Standardised ECC Cipher Suites for TLS
draft-gutmann-tls-eccsuites-01.txt

Abstract

This document describes a set of standard ECC cipher suites for TLS that simplify the complex selection procedure described in the existing ECC RFC, simplifying implementation and easing interoperability problems.

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Table of Contents

1. Introduction .................................................. 3
   1.1. Conventions Used in This Document ....................... 3
2. Cipher Suites .................................................. 4
   2.1. Discussion .............................................. 5
3. Security Considerations ................................. 7
4. IANA Considerations ........................................ 8
5. Normative References ....................................... 9
Author’s Address ............................................. 10
1. Introduction

[TLS-ECC] provides an extremely flexible, and by extension extremely complex means of specifying a large number of options involving the use of ECC algorithms for [TLS]. As such the "cipher suites" in [TLS-ECC] aren’t suites in the conventional TLS sense but more an indication of intent to negotiate a Chinese menu, with details to be decided on later via various TLS extensions and parameter settings. This makes deciding on a particular suite nondeterministic, since later parameter choices and settings can negate the initial "cipher suite" choice, requiring returning to the suite list to try with another Chinese-menu suite in the hope that later parameter choices allow it to be used.

In practice no deployed implementation actually does this, either dropping the connection or aborting the handshake with a handshake-failure if the expected parameters aren’t present throughout the various locations in the TLS handshake in which ECC parameters can be specified. This means that establishing a TLS connection using ECC often requires trial-and-error probing to ascertain what the other side is expecting to see before a connection can be established.

Experience with deployed implementations indicates that all of them appear to implement a common subset of fixed ECC parameters that work in all cases (alongside the more obscure options), representing a de facto profile of standard cipher suites rather than Chinese-menu selection options. This document standardises this de facto usage by defining a small number of standard ECC cipher suites with unambiguous parameters and settings.

1.1. Conventions Used in This Document

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. Cipher Suites

The table below defines standard ECC cipher suites with fixed, unambiguous parameters, based on the de facto profiles of suites seen in use in practice. Since the form of these suites match the existing non-ECC suites, they follow the existing suites in the { 0x00, 0xXX } range rather than being placed with the Chinese-menu suites at { 0xC0, 0xXX }. 

CipherSuite TLS_ECDHE_ECDSA_P256_WITH_AES_128_CBC_SHA = { 0x00, 0xXX }  
CipherSuite TLS_ECDHE_ECDSA_P256_WITH_AES_128_CBC_SHA256 = { 0x00, 0xXX }  
CipherSuite TLS_ECDHE_ECDSA_P256_WITH_AES_256_CBC_SHA = { 0x00, 0xXX }  
CipherSuite TLS_ECDHE_ECDSA_P256_WITH_AES_256_CBC_SHA256 = { 0x00, 0xXX }  

CipherSuite TLS_ECDHE_ECDSA_P384_WITH_AES_128_CBC_SHA = { 0x00, 0xXX }  
CipherSuite TLS_ECDHE_ECDSA_P384_WITH_AES_128_CBC_SHA256 = { 0x00, 0xXX }  
CipherSuite TLS_ECDHE_ECDSA_P384_WITH_AES_256_CBC_SHA = { 0x00, 0xXX }  
CipherSuite TLS_ECDHE_ECDSA_P384_WITH_AES_256_CBC_SHA256 = { 0x00, 0xXX }  

In the above lists, the first set of suites allows use with TLS 1.0 and 1.1, the second set allows use with TLS 1.2, and the third set allows use with Suite B. 

[At least one major implementation, Microsoft’s SChannel, already does this, see <http://msdn.microsoft.com/en-us/library/aa374757%28v=vs.85%29.aspx>. For example it lists ‘suites’ like TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256_P256 and TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256_P256. The above choices happen to coincide with the Microsoft ones not because of any explicit attempt to copy the Microsoft options but because they represent the obvious, logical choices].

