A well-known vulnerability of TLS v1.0 and earlier has recently gained some attention:

http://www.theregister.co.uk/2011/09/19/beast_exploits_paypal_ssl/

Although this has been known for a long time (http://www.openssl.org/~bodo/tls-cbc.txt), and a fix for this has been provided, in reality most applications seem to be working with SSL_OP_ALL

which is a flag that enables some bug workarounds that were considered harmless.

We, too, use this in ossl_sslctx_s_alloc(VALUE klass) in ossl_ssl.c. Unfortunately, this flag also includes SSL_OP_DONT_INSERT_EMPTY_FRAGMENTS

which disables the fix for the "CBC vulnerability". Here is what a comment says about the flag (OpenSSL 1.0.0d)

/* Disable SSL 3.0/TLS 1.0 CBC vulnerability workaround that was added * in OpenSSL 0.9.6d. Usually (depending on the application protocol) * the workaround is not needed. Unfortunately some broken SSL/TLS * implementations cannot handle it at all, which is why we include * it in SSL_OP_ALL. */

If I understand http://www.openssl.org/~bodo/tls-cbc.txt correctly, the most notable implementation that does not play well with these empty fragments was (is?) IE - I don't know how this has evolved over time, I would have to research further.

An easy fix for the situation would be to discard SSL_OP_DONT_INSERT_EMPTY_FRAGMENTS, but this would risk affecting existing installations.

What do you propose? Should we solve this before the 1.9.3 release?

(PS: The actual attack and fix are outlined in

http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.61.5887&rep=rep1&type=pdf

The attack to be presented by Thai Duong and Juliano Rizzo at

http://ekoparty.org/cronograma.php (caution: currently the site is victim to the "reddit effect")

is very likely to be based on what was already known and should therefore hopefully require no further fixes.)
ext/openssl/ossl_ssl.c: Add SSL constants and allow to unset SSL option to prevent BEAST attack. See [Bug #5353].

In OpenSSL, OP_DONT_INSERT_EMPTY_FRAGMENTS is used to prevent TLS-CBC-IV vulnerability described at http://www.openssl.org/~bodo/tls-cbc.txt. It's known issue of TLSv1/SSLv3 but it attracts lots of attention these days as BEAST attack. (CVE-2011-3389)

Until now ossl sets OP_ALL at SSLContext allocation and call SSL_CTX_set_options at connection. SSL_CTX_set_options updates the value by using |= so bits set by OP_ALL cannot be unset afterwards.

This commit changes to call SSL_CTX_set_options only 1 time for each SSLContext. It sets the specified value if SSLContext#options= are called and sets OP_ALL if not.

To help users to unset bits in OP_ALL, this commit also adds several constant to SSL such as OpenSSL::SSL::OP_DONT_INSERT_EMPTY_FRAGMENTS. These constants were not exposed in Ruby because there's no way to unset bits in OP_ALL before.

Following is an example to enable 0/n split for BEAST prevention.

ctx.options = OP_ALL & ~OP_DONT_INSERT_EMPTY_FRAGMENTS

* test/openssl/test_ssl.rb: Test above option exists.

Revision 34482 - 02/08/2012 05:27 AM - nahi (Hiroshi Nakamura)
In OpenSSL, OP_DONT_INSERT_EMPTY_FRAGMENTS is used to prevent TLS-CBC-IV vulnerability described at http://www.openssl.org/~bodo/tls-cbc.txt. It's a known issue of TLSv1/SSLv3 but it attracts lots of attention these days as BEAST attack. (CVE-2011-3389)

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test/openssl/test_ssl.rb: Test above option exists.

Revision 34482 - 02/08/2012 05:27 AM - nahi (Hiroshi Nakamura)

- ext.openssl/ossj_ssl.c: Add SSL constants and allow to unset SSL option to prevent BEAST attack. See [Bug #5353].

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Revision 34482 - 02/08/2012 05:27 AM - nahi (Hiroshi Nakamura)

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Revision 34482 - 02/08/2012 05:27 AM - nahi (Hiroshi Nakamura)

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• test/openssl/test_ssl.rb: Test above option exists.

Revision 34482 - 02/08/2012 05:27 AM - nahi (Hiroshi Nakamura)

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* test/openssl/test_ssl.rb: Test above option exists.

