





Welcome to

# 11. DNS and Email Security

Communication and Network Security 2021

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Slides are available as PDF, [kramse@Github](https://github.com/kramse)  
11-DNS-and-Email-Security.tex in the repo security-courses

# Goals for today



Today's goals:

- Talk about DNS and email standards
- We already discussed DNSSEC
- Try running DNS servers!

Trying to make today less heavy with information.

# Plan for today



## Subjects

- DNS introduction
- SMTP introduction
- SMTP TLS
- SPF, DKIM, DMARC
- DNSSEC - DNS integrity
- DNS over TLS vs DNS over HTTPS - DNS encryption

## Exercises

## Exercises

- Check some examples like how danish banks are using DMARC, and how your own companies can start using it
- SSLscan with SMTP TLS
- Run a DNS server Unbound

# Reading Summary



Re-read PPA DNS pages 173-183

[https://en.wikipedia.org/wiki/Sender\\_Policy\\_Framework](https://en.wikipedia.org/wiki/Sender_Policy_Framework)

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

[https://en.wikipedia.org/wiki/DomainKeys\\_Identified\\_Mail](https://en.wikipedia.org/wiki/DomainKeys_Identified_Mail)

ANSM chapter 14,15 - 66 pages

# Fokus 2021: DNS og email



- Vi er afhængige af email, modtagelse og afsendelse
- Når vi modtager skal det helst gå hurtigt
- Når vi sender skal vi ikke ende i spam mappen
- Phishing, hvem kan sende *fra vores domæne*

# Various key attack types, clients and employees



- Phishing - sending fake emails, to collect credentials
- Spear phishing - targetted attacks
- Person in the middle - sniffing and changing data in transit
- Drive-by attacks - web pages infected with malware, often ad servers
- Malware transferred via USB or email
- Credential Stuffing, Password related, like re-use of password, see slide about being pwned

**If we all wait a bit, and not click links immediately**

Hackers try to create "urgency", click this or loose money

# DNS introduction



# Well-known port numbers



IANA vedligeholder en liste over magiske konstanter i IP

De har lister med hvilke protokoller har hvilke protokol ID m.v.

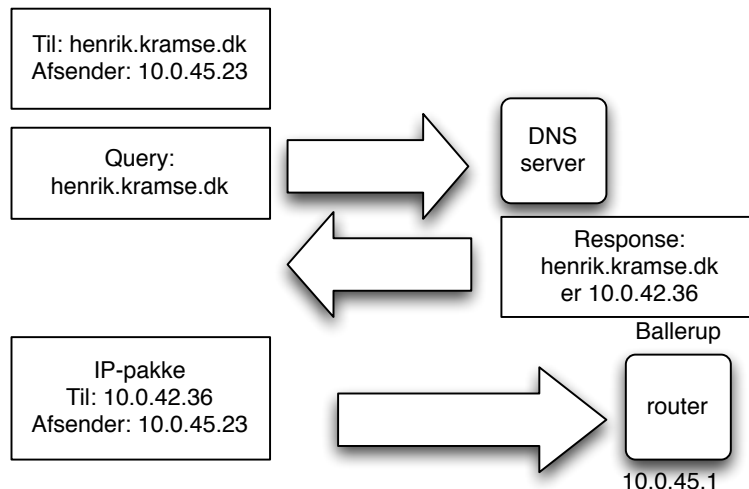
En liste af interesse er port numre, hvor et par eksempler er:

- Port 25 SMTP Simple Mail Transfer Protocol
- Port 53 DNS Domain Name System
- Port 80 HTTP Hyper Text Transfer Protocol over TLS/SSL
- Port 443 HTTP over TLS/SSL

Se flere på <http://www.iana.org>



# Domain Name System



Gennem DHCP får man typisk også information om DNS servere

En DNS server kan slå navne, domæner og adresser op

Foregår via query og response med datatyper kaldet resource records

DNS er en distribueret database, så opslag kan resultere i flere opslag

# DNS systemet



navneopslag på Internet

tidligere brugte man en **hosts** fil

hosts fil bruges stadig lokalt til serveren - IP-adresser

UNIX: /etc/hosts

Windows c:\windows\system32\drivers\etc\hosts

Eksempel: www.zencurity.com har adressen 185.129.60.130

skrives i database filer, zone filer

ns1	IN	A	185.129.60.130
	IN	AAAA	2a06:d380:0:3065::53
www	IN	A	185.129.60.130
	IN	AAAA	2a06:d380:0:3065::80

# DNS er mere end navneopslag



består af resource records med en type:

- adresser A-records
- IPv6 adresser AAAA-records
- autoritative navneservere NS-records
- post, mail-exchanger MX-records
- flere andre: md , mf , cname , soa , mb , mg , mr , null , wks , ptr , hinfo , minfo , mx ....

