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Abstract

This document discusses how RFC 1858 compliant filters can be
vulnerable to a variant of the "Tiny Fragment Attack" described in
section 3.1 of the RFC. This document describes the attack and
recommends corrective action.

1. Introduction

RFC 1858 provides an excellent description of a class of attack on
Internet firewalls and proposes countermeasures. However one of
these countermeasures, the "Indirect Method" (section 3.2.2) is
vulnerable to a combination of two of the attacks described.

The attack combines the features of the "Tiny Fragment Attack"
(section 3) and the "Overlapping Fragment Attack" (section 4).

1.1 The scope of the attack

Where the filtering rules allow incoming connections to a machine AND
there other ports which allow only outgoing connections on the same
host, the attack allows incoming connections to the supposedly
outgoing-only ports.

Note that only the initial connection message need be fragmented.
Once the connection is established further traffic on it is legal.
The significance of this weakness will depend on the security policy
in force.
2. The Tiny Overlapping Fragment Attack

The attack typically consists of sending three fragments.

Fragment 1: (Fragment offset = 0; length >= 16)
Includes whole header and is entirely legal. Typically it
describes a SYN packet initiating a new TCP connection to a port
on the target host that is allowed to receive incoming
connections.
e.g., Incoming connection to port 25 SMTP.

Fragment 2: (Fragment offset = 0; length = 8)
Is only the first 8 bytes and could be legal depending on the
other 8-bytes of the header, but is NOT legal combined with the
corresponding bytes from Fragment 1. Such a fragment includes
only the port numbers and sequence number from the TCP header.
Typically this packet replaces the destination port number with a
port number on which the destination host that is not allowed to
receive incoming connections.

Fragment 3: (Fragment offset >= 2; length = rest of message)
Contains no header and completes the message. (This third
fragment is not part of the attack. However Fragment 1 cannot be
the complete message or it would be passed up to the application
before Fragment 2 arrived so a third fragment is necessary.)

2.1 Example of the attack

Consider the following trivial set of rules for incoming packets:

<table>
<thead>
<tr>
<th>No</th>
<th>Action</th>
<th>Source Port</th>
<th>Dest. Port</th>
<th>Flags</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Permit</td>
<td>&gt;1023</td>
<td>SMTP</td>
<td>ANY</td>
<td>Incoming E-mail</td>
</tr>
<tr>
<td>2</td>
<td>Permit</td>
<td>&gt;1023</td>
<td>ANY</td>
<td>Ack=1</td>
<td>Existing FTP data channel connections.</td>
</tr>
<tr>
<td>3</td>
<td>Deny</td>
<td>ANY</td>
<td>ANY</td>
<td>ANY</td>
<td>Default deny</td>
</tr>
</tbody>
</table>

Fragment 1: attacker(1234) -> target(SMTP) Ack=0
This is a new SMTP connection and is permitted by rule 1.

Fragment 2: attacker(1234) -> target(Telnet=23) Ack=absent
All fields present conform to rule 2, as it could be the start of
an FTP packet.
Depending on the precise implementation of the fragment reassembly in the target machine’s IP stack, fragment B may overwrite fragment A to produce:

attacker(1234) -> target(Telnet) Ack=0
(new telnet connection)

2.2 The failure of "Indirect Method"

The Indirect Method attempts to solve both Tiny Fragment and Overlapping Fragment attacks, solely by rejecting packets with FO=1. However none of the above fragments have FO=1, so none are rejected.

The failure is clear on careful reading. In section 3.2.2 "Indirect Method", RFC 1858 states:-

The indirect method relies on the observation that when a TCP packet is fragmented so as to force "interesting" header fields out of the zero-offset fragment, there must exist a fragment with FO equal to 1.

This is normally true where the fragments are genuine fragments, generally by bona fide software, but it is simply not true that a hacker forging fragments is forced to produce an FO=1 fragment simply because (s)he has produced an 8-byte FO=0 fragment. The vulnerability flows from this false premise.

3. Countermeasures

Whereas apparently very elegant, RFC 1858’s Indirect Method is not robust. In addition to blocking FO=1 packets, it is also necessary to block FO=0 that hold less than a complete header.

if FO=0 and PROTOCOL=TCP and TRANSPORTLEN < tmin then
DROP PACKET
if FO=1 and PROTOCOL=TCP then
DROP PACKET

4. Security Considerations

This memo is concerned entirely with the security implications of filtering fragmented IP packets.
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