The potential impact of Encrypted Client Hello (ECH) on public and private network operators and others

OARC 39

23rd October 2022

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Introduction

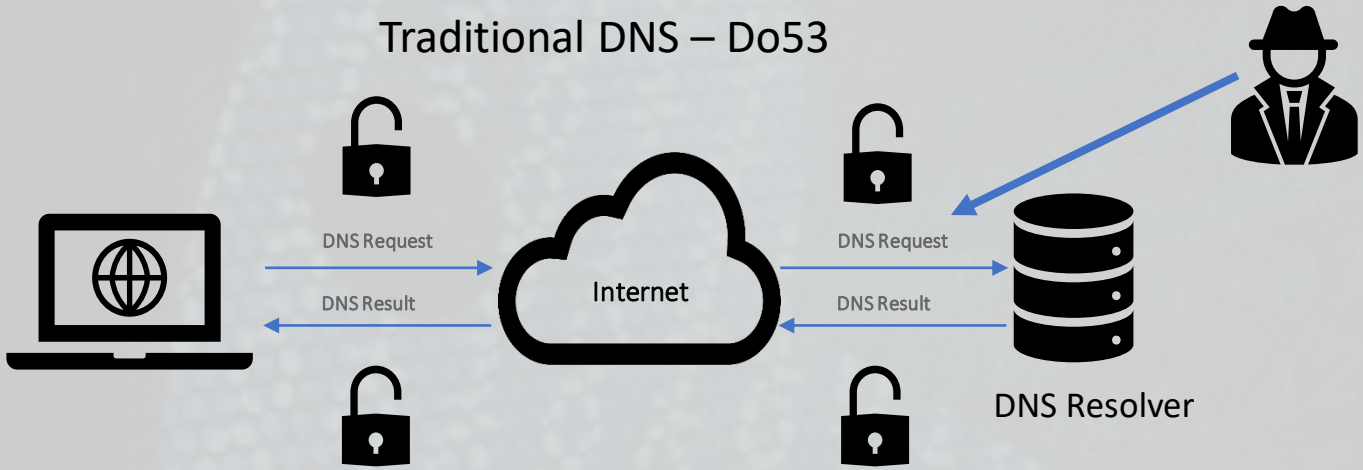
- Encryption is being used to secure all parts of the Internet ecosystem
- Recent developments have covered the Domain Name System (DNS) and related elements
- The input of end-users (and operational security people) is often missing in the development of Internet standards
- The operational impact of encrypted DNS and Encrypted SNI (Encrypted Client Hello or ECH) are often overlooked
- Changes designed to improve privacy may actually weaken both privacy and security