IN	MX	10	mail.zencurity.dk.
IN	MX	20	mail2.zencurity.dk.

# Basal DNS opsætning



```
domain zencurity.net
nameserver 91.239.100.100
nameserver 2001:67c:28a4::
nameserver 89.233.43.71
nameserver 2a01:3a0:53:53::
```

/etc/resolv.conf angiver navneservere og søgedomæner  
typisk indhold er domænenavn og IP-adresser for navneservere  
Filen opdateres også automatisk på DHCP klienter

**Husk at man godt kan slå AAAA records op over IPv4**

De viste servere er fra censurfridns.dk og kan benyttes frit

# DNS root servere



As of 2019-01-29, the root server system consists of 933 instances operated by the 12 independent root server operators.

<http://root-servers.org/>



bestyrer .dk TLD - top level domain

man registrerer ikke .dk-domæner hos DK-hostmaster, men hos en registrator

Et domæne bør have flere navneservere og flere postservere

autoritativ navneserver - ved autoritativt om IP-adresse for maskine.domæne.dk findes

ikke-autoritativ - har på vegne af en klient slået en adresse op

Det anbefales at overveje en service som <http://www.gratisdns.dk> der har flere navneservere distribueret over stor geografisk afstand

# Hvordan bruger man IPv6



www.zencurity.com

hlk@zencurity.com

DNS AAAA record tilføjes

```
www      IN A      91.102.91.17
          IN AAAA 2001:16d8:ff00:12f::2
```

mail.zencurity.com has address 91.102.91.22

mail.zencurity.com has IPv6 address 2a02:9d0:3000:1::216

# BIND DNS server



Berkeley Internet Name Daemon server

Mange bruger BIND fra Internet Systems Consortium - altså Open Source

konfigureres gennem `named.conf`

det anbefales at bruge BIND version 9

- Biblen omkring DNS og BIND er:  
*DNS and BIND*, Paul Albitz & Cricket Liu, O'Reilly, 5th edition Maj 2006



# BIND konfiguration - et udgangspunkt



```
acl internals { 127.0.0.1; ::1; 10.0.0.0/24; };
options {
    // the random device depends on the OS !
    random-device "/dev/random"; directory "/namedb";
    listen-on-v6 any; ;
    port 53; version "Dont know"; allow-query { any; };
};
view "internal" {
    match-clients { internals; }; recursion yes;
    zone "." {
        type hint;    file "root.cache"; };
    // localhost forward lookup
    zone "localhost." { type master; file "internal/db.localhost";    };
    // localhost reverse lookup from IPv4 address
    zone "0.0.127.in-addr.arpa" { type master; file "internal/db.127.0.0"; notify no;    };
    ...
}
```

BIND is still used a lot, but I recommend Unbound for recursive servers, and outsourcing authoritative DNS

# Unbound and NSD



Unbound is a validating, recursive, caching DNS resolver. It is designed to be fast and lean and incorporates modern features based on open standards.

To help increase online privacy, Unbound supports DNS-over-TLS which allows clients to encrypt their communication. In addition, it supports various modern standards that limit the amount of data exchanged with authoritative servers.

<https://www.nlnetlabs.nl/projects/unbound/about/>

My preferred local DNS server. We will now stop and look at this configuration file and function.

Also check out uncensored DNS and his DNS over TLS setup!

Even has pinning information available:

<https://blog.censurfridns.dk/blog/32-dns-over-tls-pinning-information-for-unicastcensurfridnsdk/>

# Exercise



Now lets do the exercise

## Test a DNS server 30min

which is number **63** in the exercise PDF.

