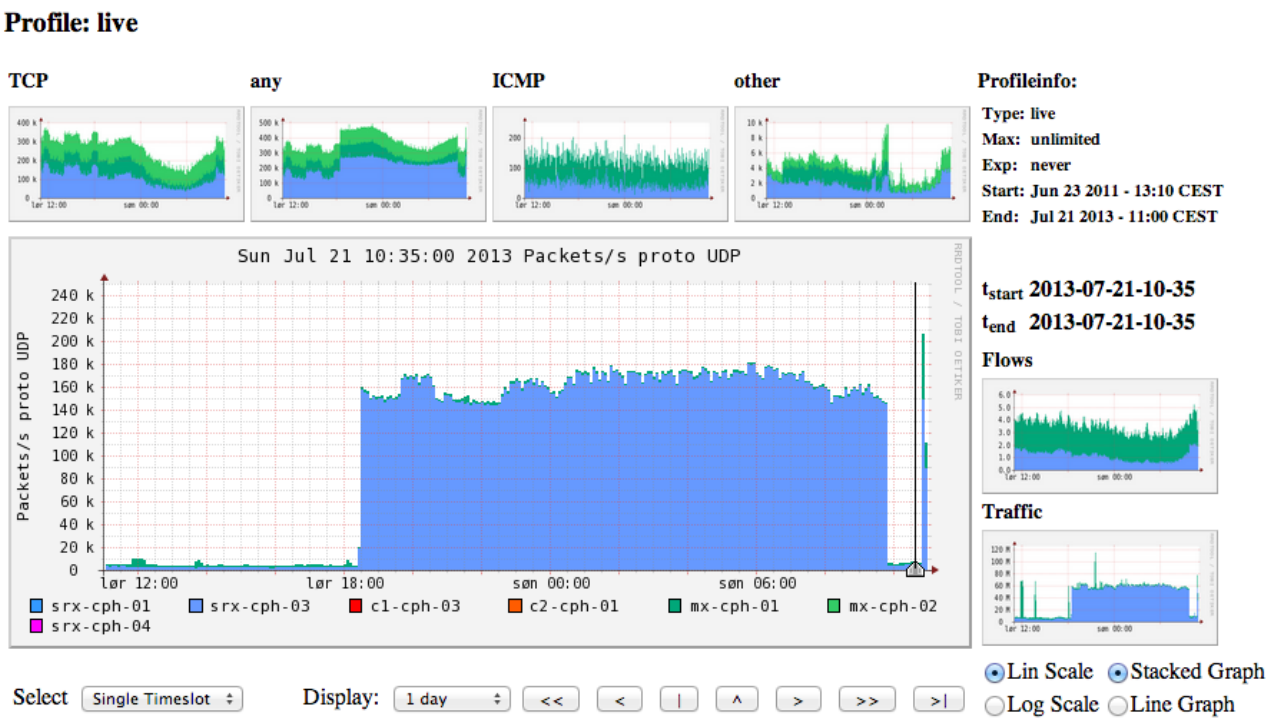
Source:

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

Netflow using NFSen



Netflow NFSen



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

How to get started

How to get started searching for security events?

Collect basic data from your devices and networks

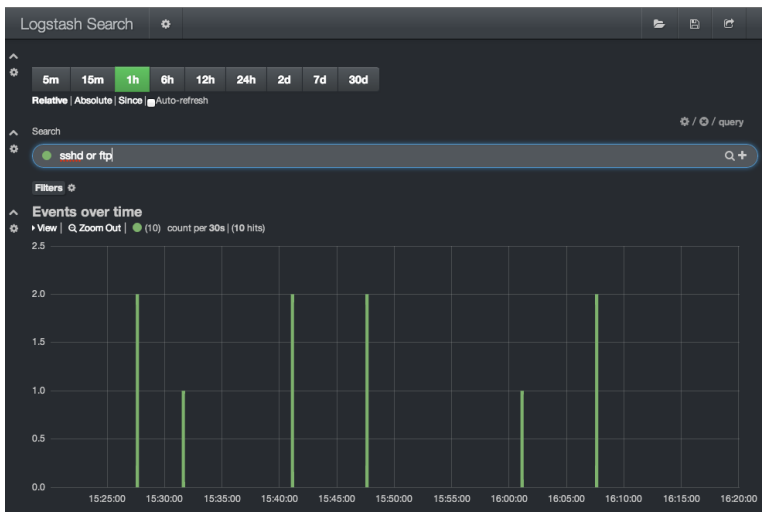
- Netflow data from routers
- Session data from firewalls
- Logging from applications: email, web, proxy systems