Revision 0dea8a71 - 02/08/2012 05:57 AM - nahi (Hiroshi Nakamura)
Backport r34482 from trunk. See #5353

git-svn-id: svn+ssh://ci.ruby-lang.org/ruby/branches/ruby_1_8@34485 b2dd03c8-39d4-4d8f-98ff-823fe69b080e

Revision 2cb7a6c0 - 02/08/2012 06:09 AM - nahi (Hiroshi Nakamura)
Backport r34482 from trunk. See #5353

git-svn-id: svn+ssh://ci.ruby-lang.org/ruby/branches/ruby_1_8_7@34486 b2dd03c8-39d4-4d8f-98ff-823fe69b080e

Revision 0234bcfd - 02/09/2012 05:04 PM - emboss

* ext/openssl/ossl_ssl.c: Add SSL constants and allow to unset SSL
  option to prevent BEAST attack. See [Bug #5353].

In OpenSSL, OP_DONT_INSERT_EMPTY_FRAGMENTS is used to prevent
TLS-CBC-IV vulnerability described at
http://www.openssl.org/~bodo/tls-cbc.txt
It's known issue of TLSv1/SSLv3 but it attracts lots of attention
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Until now ossl sets OP_ALL at SSLContext allocation and call
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value by using |= so bits set by OP_ALL cannot be unset afterwards.
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before.

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cxt.options = OP_ALL & ~OP_DONT_INSERT_EMPTY_FRAGMENTS

* test/openssl/test_ssl.rb: Test above option exists.

git-svn-id: svn+ssh://ci.ruby-lang.org/ruby/branches/ruby_1_9_3@34524 b2dd03c8-39d4-4d8f-98ff-823fe69b080e

Revision 85fd9aad - 02/09/2012 05:20 PM - emboss
backport r34482 from trunk

ext/openssl/ossl_ssl.c: Add SSL constants and allow to unset SSL option to prevent BEAST attack. See [Bug #5353].

In OpenSSL, OP_DONT_INSERT_EMPTY_FRAGMENTS is used to prevent TLS-CBC-IV vulnerability described at http://www.openssl.org/~bodo/tls-cbc.txt
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Following is an example to enable 0/n split for BEAST prevention.

ctx.options = OP_ALL & ~OP_DONT_INSERT_EMPTY_FRAGMENTS

test/openssl/test_ssl.rb: Test above option exists.

git-svn-id: svn+ssh://ci.ruby-lang.org/ruby/branches/ruby_1_9_2@34525 b2dd03c8-39d4-4d8f-98ff-823fe69b080e

Revision 84f1dae9 - 12/18/2012 02:02 AM - emboss

ext/openssl/lib/ssl.rb: Enable insertion of empty fragments as a countermeasure for the BEAST attack by default. The default options of OpenSSL::SSL::SSLContext are now:
OpenSSL::SSL::OP_ALL & ~OpenSSL::SSL::OP_DONT_INSERT_EMPTY_FRAGMENTS
[Bug #5353] [ruby-core:39673]

test/openssl/test_ssl.rb: Adapt tests to new SSLContext default.

NEWS: Announce the new default.

git-svn-id: svn+ssh://ci.ruby-lang.org/ruby/trunk@38433 b2dd03c8-39d4-4d8f-98ff-823fe69b080e

Revision 38433 - 12/18/2012 02:02 AM - emboss

ext/openssl/lib/ssl.rb: Enable insertion of empty fragments as a countermeasure for the BEAST attack by default. The default options of OpenSSL::SSL::SSLContext are now:
OpenSSL::SSL::OP_ALL & ~OpenSSL::SSL::OP_DONT_INSERT_EMPTY_FRAGMENTS
[Bug #5353] [ruby-core:39673]

test/openssl/test_ssl.rb: Adapt tests to new SSLContext default.

NEWS: Announce the new default.
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OpenSSL::SSL::OP_ALL & ~OpenSSL::SSL::OP_DONT_INSERT_EMPTY_FRAGMENTS
[Bug #5353] [ruby-core:39673]

test/openssl/test_ssl.rb: Adapt tests to new SSLContext default.

NEWS: Announce the new default.