# SMTP Simple Mail Transfer Protocol



```
hlk@bigfoot:hlk$ telnet mail.kramse.dk 25
Connected to sunny.
220 sunny.kramse.dk ESMTP Postfix
HELO bigfoot
250 sunny.kramse.dk
MAIL FROM: Henrik
250 Ok
RCPT TO: hlk@kramse.dk
250 Ok
DATA
354 End data with <CR><LF>.<CR><LF>
hejsa
.
250 Ok: queued as 749193BD2
QUIT
221 Bye
```

- RFC-821 SMTP Simple Mail Transfer Protocol fra 1982
- [http://en.wikipedia.org/wiki/Simple\\_Mail\\_Transfer\\_Protocol](http://en.wikipedia.org/wiki/Simple_Mail_Transfer_Protocol)

# e-mail servere



Example software Sendmail og Postfix

- Sendmail - den ældste
- Postfix en modulært og sikkerhedsmæssigt god e-mail server er ligeledes nem at konfigurere

Dertil kommer diverse andre mailservere:

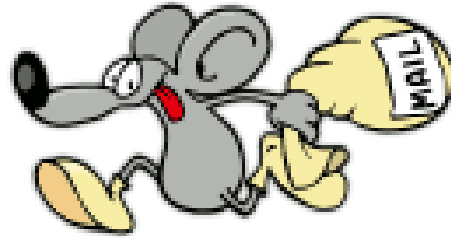
Microsoft Exchange på Windows servere

Related software Roundcube, Dovecot IMAP server, Thunderbird, etc.

also need anti-spam solutions

I use Spamhaus lists, <https://www.spamhaus.org/>

# Postfix postserveren



**POSTFIX**

Lavet af Wietse Venema for IBM

Nem at konfigurere og sikker

`main.cf` findes typisk i kataloget `/etc/postfix`

# Audit af postservere



Typisk findes konfigurationsfilerne til postservere under /etc

- /etc/mail
- /etc/postfix

Det vigtigste er at den er opdateret og IKKE tillader relaying

Der findes diverse test-scripts til relaycheck på internet

Husk også at checke domæne records, MX og A

# Test af e-mail server



```
[hlk]$ telnet localhost 25
Connected.
Escape character is '^]'.
220 server ESMTP Postfix
  helo test
250 server
  mail from: postmaster@pentest.dk
250 Ok
  rcpt to: root@pentest.dk
250 Ok
  data
354 End data with <CR><LF>.<CR><LF>
  skriv en kort besked
.
250 Ok: queued as 91AA34D18
quit
```

Skal ikke tillade relaying

Idag benyttes ofte en stjålet brugerkonto med brugernavn og kodeord til at sende spam.



# Postservere til klienter



SMTP som vi har gennemgået er til at sende mail mellem servere

Når vi skal hente post sker det typisk med POP3 eller IMAP

- POP3 Post Office Protocol version 3 RFC-1939
- Internet Message Access Protocol (typisk IMAPv4) RFC-3501

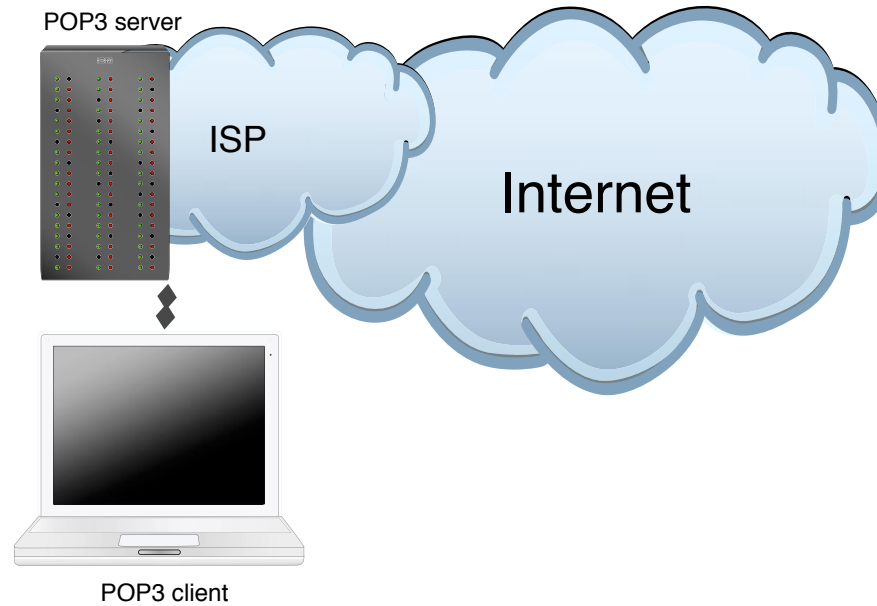
Forskellen mellem de to er at man typisk med POP3 henter posten, hvor man med IMAP lader den ligge på serveren

