State of the "DNS privacy" project

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Warsaw OARC workshop

- May 2014: talk of the “DNS privacy project”
- See the slides for the context

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A brief reminder

1. A DNS query reveals what you're interested in (`_bittorrent-tracker._tcp.domain.example`)
2. Eve can be on the wire (sniffer) but also in the name servers ("DNSCrypt doesn't prevent third-party DNS resolvers from logging your activity", to quote the DNSCrypt documentation)

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Encryption is not everything

1. Send as little data as possible (RFC 6973, section 6.1)
2. Encrypt it

1) is necessary against the evil name server. 2) is necessary against third-party sniffers.

State of the project

On the standards side:

1. RFC 7626 “DNS Privacy Considerations” published
2. RFC 7816 “DNS Query Name Minimisation to Improve Privacy” published (status “experimental”)
3. Future RFC “Specification for DNS over TLS” approved by IESG, in the RFC Editor queue (status “standard”)
4. A few drafts are still under discussion

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Running code

Stolen from Sinodun `https://portal.sinodun.com/wiki/display/TDNS/DNS-over-TLS+implementations`

Client/Server	Client - Stub				Client - Recursive			Server - Recursive		Server - Auth	
Software	ldns (drill)	digit	getdns	BIND (dig)	getdns*	Unbound	BIND	Unbound	BIND	NSD	BIND
Port based TLS		✓	✓		✓	✓		✓			
TCP fast open**		✓	✓		P						
Connection reuse		✓	✓	✓	WIP	WIP		✓	✓	✓	✓
Pipelining***	n/a	✓	✓	n/a				✓	✓	✓	✓
OOOP***	n/a	✓	✓	n/a				WIP	✓		
TLS authentication			✓			2016		✓			
EDNS0 Padding			✓								
EDNS0 Keepalive			✓			2016					

Minimising the QNAME

1. No need to send the full QNAME to the authoritative name servers
2. Ask `NS fr` to the root name servers instead of `AAAA www.internautique.fr`
3. In resolvers only (no change of the protocol)

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Implementation of QNAME minimisation

- Unbound (version $\geq$ 1.5.7). Off by default. See Ralph Dolman's' talk.
- Knot Resolver (currently beta). On by default. See Ondřej Surý's talk.

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QNAME minimisation with Knot

`dig -x` of an IPv6 address, seen by tcpdump:

```
> 38773% [1au] NS? aRpA. (33)
> 22056% [1au] NS? Ip6.aRPa. (37)
> 43002% [1au] NS? 2.ip6.arPA. (39)
```

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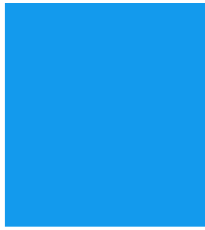
The annoying broken name servers

Knot retries with full QNAME when receiving NXDOMAIN:

```
> 24014% [1au] A? WwW.UpENn.edU. (42)
< 24014*- 2/0/1 CNAME www.upenn.edu-dscg.edgesuite.net., RRSIG (270)
> 52576% [1au] NS? edGeSUItE.NEt. (42)
< 52576- 0/17/15 (1034)
> 22228 [1au] NS? EdU-DScG.EdGesUITe.nET. (51)
< 22228 NXDomain*- 0/1/1 (114)
> 1355 [1au] A? WWW.UPenN.edu-dSCG.EdgESuItE.net. (61)
```



No way to know if it is an ENT

(ENT = Empty Non-Terminal domain name) Request for `www.long.verylong.detail.example`:

```
> 19881% [1au] NS? ExaMpLE. (36)
[NXDOMAIN received]
> 40708% [1au] AAAA? www.LONg.VeRylONG.DEtaIl.eXamPLE. (61)
```

(Same thing with Unbound)

```
< 33070 NXDomain*- q: NS? example. 0/6/1
> 31355% [1au] A? www.long.verylong.detail.example. ar: . OPT UDPsize=4
```

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Encrypting data

1. DNScurve/DNScrypt.
2. TLS. Relies on the well-known TLS. Main version, above TCP and therefore persistent connections (RFC 7766). Port 853.

