Network management of encrypted traffic
draft-smith-encrypted-traffic-management-04

Abstract

   Encrypted Internet traffic may pose traffic management challenges to
   network operators. This document recommends approaches to help
   manage encrypted traffic, without breaching user privacy or security.

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1. Introduction

   Networks utilise various management techniques to ensure efficient
   throughput, congestion management, anti-SPAM and security measures.
   Historically these functions have utilised visibility of the Internet
   application layer.

   This visibility is rapidly diminishing - encrypted Internet traffic
   is expected to continue its upward trend, driven by increased privacy
   awareness, uptake by popular services, and advocacy from the [IAB],
   [RFC7258] and W3C [TAG] .

   [IAB], [RFC7258] and [mm-effect-encrypt] recognise that network
   management functions may be impacted by encryption, and that
   solutions to persist these management functions must not threaten
   user security or privacy. Such solutions can ensure the benefits of
   encryption do not degrade network efficiency.

   This document lists such solutions, and points to evolving IETF work
   addressing the problem.

1.1. Document structure

This document refers to network management functions that may be hindered by traffic encryption, as described in [mm-effect-encrypt]

It then describes the technical details of existing options to fully or partially persist these functions under encryption. The guidance includes existing techniques as well as ongoing IETF work in this area.'Encryption' in this document typically refers to HTTP over TLS [RFC2818]; other forms of encryption are noted where applicable.

Finally, a summary is provided of ongoing IETF work which is investigating how network operators, origin servers and clients may co-operate in efficient traffic delivery without the need for pervasive network monitoring.

The legal, political and commercial aspects of network management are recgnised but not covered in this technical document.

2. Network management functions

Please refer to 'Network Service Provider Monitoring' in [mm-effect-encrypt]

3. Persisting traffic management without breaching encryption

This section involves utilisation of 'Application-based Flow Information Visible to a Network', [mm-effect-encrypt].

3.1. Providing hints to and from the network

The following protocols aim to support a secure and privacy-aware dialogue between client, server and the network elements. These hints can allow information item exchange between the endpoints and the network, to assist queuing mechanisms and traffic pacing that accounts for network congestion and variable connection strength. These relate to the cooperative path to endpoint signalling as discussed at the IAB SEMI [SEMI] and MaRNEW [MaRNEW] workshops, with the network following a more clearly-defined role in encrypted traffic delivery.

3.1.1. DiffServ Code Points (DSCP)

Data packets may be flagged with a traffic class (class of service). Network operators may honour a DiffServ classification [RFC2474] entering their network, or may choose to override it (since it is potentially open to abuse by a service provider that classifies all

its content as high priority). The purpose is to help manage traffic
and congestion in the network.

This requires the content provider to flag data packets. This is
extra work for the provider, and it has potential for abuse if a
content provider simply flags all packets with high priorities. The
network would need to know which flags to trust and which to
override. The use of DiffServ within the operator network is
beneficial where the operator determines the class of service itself;
but where content is encrypted then heuristics would be needed to
predict the traffic type entering the network. HTTP/2 allows several
streams to be multiplexed over a single TCP connection. This means
that if a provider decides to send Web pages, videos, chat etc. as
individual streams over the same connection, then DiffServ would be
useless as it would apply to the TCP/IP connection as a whole.
However it may be more efficient for such Web providers to serve each
content type from separate, dedicated servers - this will become
clearer as HTTP/2 deployments are tuned for optimal delivery.

3.1.2. Explicit Congestion Notification (ECN)

Explicit Congestion Notification [RFC6138] routers can exchange
congestion notification headers to ECN compliant endpoints. This is
in preference to inferring congestion from dropped packets (e.g. in
TCP). The purpose is to help manage traffic and congestion in the
network.

This solution is required to be implemented at network and service
provider. The service provider will utilise the ECN to reduce
throughput until it is notified that congestion has eased.

As with DiffServ, operators may not trust an external entity to mark
packets in a fair/consistent manner.

3.1.3. Multiprotocol Label Switching (MPLS)

On entering an MPLS-compliant network [RFC3031], IP packets are
flagged with a 'Forward Equivalence Class' (FEC). This allows the
network to make packet-forwarding decisions according to their
latency requirements. MPLS routers within the network parse and act
upon the FEC value. The FEC is set according to the source IP
address and port. The purpose is to help managing traffic and
congestion in the network. This requires deployment of an MPLS
'backbone' with label-aware switches/ routers.