POP3 er bedst hvis kun en klient skal hente

IMAP er bedst hvis du vil tilgå din post fra flere systemer

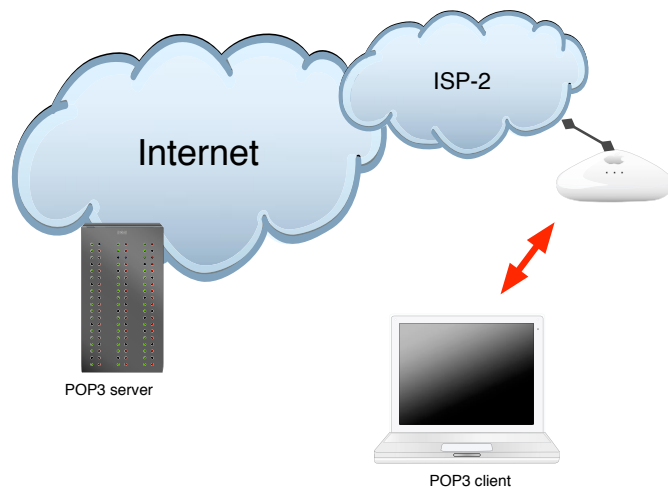
Jeg bruger selv IMAPS, IMAP over SSL kryptering - idet kodeord ellers sendes i klartekst

# POP3 i Danmark



Man har tillid til sin ISP - der administrerer såvel net som server

# POP3 i Danmark - trådløst



Har man tillid til andre ISP'er? Alle ISP'er?

Deler man et netværksmedium med andre?

Brug de rigtige protokoller! IMAPS SMTPTLS

# SMTP TLS



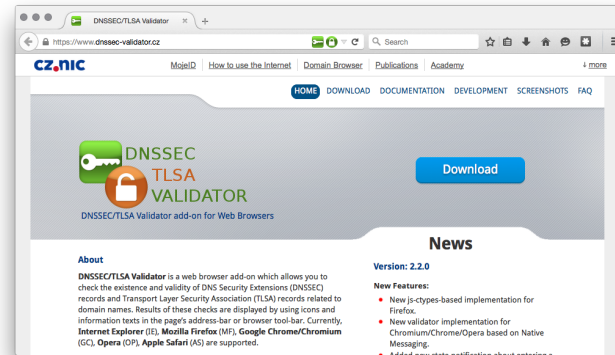
The STARTTLS command for IMAP and POP3 is defined in RFC 2595, for SMTP in RFC 3207, for XMPP in RFC 6120 and for NNTP in RFC 4642. For IRC, the IRCv3 Working Group has defined the STARTTLS extension. FTP uses the command "AUTH TLS" defined in RFC 4217 and LDAP defines a protocol extension OID in RFC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

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](https://en.wikipedia.org/wiki/Opportunistic_TLS)

# DNSSEC DNS integrity





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

DNSSEC is something you should enable ASAP where possible



DNSSEC nøgle(r)

( Bruger-id: DKHM1-DK )

<u>Domænenavn</u> ▾	<u>Nøgle-ID</u>	<u>Algoritme</u>	<u>Hashingalgoritme</u>	<u>Hash</u>
<input type="checkbox"/> net.dk	9880	RSASHA256	SHA-1	
<input type="checkbox"/> net.dk	9880	RSASHA256	SHA-256	

Slet nøgle

Opret nøgle

Tilbage til Selvbetjeningens forside

DNSSEC - nu ogs<E5> i Danmark

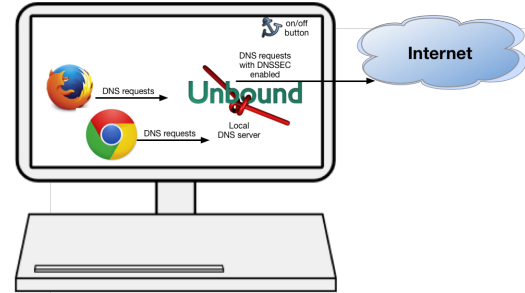
Du kan sikre dit domæne med DNSSEC - woohooo!

Det betyder en tillid til DNS som muliggør alskens services.