Revision 38433 - 12/18/2012 02:02 AM - emboss

ext/openssl/lib/ssl.rb: Enable insertion of empty fragments as a countermeasure for the BEAST attack by default. The default options of OpenSSL::SSL::SSLContext are now:
OpenSSL::SSL::OP_ALL & ~OpenSSL::SSL::OP_DONT_INSERT_EMPTY_FRAGMENTS
[Bug #5353] [ruby-core:39673]

test/openssl/test_ssl.rb: Adapt tests to new SSLContext default.

NEWS: Announce the new default.

Revision 38433 - 12/18/2012 02:02 AM - emboss

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Revision 38433 - 12/18/2012 02:02 AM - emboss

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OpenSSL::SSL::OP_ALL & ~OpenSSL::SSL::OP_DONT_INSERT_EMPTY_FRAGMENTS
[Bug #5353] [ruby-core:39673]

test/openssl/test_ssl.rb: Adapt tests to new SSLContext default.

NEWS: Announce the new default.
NEWS: Announce the new default.

History

#1 - 09/23/2011 09:29 AM - Anonymous

-----BEGIN PGP SIGNED MESSAGE-----
Hash: SHA1

(2011/09/23 1:14), Martin Bosslet wrote:

A well-known vulnerability of TLS v1.0 and earlier has recently gained some attention:

http://www.theregister.co.uk/2011/09/19/beast_exploits_paypal_ssl/

I think the thread here would be better than media articles.

http://www.ietf.org/mail-archive/web/tls/current/msg08032.html

My current BEAST understanding is: "TLS/SSL CBC IV chaining + victim/attacker multiplexed onto a single TLS/SSL connection on Browser (SSL client side) + CPA(Chosen-plaintext Attack)" but we should wait the conference session today. Done already?

For existing TLS/SSL + CBC IV vuln issue, I rarely set SSL_OP_DONT_INSERT_EMPTY_FRAGMENTS since clients I write don't allow CPA by attacker. In ossl, when an attacker can have the same SSLSession object with a victim, the attacker can sniff plaintext easier in another way. I do the same for servers.

But yeah, using this option correctly must be hard for Ruby users. It would be better to turn the SSL_OP_DONT_INSERT_EMPTY_FRAGMENTS bit off by default. We might get some claims, but we can explain the reason.

What do you propose? Should we solve this before the 1.9.3 release?

// NaHi

-----BEGIN PGP SIGNATURE-----
Version: GnuPG v1.4.9 (Cygwin)
iQEcBAEBAgAGBQJOe9GyAAoJEC7N6P3yLbi2yGUH/0BWS2Fzpvuy22ul9uQPyBCJocp+T+UeuJDZVxf0qzA8ri7TLKCH8/VbA16ny5LmH9Dq41mxJwPn8o0hmCaQXOuUZh8MfP4t9VdZlIF/3RwYB35amGrSr5xc4XQ60c2GhJUtllrI6fzrqUG7FJYkEty4prAba2e4fwpwV/A1K7R+OQJe37fRhvv5ZDGIIXBNbGso3L8znCwmcnk4N29hP2fhMyeFh1b99+kaB9IfyYzwKPlKLrdmAxtOZrlu0INRMzgnUoddHIbixiB6ElTVz2BCf0p07sP3gTzyykaZQRhUsExLA6PorhHv3asnYEx3ddWZJjGUXI1ux=+wTo
-----END PGP SIGNATURE-----

#2 - 09/23/2011 09:53 AM - Anonymous

-----BEGIN PGP SIGNED MESSAGE-----
Hash: SHA1

(2011/09/23 9:25), Hiroshi Nakamura wrote:

For existing TLS/SSL + CBC IV vuln issue, I rarely set SSL_OP_DONT_INSERT_EMPTY_FRAGMENTS since clients I write don't allow

Must be "I rarely unset", I meant "I always use SSL_OP_ALL". Using 'NOT' in flag is harmful :)

And additional note: I'm not a cryptographer!

// NaHi

-----BEGIN PGP SIGNATURE-----
Version: GnuPG v1.4.9 (Cygwin)
Some first reactions:


From what I understand this is really sweet, instead of trying to guess a whole block at a time they play with block boundaries so that they effectively only have to guess one byte at a time instead of let's say 16.