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

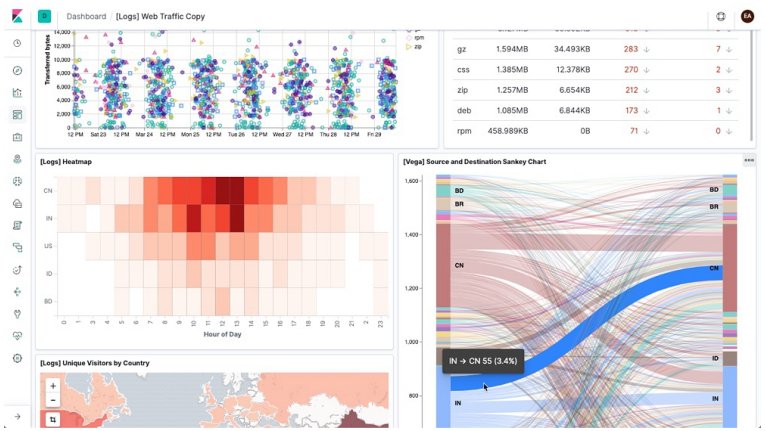


View data by digging into it easily - must be fast

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

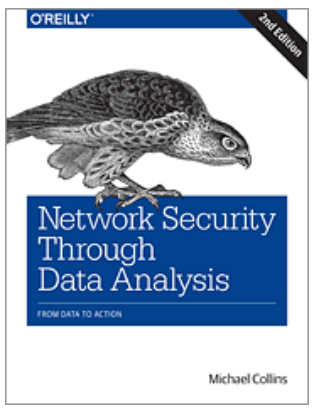
Source: `https://www.elastic.co/products/kibana`

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'"
- name: Move elasticsearch data into /data
  command: creates=/data/elasticsearch mv /var/lib/elasticsearch /data/
- name: Make link to /data/elasticsearch
  file: state=link src=/data/elasticsearch path=/var/lib/elasticsearch
```

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

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

Packet sniffing tools

Tcpdump for capturing packets

Wireshark for dissecting packets manually with GUI

Zeek Network Security Monitor

Snort, old timer Intrusion Detection Engine (IDS)

Suricata, modern robust capable of IDS and IPS (prevention)

ntopng High-speed web-based traffic analysis

Maltrail Malicious traffic detection system `https://github.com/stamparm/MalTrail`

Often a combination of tools and methods used in practice

Full packet capture big data tools also exist

Blue Team

Think like a blue team member find hacker traffic

Get basic tools running

Improve situation

- See where the data end up
- What kind of data and metadata can we extract
- How can we collect and make use of it
- Databases and web interfaces, examples shown
- Consider what your deployment could be

Experiences gathered

Lots of information

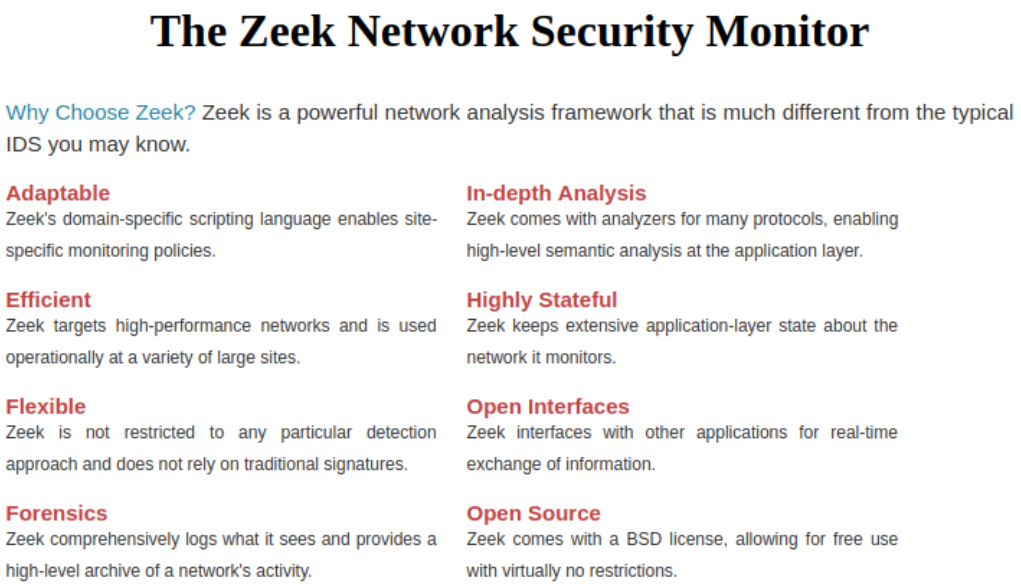
Reveals a lot about the network, operating systems, services etc.

I use a template when getting data

- Respond to ICMP: □ echo, □ mask, □ time
- Respond to traceroute: □ ICMP, □ UDP
- Open ports TCP og UDP:
- Operating system:
- ... (banner information)

Beware when doing scans it is possible to make routers, firewalls and devices perform badly or even crash!

The Zeek Network Security Monitor



The Zeek Network Security Monitor is not a single tool, more of a powerful network analysis framework

Zeek is the tool formerly known as Bro, changed name in 2018. `https://www.zeek.org/`

Zeek IDS is

The Zeek Network Security Monitor

While focusing on network security monitoring, Zeek provides a comprehensive platform for more general network traffic analysis as well. Well grounded in more than 15 years of research, Zeek has successfully bridged the traditional gap between academia and operations since its inception.

`https://www.Zeek.org/`

Zeek scripts