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DNScrypt

`https://dnscrypt.org/`

- Not a standard (but there is running code, and deployment)
- Encrypt DNS requests to a trusted resolver
- Uses UDP
- No cryptographic agility
- Resolver authentified by its public key (last column in the CSV file)
- Free software
- Many public resolvers (come and go quite often)

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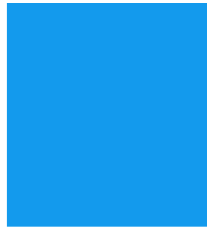

DNScrypt encrypted

```
17:26:41.720678 IP (tos 0x0, ttl 64, id 59095, offset 0, flags [+], pro
    192.168.2.9.33725 > 212.47.228.136.443: UDP, bad length 1664 > 1472
17:26:41.721372 IP (tos 0x0, ttl 64, id 59095, offset 1480, flags [none
    192.168.2.9 > 212.47.228.136: ip-proto-17
17:26:41.794366 IP (tos 0x0, ttl 64, id 59102, offset 0, flags [none],
    192.168.2.9.33725 > 212.47.228.136.443: [bad udp cksum 0x8143 -> 0x
17:26:41.840503 IP (tos 0x0, ttl 50, id 52891, offset 0, flags [none],
    212.47.228.136.443 > 192.168.2.9.33725: [udp sum ok] UDP, length 56
```

TLS with Unbound

Implemented for a long time (1.4.22?)

```
ssl-service-key: "/etc/unbound/privatekeyfile.key"
ssl-service-pem: "/etc/unbound/publiccertfile.pem"
interface: 2001:db8:1::dead:beef@853
ssl-port: 853
```

If you don't know OpenSSL :

```
openssl req -x509 -newkey rsa:4096 \
      -keyout privatekeyfile.key -out publiccertfile.pem \
      -days 1000 -nodes
```

Unbound starts and answers

```
unbound[12959:0] debug: setup TCP for SSL service
...
unbound[12959:0] debug: SSL DNS connection ip4 192.168.2.1 port 52185 (
...
unbound[12959:0] debug: Reading ssl tcp query of length 59
```

And if I don't have a server?

`https://portal.sinodun.com/wiki/display/TDNS/DNS-over-TLS+test+servers`

Testing only, no production (one serves only one zone)

First client, digit

`https://ant.isi.edu/software/tdns/index.html` Not fully maintained? (Strange errors, no IPv6)

```
% ./digit/digit  -f domains-short -t tls  -r 192.168.2.9 -p 853
#fsdb index t_complete t_avg t_individual t_sum t_mean id
query_send_ts response_receive_ts program_start_ts
1 0.614152 0.614152 0.614152 0.614152 0.614152 19383
1459097697.585573 1459097698.199725 1459097697.585572
```

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Second client, getdns

`https://getdnsapi.net/`, see Sara Dickinson's talk

```
% ./getdns/src/test/getdns\_query @192.168.2.9 -s -A -l L \
    www.bortzmeyer.org
...
Response code was: GOOD. Status was: At least one response was returned
```

(-s: stub resolver, -A: ask for addresses, -l L: TLS transport)

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TLS in Go

https://miek.nl/2014/August/16/go-dns-package/

```
c := new(dns.Client)
c.Net = "tcp-tls"
if *insecure {
        c.TLSConfig = new(tls.Config)
        c.TLSConfig.InsecureSkipVerify = true
}
in, rtt, err := c.Exchange(m, net.JoinHostPort(ns, "853"))
```

The pleasures of TLS authentication

1. No auth.: vulnerable to Mallory (the man in the middle)
2. Auth.: lots of trouble ("do you really trust this expired auto-signed certificate using SHA-1?")
3. No hard rules: different profiles for authentication

```
%  ./tls  my-resolver internautique.fr
Error in query: x509: certificate signed by unknown authority

%  ./tls -k my-resolver internautique.fr
(time 43051 µs) 2 keys. TC=false
```

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See the traffic

```
% tshark -n -d tcp.port==853,ssl -r /tmp/dnstls.pcap
 4   0.002996  192.168.2.9 -> 192.168.2.9  SSL Client Hello
 6   0.594206  192.168.2.9 -> 192.168.2.9  TLSv1.2 Server Hello, Certif
 8   0.734094  192.168.2.9 -> 192.168.2.9  TLSv1.2 Client Key Exchange
16   0.751614  192.168.2.9 -> 192.168.2.9  TLSv1.2 Application Data
17   0.759223  192.168.2.9 -> 192.168.2.9  TLSv1.2 Application Data
```

(With Wireshark, Analyze $\longrightarrow$ Decode as $\longrightarrow$ SSL)

(Provisional) Conclusion

1. We have running code
2. Deployment almost zero, currently

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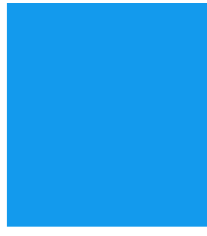

Merci !

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