



# IP Fragmentation Considered Fragile

<draft-bonica-intarea-frag fragile-01>

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# Overview



- IP Fragmentation reduces the reliability of the Internet
- This document
  - Describes how IP Fragmentation works for IPv4 and IPv6
  - Describes how IP Fragmentation reduces reliability
  - Provides recommendations protocol developers and network operators

# Terminology



- Maximum Transmission Unit (MTU)
  - The maximum number of bytes a link can convey
- Minimum Link MTU
  - IPv4 – 68 bytes or greater
  - IPv6 – 1280 bytes or greater
- Path MTU (PMTU)
  - Number of bytes that can convey from a source to destination (Min of link MTU)
  - This will change as path changes

# IP Fragmentation



- IPv4 Fragmentation
  - Defined in RFC0791
  - Fragmentation allowed at source and routers along path
- IPv6 Fragmentation
  - Defined in RFC8200
  - Fragmentation only allowed at source
- Upper layer headers only appear in first fragment

# Path MTU Discovery (PMTUD)



- Source maintains a running estimate of PMTU for each destination
- The estimate may be too large
- Estimate is refined by ICMP Packet Too Big messages
  - Contain next-hop MTU
- Requires ICMP Packet Too Big message to reach source node

# Packetization Layer PMTUD (PLPMTUD)



- Packetization layer maintains PMTU estimate by sending probe packets of various sizes and receiving acknowledgements
- Defined for
  - TCP [RFC 4821]
  - Other protocols [draft-fairhurst-tsvwg-datagram-plpmtud]
  - Not UDP
- Does not rely on ICMP Packet Too Big

# Fragmentation Issues



- Only first fragment has transport layer header
- Impacts
  - Load balancers
  - Firewalls
  - Other middle boxes

# Fragmentation Issues (cont.)



- Security Vulnerabilities
  - Overlapping Fragments
  - Resource exhaustion attacks
  - More.....
- Blackholing due to ICMP loss
  - PMTU fails due to loss of ICMP Packet Too Big messages
- Blackholing due to filtering
  - Widespread dropping of packets with extension headers



# Transport Layer Solutions



- Select MTU that is unlikely to need fragmentation
- PLPMTUD for TCP
- <draft-fairhurst-tsvwg-datagram-plpmtud>  
work in progress

# Recommendations



- Application Developers
  - SHOULD NOT develop applications that rely on IP Fragmentation
- Network Operators
  - MUST NOT filter ICMPv6 Packet Too Big messages
- Meta Recommendation
  - DNSSEC needs a solution

# Next Steps



- Internet Area w.g. adopt as working group document?



# QUESTIONS / COMMENTS?