An up-to-date correspondence table between Websites (or service sites
in general) and server IP address must be created. Then, the
category(s) of traffic have to be consistently mapped to a set of

   MPLS labels ,which entails a significant effort to setup and
   maintain.

   Note: MPLS can specify how OSI Layer 3 (IP layer) traffic can be
   routed over Layer 2 (Data Link); DiffServ only operates over Layer 3.
   DiffServ is potentially a less complex integration as it is applied
   at the network edge servers only.

3.1.4. Substrate Protocol for User Datagrams (SPUD)

   SPUD [SPUD] is a prototype to research how network devices on the
   path between endpoints can share information to improve a flow. The
   network involvement is outside of the end-to-end context, to minimise
   any privacy or security breach. The initial prototype involves
   grouping UDP packets into an explicit 'tube', however support of
   additional transport layers (such as TCP) will also be investigated.

3.1.5. Mobile throughput Guidance

   Mobile Throughput Guidance In-band Signalling [MTG] is a draft
   proposal to allows the network to inform the server endpoint as to
   what bandwidth the TCP connection can reasonably expect. This allows
   the server to adapt their throughput pacing based on dynamic network
   conditions, which can assist mechanisms such as Adaptive Bitrate
   Streaming and TCP congestion control.

3.1.6. Port Control Protocol Flowdata options

   PCP Flowdata options [PCPFD] defines a mechanism for a host to signal
   flow characteristics to the network, and the network to signal its
   ability to accommodate that flow back to the host. This allows
   certain network flows to receive service that is differentiated from
   other network flows, and may be used to establish flow priority
   before connection establishment. PCP Flowdata operates at IPv4/IPv6
   level.

3.1.7. IPv6 Flow label

   IPv6 includes a flow label header field. [RFC6438] details how this
   may be used to identify flows for load balancing and multipath
   routing, which may be of particular use for application-layer
   encrypted traffic. The flow label field is part of the main header,
   which means it is not subject to the disadvantages of extension
   headers (namely their risk of being dropped by intermediary routers).
   The flow label may also be exposed as part of the outer IP packet in
   an IP tunnel, thus providing network flow information without
   compromising the payload.

3.1.8. DISCUSS

Differentiated prIorities and Status Code-points Using Stun
Signalling [DISCUSS] describes a mechanism for information exchange
between an application and the network, viable only for UDP. As such
it can be considered in the same bracket as SPUD

3.2. Inferred flow information

3.2.1. Heuristics

Heuristics can be used to map given input data to particular
conclusions via some heuristic reasoning. Examples of input data to
this reasoning include IP destination address, TCP destination port,
server name from SNI, and typical traffic patterns (e.g. occurrence
of IP packets and TCP segments over time). The accuracy of
heuristics depends on whether the observed traffic originates from a
source delivering a single service, or a blend of services. In many
scenarios, this makes it possible to directly classify the traffic
related to a specific server/service even when the traffic is fully
encrypted.

If the server/service is co-located on an infrastructure with other
services that shares the same IP-address, the encrypted traffic
cannot be directly classified. However, commercial traffic
classifiers today typically apply heuristic methods, using traffic
pattern matching algorithms to be able to identify the traffic. As
an example, classifier products are able to identify popular VoIP
services using heuristic methods although the traffic is encrypted
and mostly peer-to-peer.

3.3. Co-operation on congestion control

One idea from the IAB 'Managing Radio Networks in an Encrypted World'
workshop [MaRNEW] was that of better co-operation between 3GPP mobile
networks and Internet services on congestion management. . 3GPP
networks are concerned with ensuring that all devices attached to a
particular cell receive a fair share of radio resources. This is
critical, since these resources are constrained to various licenced
spectrum bands, and volatile due to signal strength variation/cell
handover/interference etc. The resource sharing process occurs
independently to TCP congestion management performed between the
client and server connected via the mobile network: the result is
that TCP may wrongly infer congestion and react accordingly, or
attempt to accelerate throughput without consideration of the
available radio resources. Therefore the notion is to investigate
co-operation between radio and TCP congestion controls to better
manage connection throughput.

4. Acknowledgements

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5. IANA Considerations

There are no IANA considerations.

6. Security Considerations

The intention of this document is to consider how to persist network management of encrypted traffic, without breaching user privacy or end-to-end security. In particular this document does not recommend any approach that intercepts or modifies client-server Transport Layer Security.

7. References

7.1. Normative References

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