TCP-ENO: Encryption Negotiation Option
draft-ietf-tcpinc-tcpeno

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IETF96

Tuesday, July 18, 2016
Goal

Abstract away details of TCPINC encryption protocols

Facilitate adoption of future TCP-level encryption specs
  - New specs do not require additional TCP option kinds
  - New specs incrementally deployable, fall back to older specs
  - New specs compatible with existing TCPINC-aware applications (recall charter requires authentication hooks)

Minimize consumption of TCP option space

Avoid unnecessary round trips for connection setup

Revert to unencrypted TCP when encryption not possible
Overview of common case

Active opener $A$ lists spec preferences in ENO option
Passive opener $B$ lists spec preferences in ENO option
$A$ sends empty ENO option indicating encryption enabled
If any of the above ENOs missing, revert to unencrypted TCP
Overview of common case

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Passive opener $B$ lists spec preferences in ENO option
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Passive opener $B$ lists spec preferences in ENO option
$A$ sends empty ENO option indicating encryption enabled
If any of the above ENOs missing, revert to unencrypted TCP
Two kinds of ENO option

<table>
<thead>
<tr>
<th>Kind= TBD</th>
<th>Len= (N + 2)</th>
<th>contents ((N) bytes)</th>
<th>(N + 1)</th>
</tr>
</thead>
</table>

- MUST not use before TBD assigned by IANA

| Kind= 253 | Len= \(N + 4\) | ExID= 0x454E | contents (\(N\) bytes) | \(N + 3\) |

(New)

The good news: we officially have RFC6994 ExID 0x454E
- Current implementation now fully IANA compliant

The bad news: extra two bytes may push us over the edge
- E.g., tcpcrypt session resumption and default OSX options use all 40 bytes of option space in SYN segment
**ENO option contents in SYN segments**

<table>
<thead>
<tr>
<th>Opt₁</th>
<th>Opt₂</th>
<th>...</th>
<th>Optₖ</th>
</tr>
</thead>
</table>

**SYN-form ENO is a container for a set of suboptions**

**Zero or one general suboption**

**One or more spec identifier suboptions**

- Lists supported encryption specs
- Host B (passive opener) SHOULD list only one spec if possible
- Otherwise, B lists in order of increasing preference
ENO contents in non-SYN segments

Non-SYN-form ENO is just a flag (present/not present)
  - Required for graceful fallback when ENO stripped from SYN-ACK

Contents does not matter
  - Available for use by encryption specs
  - If negotiated spec does not specify use, SHOULD be 0 bytes

New: Send in all segments until you receive non-SYN segment
  - Wasn’t totally clear in draft
  - Required to recover from lost initial ACK segment
Initial suboption byte

<table>
<thead>
<tr>
<th>cs</th>
<th>v</th>
<th>meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00–0x1f</td>
<td>0</td>
<td>General suboption</td>
</tr>
<tr>
<td>0x00–0x1f</td>
<td>1</td>
<td>Length field</td>
</tr>
<tr>
<td>0x20–0x7f</td>
<td>0</td>
<td>Spec identifier suboption without data</td>
</tr>
<tr>
<td>0x20–0x7f</td>
<td>1</td>
<td>Spec identifier suboption followed by data</td>
</tr>
</tbody>
</table>

**New:** Eliminated reserved values
- General suboption now five bits
- Makes table easier to understand
General suboption format

<table>
<thead>
<tr>
<th>bit</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>2</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>zz</td>
<td>m</td>
<td>a</td>
<td>b</td>
<td></td>
</tr>
</tbody>
</table>

**b** – Passive role bit
- **New:** Required to be 1 for all passive openers
- **New:** Disable ENO if both sides have same value (eliminated \( p \) bit)

**a** – Application-aware bit (**New:** one bit, not two)
- Mandatory application aware doesn’t require separate bit

**m** – **New:** Middleware bit
- Similar to \( a \), but for use by cross-application middleware

**zz** – Reserved (send as 00 and ignore on receipt)

**New:** Ignore all but first general suboption in ENO
- If necessary, can later define bits in second 0x00–0x1f byte
Why both $a$ and $m$ bits?

Previously had two $a$ bits (so $m$ doesn’t consume another bit)

$a$ bit negotiates changes in application protocol
- Example: hash role+session ID into authentication cookie
- Intent: no future drafts place any cross-application restrictions on use

$m$ bit negotiates authentication protocol before application
- Negotiated protocol happens entirely before application protocol
- Future draft required to provide guidance
  - Need authentication protocol id or GUID to multiplex bit
  - Maybe length field to skip unsupported authentication messages
- Example: Sign session ID with public key in DNSSEC
  - Assumes DANE + secure DNS record saying server supports protocol
- Intent: secure legacy applications with LD_PRELOAD/shared lib upgrade
Spec identifier suboption format

Single-byte spec identifier suboption

<table>
<thead>
<tr>
<th>bit</th>
<th>7</th>
<th>6–0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>cs (≥0x20)</td>
<td></td>
</tr>
</tbody>
</table>

- Indicates support for spec cs:

Spec identifier suboption with suboption data

| 1 | cs (≥0x20) | one or more bytes of data |

- Indicates support for spec cs
- Format and meaning of byte determined by spec cs
By default, a multi-byte suboption extends to end of TCP option
Alternatively, can be preceded by length byte

<table>
<thead>
<tr>
<th>bit</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4–0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>nnnnn</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Indicates suboption data length of nnnn+1 bytes (not counting spec id)

**Or length word**

<table>
<thead>
<tr>
<th>bit</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12–9</th>
<th>8</th>
<th>7</th>
<th>6–0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td>m</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>zzzzz</td>
<td>m</td>
<td>0</td>
<td>nnnnnnn</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **nnnnnnnn** – low seven bits of (length − 1)
- **m** – most significant bit of (length − 1)
- **zzzz** – **New**: must be 0 or disable ENO

**New**: disable ENO in all other cases
Other changes

Much document restructuring
- New terminology and rationale sections
- Be clearer about normative/non-normative sections

First attempt at plausible IANA considerations section
- Spec ID registry is Specification Required
- Spec IDs should be allocated when Designated Expert believes RFC is more likely than not
- Requests published to TCPINC or successor WG mailing list
- $cs = 0x20$ reserved for experimental use

Improved security considerations
- Be sterner about opportunistic encryption and randomness

Pared down experiments section
Incorporate new ExID

Role negotiation requires different $b$ bits at each end
- Passive openers must include general suboption with $b = 1$

General suboption now 5 bits
- Future extensibility from second 0x00-0x1f byte, not reserved values
- One application-aware ($a$) bit instead of two, but added $m$ bit

256 byte maximum suboption data length
- Generally more precision on rejecting illegal SYN-form ENO options

Document improvements
Still to do

Agree on term “spec” or something better

Decide whether some RFC5705-like exporter mechanism needed
  - Existing requirements sufficient to virtualize session ID

Maybe take measures to free up SYN option space
  - (Flame-bait) Dedicate one bit of general suboption to declaring timestamp supported, saving 10 bytes of SYN option space…
  - Get dedicated TCP option (preferably ’E’ – 69)

Ideally not too much else before RFC

Work needed for follow-on/companion documents:
  - TCP-ENO middlebox probing
  - How to multiplex experimental spec ID 0x20 (ExID-like mechanism)
  - How to multiplex the middleware m bit (some length/uuid protocol)