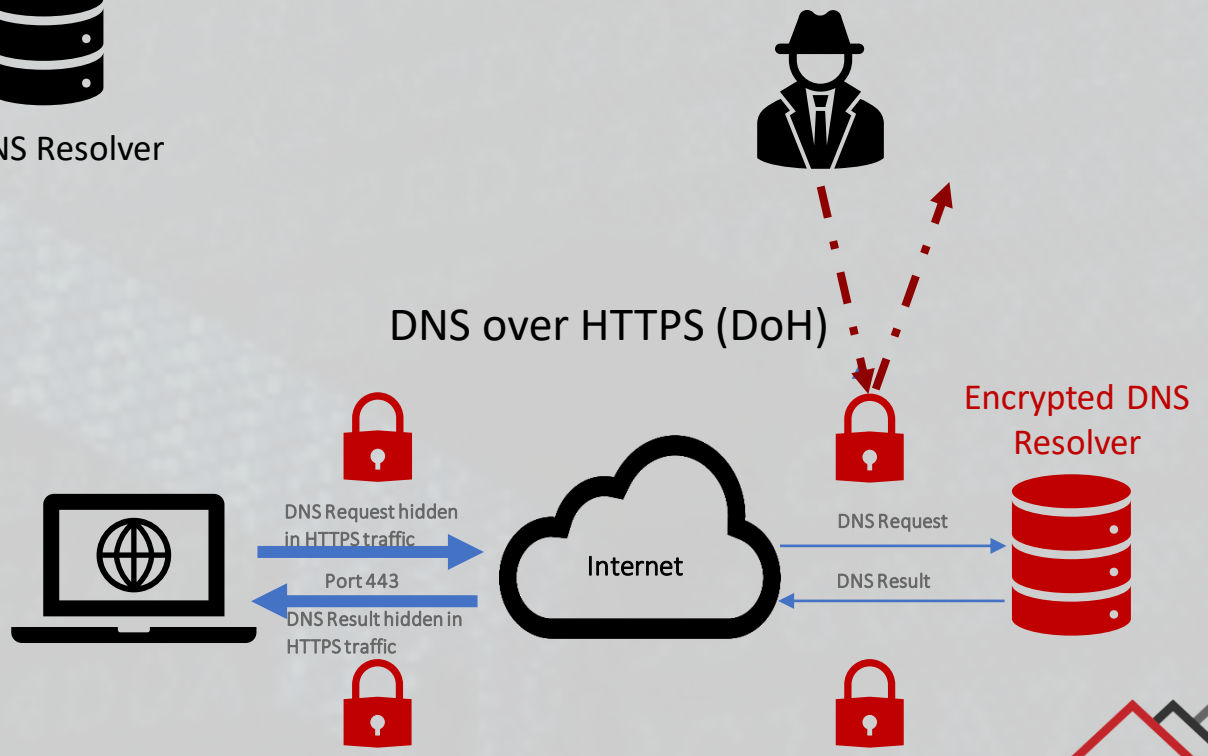
The Domain Name System and Encryption

- Domain Name System – the directory of the Internet
  - A key control mechanism for some network operators*
    - Parental Controls
    - Malware Filtering
    - Cybersecurity
  - Recent changes to standards focused on user privacy or application (particularly browser) performance
- Rise of cloud-based resolvers, eg Google, Cloudflare, Quad9 etc
  - More user choice, bypass restrictive filtering
  - Reduced infrastructure resilience
  - Greater exposure of personal data to mainly US tech companies
  - Antitrust concerns
- Risk to network operators of loss of visibility and control of network traffic

** Both public and private networks*

What is Encrypted DNS?





- DNS-over-HTTPS is defined in [IETF RFC 8484]
- Sends DNS queries from the client to the resolver via an encrypted HTTPS connection
- Can be used by any client software, bypassing any user or operating system preferences
- **The resolver operator still sees all queries**

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Approaches to DNS Resolver Upgrades

Mozilla

- In the US, Firefox automatically switches from the current resolver to one trusted by Mozilla (within its TRR programme)
- It assumes that an encrypted resolver improves protection vs status quo
  - The existing resolver may already be encrypted
  - The "upgrade" option may not provide malware filtering etc
- Creates policy challenges, for example by over-riding local choices

Google Chrome and Windows 10

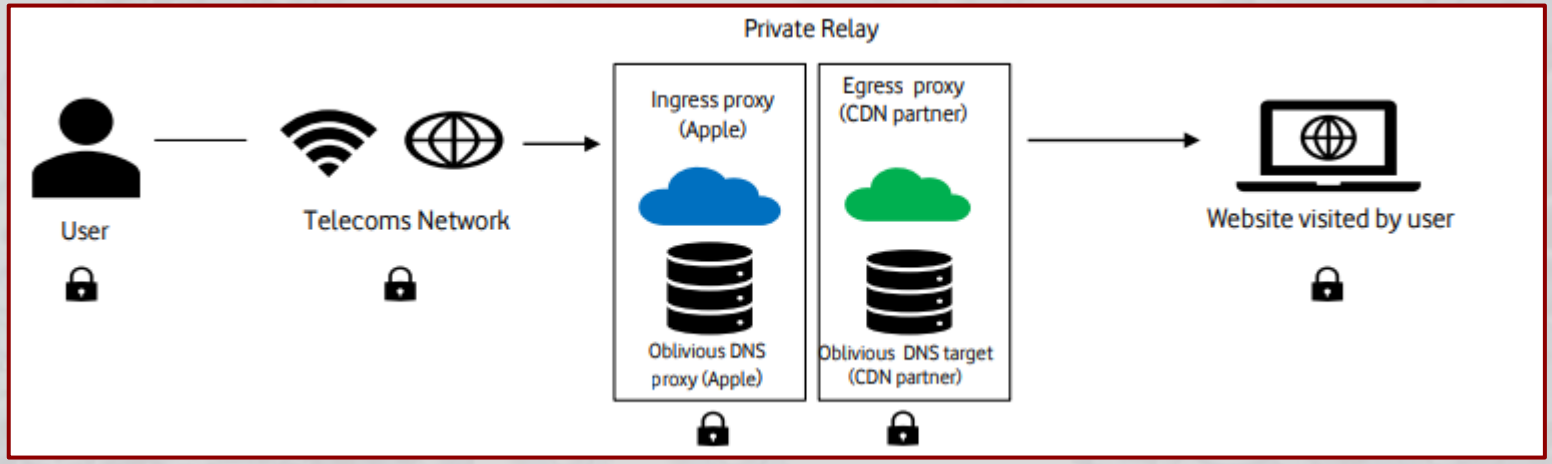
- "Same-Provider, Auto-upgrade"
- Switches to an encrypted option from the same resolver operator, so should carry forward existing policies
- Currently relies on a curated list maintained by the client software provider
- Requires a public IP address for the resolver, a problem for many ISP-operated resolvers