And it looks like turning off SSL_OP_DONT_INSERT_EMPTY_FRAGMENTS really does prevent this kind of attack, too. But then again, as nahi already hinted at, mounting this kind of attack requires quite some sophistication, usually there are often easier ways for an attacker.

An interesting approach that wouldn't break compatibility seems to be what is currently investigated for Chrome:

http://codereview.chromium.org/7621002

Instead of sending a totally empty first record they send one with exactly one byte to get the same effect of randomizing the IV.

Regards,
Martin

PS: I would be really grateful if somebody got their hands on the original paper and could post a link here or send it to me!

#4 - 09/26/2011 04:53 PM - nahi (Hiroshi Nakamura)

- ruby -v changed from trunk to -

-----BEGIN PGP SIGNED MESSAGE-----
Hash: SHA1

On 09/24/2011 08:44 PM, Martin Bosslet wrote:


From what I understand this is really sweet, instead of trying to guess a whole block at a time they play with block boundaries so that they effectively only have to guess one byte at a time instead of let's say 16.

Agreed. Wise and pragmatic :) 

And it looks like turning off SSL_OP_DONT_INSERT_EMPTY_FRAGMENTS really does prevent this kind of attack, too. But then again, as nahi already hinted at, mounting this kind of attack requires quite some sophistication, usually there are often easier ways for an attacker.

Some fix needed especially for clients but for now it should be fixed at client side, and we should wait how OpenSSL treats this issue.

I would say that it's not a blocker for 1.9.3.

An interesting approach that wouldn't break compatibility seems to be what is currently investigated for Chrome:

http://codereview.chromium.org/7621002

Instead of sending a totally empty first record they send one with exactly one
Yeah, if I understand the attack correctly, with this vulnerability, an attacker can try to guess a plain text only as the first block of CBC chain. And the above NSS patch reduces the range to 1 byte, and OpenSSL's empty fragment patch reduces it to 0 byte. It's wise and pragmatic, too. :) I wish the 1-byte patch is proven to be safe from compatibility point of view...

// NaHi
-----BEGIN PGP SIGNATURE-----
Version: GnuPG v1.4.11 (GNU/Linux)

iQEcBAEBAgABGQJQgC8DAoJEC7N6P3yLb2Duv8H/A8l8MBs3BdDFDzWtWgfrnY
5keNOMZZZ+2s5T9URtL0QrRhMvlvqzdF83oSzVvXxkwTSacGW2OYKX59z6HezO
HI7rajpO8znXJUnJW1ujO0li3NvYbQcexK08yCnuY/elw7ZQNPsB0vq4vzDwaZ
RV4uEp513Wc83M00Q+wi0HbCnl1k1gJmc+Q+vY0cJW0k4RBEW/X3QIku978+8
42GSZ\Rw8rNKO\V\E\V\AYBYzdD9ukdwhW+cxo15Sx4b1RgVyb6uog8e8xIil
h8jo7NEDx6o/HxgT4Jy/20CD5aHrT7N4dZumE8P0jgM0m5iR+6++fYfcMznrWg=
=84SS
-----END PGP SIGNATURE-----

#5 - 02/08/2012 02:27 PM - nahi (Hiroshi Nakamura)
- Status changed from Open to Closed
- % Done changed from 0 to 100

This issue was solved with changeset r34482.
Martin, thank you for reporting this issue.
Your contribution to Ruby is greatly appreciated.
May Ruby be with you.

- ext/openssl/ossl_ssl.c: Add SSL constants and allow to unset SSL option to prevent BEAST attack. See [Bug #5353].

In OpenSSL, OP_DONT_INSERT_EMPTY_FRAGMENTS is used to prevent TLS-CBC-IV vulnerability described at http://www.openssl.org/~bodo/tls-cbc.txt
It's known issue of TLSv1/SSLv3 but it attracts lots of attention these days as BEAST attack. (CVE-2011-3389)

Until now ossl sets OP_ALL at SSLContext allocation and call SSL_CTX_set_options at connection. SSL_CTX_set_options updates the value by using |= so bits set by OP_ALL cannot be unset afterwards.

