DNS Privacy - The Problem

- Why is DNS a privacy concern?
  - DNS Queries
  - DNS Zone Transfers
- Overview of solutions
  - Client (stub) to recursive resolver
  - Recursive discovery
  - Recursive resolver to Authoritative server
  - Zone transfer
  - A note on SNI

Why is DNS a privacy concern?

The DNS is one of the most significant leaks of data about an individuals and an organisation's activity on the Internet.

Some of the issues in simple terms:

DNS Queries

- Almost every activity on the Internet starts with a DNS query (and often several). A key function of the DNS is to map human readable names (e.g. example.com) to IP addresses that computers need in order to connect to each other.
- Those queries can reveal not only what websites an individual visits but also meta data about other services such as the domains of email contacts or chat services.
- Whilst the data in the DNS is public, individual transactions made by an end user should not be public.
- However DNS queries are sent in clear text (using UDP or TCP) which means passive eavesdroppers can observe all the DNS lookups performed.
- The DNS is a globally distributed system that crosses international boundaries and often uses servers in many different countries in order to provide resilience.
- It is well known that the NSA used the MORECOWBELL and QUANTUMDNS tools to perform covert monitoring, mass surveillance and hijacking of DNS traffic.
- Some ISPs log DNS queries at the resolver and share this information with third-parties in ways not known or obvious to end users.
- Some ISPs embed user information (e.g. a user id or MAC address) within DNS queries that go to the ISPs resolver in order to provide services such as Parental Filtering. This allows for fingerprinting of individual users.
- Some CDNs embed user information (client subnets) in queries from resolvers to authoritative servers (to geo-locate end users). This allows for correlations of queries to particular subnets.
- Note that even when using a VPN some VPNs will still leak your DNS queries by sending them unencrypted to your ISP. Use the nice tool from anonymyster.com to check if this is happening with your VPN!

An overview of the problems is given in this Tutorial: DNS Privacy Tutorial.

For an expert review of this topic recommended reading is DNS Privacy Considerations.

DNS Zone Transfers

- DNS zone transfers are transmitted in clear text, which gives attackers the opportunity to collect the content of a zone by eavesdropping on network connections. The contents of the zone could include information such as names of persons used in names of hosts. Best practice is not to use personal information for domain names, but many such domain names exist. The contents of the zone could also include references to locations that allow inference about location information of the individuals associated with the zone’s organization. It could also include references to other organizations.

Overview of solutions

For a full discussion of the options available please see DNS Privacy - The Solutions.

Client (stub) to recursive resolver
The two most widely deployed solutions for stub to recursive resolution are DNS-over-TLS and DNS-over-HTTP; they both encrypt DNS data and prevent passive surveillance of network data revealing users' DNS queries. They can both allow users to validate the server they choose for their DNS service to make sure they are using a provider who has a good privacy policy for how they handle user data. But they do have some different protocol properties and in practice are being deployed in somewhat different ways at the moment. Neither of these are trivial changes in the way DNS works and encryption of all DNS queries by default will not happen overnight.

A Best Current Practice document describing Recommendations for DNS Privacy Service Operators has been approved for publication. This covers both downstream and upstream protocol issues and data handling recommendations for Operators of recursive resolvers that offer an encrypted protocol.

See DNS Privacy Clients, DNS Privacy Implementation Status, DNS Privacy Public Resolvers, DNS Privacy Test Servers for more information.

Recursive discovery

One significant challenge is around discovery of which transports a particular resolver supports and securely acquiring information required to connect and validate a particular resolver. The ADD working group in the IETF is currently working on a range of proposals around this issue.

Recursive resolver to Authoritative server

The DPRIVE working group at the IETF has been working on requirements and solutions for that, if you are interested see the DPRIVE mailing list.

Zone transfer

A draft in the DPRIVE working group is proposing encrypting zone transfers using TLS: Zone Transfer over TLS (XoT).

A note on SNI

Unfortunately the Server Name Indicator header in HTTPS messages also reveals the name of the website contacted by the user so provides a similar leakage channel for web traffic as the DNS queries. However there is work underway in the TLS working group at IETF to encrypt the Client Hello including the SNI: TLS Encrypted Client Hello.