Fixed-Bandwidth Mode for SSH Channels
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Abstract

This memo defines a mechanism for SSH clients and servers to counter some types of traffic analysis, especially keystroke analysis, in SSH terminal session channels.

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1. Overview and Rationale

Secure Shell (SSH) is a common protocol for secure communication on the Internet. Despite encryption, naive SSH terminal implementations are vulnerable to keystroke traffic analysis. When a user is typing, each keystroke results in a small packet sent to the server, and the server echoes the key back. The sizes and timings of packets betray how many keys the user has pressed, as well as what key combinations are most likely, because different key combinations cause subtle but consistently different delays.

It is also possible to analyze non-keystroke traffic in the direction from the server to client. When a client makes a directory listing, the resulting encrypted TCP stream is distinguishable from viewing a man page, or running a SQL statement.

This memo defines a mechanism intended to counter keystroke analysis, and to generally improve terminal session privacy.

1.1. Requirements Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

2. Mechanism

2.1. Entering Fixed-Bandwidth Mode

Because the SSH server will generally echo received keystrokes to the client, defending against keystroke analysis requires cooperation between the client and server.

To enable fixed-bandwidth mode, the client sends the following channel request at any point after opening the channel [RFC4254]:

```plaintext
byte    SSH_MSG_CHANNEL_REQUEST
uint32  remoteChannel Nr
string  "fixed-bandwidth"
bool    wantReply
uint32  burstWindowSeconds
uint32  msBetweenTransmissions (milliseconds)
uint32  bytesPerTransmission
```

This mechanism is mainly intended for channels of type "session" that are used for interactive terminal, but a client MAY use it for other channels. A server that responds positively to this request MUST enable fixed-bandwidth mode for that channel. A server MAY internally constrain parameters of this request to values it deems sensible.
If a server responds negatively to this request, a client MAY still enter fixed-bandwidth mode for data sent in the direction from client-to-server. However, such a server is likely to echo keystrokes back to the client, defeating the effort.

When fixed-bandwidth mode is requested by the client and confirmed by the server, the channel starts in the resting state.

### 2.2. Resting State

In resting state, the channel waits either for an outgoing channel message to send, or for an incoming channel message received. Each of these is a triggering event.

When a triggering event occurs — either a channel message is ready to send, or a channel message is received — this causes the channel to enter two or more consecutive burst windows.

### 2.3. Burst Window

When a triggering event occurs, the channel enters a burst window of duration `burstWindowSeconds`. A channel returns to resting state at the end of a burst window — if, and only if, no triggering event occurred during the last burst window. If any channel message was sent or received during a burst window; even if this was only the initial event that started the burst; then the channel continues with another burst window of duration `burstWindowSeconds`.

When the channel is in a burst window; instead of sending messages as it would outside this mechanism; the channel operates as follows:

1. The SSH implementation operates a timer. It checks if a message should be sent on the channel every `msBetweenTransmissions`.
2. If a channel message is to be sent, the implementation sends it as a transmission of size `bytesPerTransmission`; exceeding that size only if a message cannot be broken apart. Any further channel messages or data are left in queue until next sending opportunity.
3. If no channel message is to be sent, the implementation sends a transmission based on SSH_MSG_IGNORE of size `bytesPerTransmission`.

The preceding treatment is applied to the following channel messages:

- SSH_MSG_CHANNEL_DATA
- SSH_MSG_CHANNEL_EXTENDED_DATA
- SSH_MSG_CHANNEL_WINDOW_ADJUST
- SSH_MSG_CHANNEL_REQUEST
- SSH_MSG_CHANNEL_SUCCESS
- SSH_MSG_CHANNEL_FAILURE
- SSH_MSG_CHANNEL_EOF
- SSH_MSG_CHANNEL_CLOSE
2.4. Unencrypted Packet Lengths and Small Transmission Targets

A small transmission target is a bytesPerTransmission parameter which does not exceed the maximum empty packet length currently achievable using maximum padding and respecting any block alignment requirements.

When the session encryption algorithm uses unencrypted packet lengths, the parameter bytesPerTransmission MUST be coerced, each time at the point where it is used, to a small transmission target.

When a small transmission target is in use, each transmission consists of a single packet; either SSH_MSG_IGNORE or a payload packet; padded to the transmission size, while respecting any block alignment.

2.5. Encrypted Packet Lengths and Multi-Packet Transmission Targets

A multi-packet transmission target is a bytesPerTransmission parameter which DOES exceed the maximum empty packet length currently achievable using maximum padding and respecting any block alignment requirements.

A multi-packet transmission target may be used ONLY if the session encryption algorithm uses encrypted packet lengths.

When a multi-packet transmission target is in use, each transmission consists of two packets sent back-to-back. The first packet is either SSH_MSG_IGNORE, or a payload packet with minimal padding, respecting any block alignment. The second packet is an SSH_MSG_IGNORE such that total size reaches transmission size, subject to any block alignment.

It is important that the encrypted back-to-back packets are delivered to the TCP layer as a single chunk.

2.6. Key Re-Exchange

Key re-exchange may change session encryption parameters, including block alignment, MAC size, and whether packet lengths are encrypted. Key re-exchange may therefore change the way transmissions are sent, and the way bytesPerTransmission is interpreted by both parties.

2.7. Permissive Receiving

A receiver MAY implement logic to verify a sender’s conformance to this specification. If a receiver detects a sender’s non-conformance, it MAY output a diagnostic message, but it MUST NOT disconnect. Detection of apparent non-conformance is not in itself proof that the sender is not employing a different, potentially effective strategy.
3. IANA Considerations

3.1. Additions to existing tables

IANA is requested to insert the following entry into the table
Connection Protocol Channel Request Names under Secure Shell (SSH)
Protocol Parameters [RFC4250]:

<table>
<thead>
<tr>
<th>Request Type</th>
<th>Reference</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>fixed-bandwidth</td>
<td>[this document]</td>
<td>Section 2.1</td>
</tr>
</tbody>
</table>

4. References

4.1. Normative References


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