Kilde:

<https://www.dk-hostmaster.dk/english/tech-notes/dnssec/>

# DNSSEC trigger



Der findes mange DNSSEC programmer, blandt andet DNSSEC-trigger som er en navneserver til din lokale PC

- DNSSEC Validator for firefox  
<https://addons.mozilla.org/en-us/firefox/addon/dnssec-validator/>
- OARC tools <https://www.dns-oarc.net/oarc/services/odvr>
- <http://www.nlnetlabs.nl/projects/dnssec-trigger/>

# 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)



# SPF, DKIM, DMARC



- SPF Sender Policy Framework - which IPs can send for my domain

[https://en.wikipedia.org/wiki/Sender\\_Policy\\_Framework](https://en.wikipedia.org/wiki/Sender_Policy_Framework)

- DKIM DomainKeys Identified Mail - when sending we use these keys

[https://en.wikipedia.org/wiki/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>

Who tried sending spam which does not match our SPF and DKIM, tell us!

- DANE DNS-based Authentication of Named Entities

[https://en.wikipedia.org/wiki/DNS-based\\_Authentication\\_of\\_Named\\_Entities](https://en.wikipedia.org/wiki/DNS-based_Authentication_of_Named_Entities)

Put everything in DNS and secure it with DNSSEC

- Brug allesammen, check efter ændringer!

## Email security 2021- Goals

# DNS problems



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.

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 day <https://dnsflagday.net/> after which kludges will be REMOVED!
- DNS is unencrypted

# DNS attacks, Your registrar



## 26 Webnic Registrar Blamed for Hijack of Lenovo, Google Domains

FEB 15



Two days ago, attackers allegedly associated with the fame-seeking group **Lizard Squad** briefly hijacked Google's Vietnam domain (google.com.vn). On Wednesday, **Lenovo.com** was similarly attacked. Sources now tell KrebsOnSecurity that both hijacks were possible because the attackers seized control over **Webnic.cc**, the Malaysian registrar that serves both domains and 600,000 others.

DNS insecurity has huge impact on your security!

Most are denial of service, by may create Mitm or confidentiality concerns

Select DNS providers with care

Sources:

<https://krebsonsecurity.com/2015/02/webnic-registrar-blamed-for-hijack-of-lenovo-google-domains/>

<http://www.version2.dk/artikel/google-og-lenovo-defaced-som-foelge-af-overset-sikkerhedsproblemstilling-91295>

# DNS over TLS vs DNS over HTTPS - DNS encryption



- Protocols exist that encrypt DNS data, like dnscrypt which is not RFC standard <https://dnscrypt.info/> <https://en.wikipedia.org/wiki/DNSCrypt>
- Today we have competing standards:
- *Specification for DNS over Transport Layer Security (TLS) (DoT)*, RFC 7858 MAY 2016 [https://en.wikipedia.org/wiki/DNS\\_over\\_TLS](https://en.wikipedia.org/wiki/DNS_over_TLS)
- *DNS Queries over HTTPS (DoH)* RFC 8484
- How to configure DoT <https://dnsprivacy.org/wiki/display/DP/DNS+Privacy+Clients>

# sslscaan - can do STARTTLS with SMTP too



```
$ sslscan --starttls-smtp mail.kramse.org
Connected to 91.102.91.22
Testing SSL server mail.kramse.org on port 25 using SNI name mail.kramse.org
...
Supported Server Cipher(s):
Preferred TLSv1.2 256 bits ECDHE-RSA-AES256-GCM-SHA384 Curve 25519 DHE 253
Accepted TLSv1.2 256 bits DHE-RSA-AES256-GCM-SHA384 DHE 2048 bits
Accepted TLSv1.2 256 bits DHE-RSA-AES256-SHA256 DHE 2048 bits
Accepted TLSv1.2 256 bits DHE-RSA-AES256-SHA DHE 2048 bits
Accepted TLSv1.2 256 bits ECDHE-RSA-CHACHA20-POLY1305 Curve 25519 DHE 253
Accepted TLSv1.2 256 bits DHE-RSA-CHACHA20-POLY1305 DHE 2048 bits
Accepted TLSv1.2 256 bits DHE-RSA-CAMELLIA256-SHA256 DHE 2048 bits
Accepted TLSv1.2 256 bits DHE-RSA-CAMELLIA256-SHA DHE 2048 bits
...
Subject: mail.kramse.org
Altnames: DNS:mail.kramse.org
Issuer: Let's Encrypt Authority X3
Not valid before: Mar 24 15:05:20 2020 GMT
Not valid after: Jun 22 15:05:20 2020 GMT
```

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

## 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