Resolver Discovery Standards

- Options being developed within the IETF (the ADD working group)
  - DDR (discovery of designated resolvers)
  - DNR (discovery of network resolvers)
- Early deployment of DDR by Cisco, Microsoft, Quad9, Cloudflare and Apple (iOS 16 / macOS Ventura)
- DNR suited to ISPs with DNS forwarders (common in Europe)
- Both DDR and DNR are progressing towards ratification as standards

Other Options for Encryption?

Oblivious DoH



- Requires two proxies - hides DNS query from first proxy, source IP address of query from the second
- Marked as an Experimental protocol within the IETF – the focus is currently on Oblivious HTTP
- Used by Apple within Private Relay
- Depending on the implementation, Oblivious may not offer real privacy improvements

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Do the Encrypted DNS Protocols Ensure DNS Queries are Private?

- Both queries and results may still be visible to the resolver operator (addressed by Oblivious DoH)
- Server Name Indication (SNI) data still leaves details of the domain names that are being accessed in plaintext
- Work currently underway within the standards body to address this
  - Originally Encrypted SNI (eSNI)
  - Now Encrypted Client Hello (ECH)

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How is SNI Data Used?

- Schools and businesses – to aid their content filtering policies
- Enterprises – to allow bring your own device (BYOD) policies to be implemented in a relatively light-touch way
- Zero rating of specific content on broadband and mobile networks for users with data caps
- Cybersecurity in enterprises
  - The SNI data can be a very useful so-called “indicator of compromise”
  - It can help to detect unusual behavior on a network that could be caused by, for example, malware

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Unintended Consequences of the Encryption of DNS and SNI Data

Desired Effect

Communication with target takes place without observation or interference

Additional Consequences

- Communication with malicious content
- Surveillance by client software
- Access to age-inappropriate content
- Access to CSAM

NB Better tools exist for “dissidents”, eg Tor etc

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What About Zero-Trust?

- Instead of assuming everything behind the corporate firewall is safe, the Zero Trust model verifies each request as though it originates from an open network
  - Recent and current developments make the use of DNS and SNI data to monitor communications to and from applications increasingly difficult
  - Difficult to differentiate the behaviour of benign software from that of malware
- Software that doesn't provide control and visibility to enterprises is likely to be removed
- The motivation for enterprises to act is significant

  US regulators are in the process of levying fines of $200m each on a number of institutions because they were unable to track all communications by their employees because some were encrypted though the use of WhatsApp or Signal
- Consumers will face greater exposure to malware

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Conclusion

- The introduction of encrypted DNS and SNI protocols may benefit privacy in some cases but can also have negative operational impacts
- Insufficient consideration to these impacts is currently being given
- New approaches are being developed without significant input from the various end-user communities, information security practitioners and others that may be affected

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Any Questions?

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