```
global dns_A_reply_count=0;
global dns_AAAA_reply_count=0;
...
event dns_A_reply(c: connection, msg: dns_msg, ans: dns_answer, a: addr)
        {
        ++dns_A_reply_count;
        }

event dns_AAAA_reply(c: connection, msg: dns_msg, ans: dns_answer, a: addr)
        {
        ++dns_AAAA_reply_count;
        }
```

source: dns-fire-count.bro from

https://github.com/LiamRandall/bro-scripts/tree/master/fire-scripts https://www.bro.org/sphinx-git/script-refe

scripts.html

Testing Zeek

We will use a combination of your virtual servers, my switch hardware and my virtual systems.

There will be sniffing done on traffic! Don't abuse information gathered

We try to mimic what you would do in your own networks during the exercises.

Another way of running exercises might be:
`https://github.com/jonschipp/ISLET`

Recommended and used by Zeek and Suricata projects.

Get Started with Zeek

To run in "base" mode: `bro -r traffic.pcap`

To run in a "near broctl" mode: `bro -r traffic.pcap local`

To add extra scripts: `bro -r traffic.pcap myscript.bro`

Note: the project was renamed from Bro to Zeek in Oct 2018

Zeek demo: Run Zeek

```
// back to Broctl and start it
[BroControl] > start
starting bro
// and then
kunoichi:bro root# pwd
/usr/local/var/spool/bro
kunoichi:bro root# tail -f dns.log
```

More examples at:

https://www.bro.org/sphinx/script-reference/log-files.html

Suricata IDS/IPS/NSM

Suricata is a high performance Network IDS, IPS and Network Security Monitoring engine. Open Source and owned by a community run non-profit foundation, the Open Information Security Foundation (OISF). Suricata is developed by the OISF and its supporting vendors.

`http://suricata-ids.org/` `http://openinfosecfoundation.org`

Exercise at home – Your lab setup

- Go to GitHub, Find user Kramse, click through security-courses, courses, suricatazeek and download the PDF files for the slides and exercises:

  `https://github.com/kramse/security-courses/tree/master/courses/networking/suricatazeek-workshop`

- Get the lab instructions, from

  `https://github.com/kramse/kramse-labs/tree/master/suricatazeek`

Questions?

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You are always welcome to send me questions later via email

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