This commit changes to call SSL_CTX_set_options only 1 time for each SSLContext. It sets the specified value if SSLContext#options= are called and sets OP_ALL if not.

To help users to unset bits in OP_ALL, this commit also adds several constant to SSL such as OpenSSL::SSL::OP_DONT_INSERT_EMPTY_FRAGMENTS. These constants were not exposed in Ruby because there's no way to unset bits in OP_ALL before.

Following is an example to enable 0/n split for BEAST prevention.

ctx.options = OP_ALL & ~OP_DONT_INSERT_EMPTY_FRAGMENTS

#6 - 02/08/2012 02:30 PM - nahi (Hiroshi Nakamura)
- Status changed from Closed to Open

Should have written 'See #5353' not 'See [Bug #5353]'. I don't like machinery autoclosing. :( 

#7 - 02/08/2012 03:10 PM - nahi (Hiroshi Nakamura)
Backported to ruby_1_8 and ruby_1_8_7 by r34485 and r34486 respectively.
Backported to ruby_1_9_3 in r34524 and to ruby_1_9_2 in r34525.

At first, I misunderstood the message from Martin that he just want to turn off the flag by default. I thought we can turn off the SSL_OP_DONT_INSERT_EMPTY_FRAGMENTS flag if we want.

Based on Apple's report at January, I realized that we didn't offer the feature from the beginning (I confirmed it to Gotoyuzo, the author of original code.) So we added the feature. Please see the linked commit for more detail.

The original proposal from Martin, turning off the SSL_OP_DONT_INSERT_EMPTY_FRAGMENTS bit by default, is still open.

Yes, to follow up on this: it remains to decide how this should be handled in libraries that use OpenSSL::SSL, such as Net::HTTP. In Net::HTTP's case (and I could imagine probably in most of the other cases, too), the SSLContext object is not directly accessible, so we can't configure 0/n splitting there now.

Two paths could be chosen to enable the functionality. Either patching each of the libraries by offering some way to configure 0/n splitting - or we could simply make 0/n splitting the default. The latter would only require one central change, but bears the potential to break existing installations.

Generally we are in favor of staying as compatible as possible for 2.0, but it would also mean that things like the "BEAST" attack will remain feasible in the future. So should we make this the default in trunk? The time until 2.0 gets released should give incompatible setups enough time to patch their environment?

This could be an option:

```ruby
Test/openssl/test_ssl.rb
```

--- test/openssl/test_ssl.rb (revision 37996)
+++ test/openssl/test_ssl.rb (working copy)
@@ -257,7 +257,7 @@
 ctx = OpenSSL::SSL::SSLContext.new
 assert_equal(OpenSSL::SSL::VERIFY_PEER, ctx.verify_mode)
 assert_equal(OpenSSL::SSL::OP_ALL & ~OpenSSL::SSL::OP_DONT_INSERT_EMPTY_FRAGMENTS, ctx.options)
```

---

08/27/2022
Can we safely assume every env has OP_DONT_INSERT_EMPTY_FRAGMENTS?

```ruby
def test_unset_OP_ALL
  ctx_proc = Proc.new { |ctx|
    ctx.options = OpenSSL::SSL::OP_ALL & ~OpenSSL::SSL::OP_DONT_INSERT_EMPTY_FRAGMENTS
  }

...but it causes connection problem for clients, that normally not affected by BEAST. I'll update WEBrick to disable the bit.

Martin, please close this issue if you're OK. WEBrick thing is a different problem.
=end

#13 - 12/18/2012 11:02 AM - Anonymous
- Status changed from Assigned to Closed

This issue was solved with changeset r38433.
Martin, thank you for reporting this issue.
Your contribution to Ruby is greatly appreciated.
May Ruby be with you.

- ext/openssl/lib/ssl.rb: Enable insertion of empty fragments as a countermeasure for the BEAST attack by default. The default options of OpenSSL::SSL::SSLCertificate are now:
  OpenSSL::SSL::OP_ALL & ~OpenSSL::SSL::OP_DONT_INSERT_EMPTY_FRAGMENTS
  [Bug #5353] [ruby-core:39673]

- test/openssl/test_ssl.rb: Adapt tests to new SSLSocket default.

- NEWS: Announce the new default.