For each cipher suite with their ECC parameters denoted ‘P256’ or ‘P384’, the ECC parameters are:
Internet-Draft             ECC-Suites-for-TLS                   May 2011

- ECDH key agreement in Server Key Exchange/Client Key Exchange
  message: NIST P-256/X9.62 p256r1/SECG p256r1 or NIST P-384/SECG
  p384r1 curve with uncompressed points as indicated in the suite
  name.
- ECDSA signature in Server Key Exchange message: P256 or P384 curve
  as for ECDH with uncompressed points and SHA1, SHA256 or SHA384 as
  indicated in the suite name.
- Client authentication in Certificate Request/Certificate Verify
  messages: SHA1, SHA256, or SHA384 as indicated in the suite name.

If no additional Chinese-menu ECC suites are used, implementations
SHOULD NOT send the Supported Elliptic Curves or Supported Point
Formats extensions since these parameters are fully specified by the
suite choice. If additional Chinese-menu suites are used, implementations
MUST send the Supported Elliptic Curves and Supported Point Formats
extensions as per [TLS-ECC]. The parameters specified
in these extensions apply only to the Chinese-menu suites, not the
fixed suites defined above.

[TLS] states that if the client does not send the
signature_algorithms extension then the hash algorithm defaults to
SHA1. This is required in order to provide a fall-back default if no
other means of specifying the hash algorithm to be used is available.
Since this document makes the use of the hash algorithm explicit in
the cipher suite, the fall-back to the SHA1 default is never
triggered.

Note that the suites defined in this document augment, rather than
supplant, the existing Chinese-menu suites options. Anyone requiring
the use of more unusual ECC parameters and options can use the
Chinese-menu capability to specify and select any parameters that
they require.

2.1. Discussion

The issue that this document is intended to address may be more
easily seen by considering how the parts of the Client Hello are
processed. For standard cipher suites the server iterates through a
list of suites proposed by the client and selects the most cromulent
one. For example a server may have a list of suite IDs and
parameters sorted in order of preference and select the lowest-ranked
suite in the list from the ones proposed by the client.

For the Chinese-menu suites on the other hand, the server sees a
Chinese menu selector sent by the client and then has to skip the
remaining suites and other parts of the hello and process the
extensions to see whether what’s in there matches up with that the
Chinese-menu selector requested. For example if the Chinese menu
said TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384 but the supported-curves says P256 then the server has to either hope that the other side does the special-case X9.62 handling for hash truncation and gets it right (experience with current implementations indicates that they don’t even support this capability, let alone get it right), or not take the gamble and go back to the cipher suites and look for another Chinese-menu option, and then skip the rest of the hello and process the extensions again to see if things work out this time, and if that doesn’t work either then go back ...

In practice with currently-deployed implementations it’s hard enough just trying to figure out which basic combinations of parameters they support (the usual response is a dropped connection or aborted handshake, requiring the use of trial-and-error probing to find out what’s possible), and even getting to the point of being able to interop-test any of the more exotic combinations like hash truncation becomes more or less impossible. So the purpose of this document is to try and identify the common combinations of parameters that everyone seems to implement anyway and list them as conventional cipher suites, with no further parameterisation required.

An additional problem with the Chinese-menu selection process is the fact that although it allows the specification of arbitrary numbers of handshake parameters, it never nails down how and where these parameters should be applied. Practical experience with implementations indicates that only the most straightforward combinations of algorithm parameters are likely to work. For example although it’s possible to specify both P256 and P384 as acceptable curves, what this tends to mean in practice is that { ECDH P256 + ECDSA P256 } or { ECDH P384 + ECDSA P384 } are acceptable but { ECDH P256 + ECDSA P384 } or { ECDH P384 + ECDSA P256 } aren’t. In the interests of interoperability it’s recommended that, despite the apparent flexibility implied by the Chinese menu, implementations stick to the most straightforward application of algorithm parameters, using the same algorithm or parameters throughout the handshake even if it’s implied by the Chinese-menu that mix-and-match combinations are possible. For example if the overall cipher suite is TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256 then use SHA256 everywhere a hash function is used; if the curve types are P256 or P384 then use either P256 everywhere or P384 everywhere. This design principle is captured in the requirements given in Section 2.

The term "Chinese menu" comes from the US, where Chinese restaurants traditionally had columns for ordering food, and orders were put together in a mix-and-match manner by ordering an item from column A, two from column B, and so on. Any process that involves picking a selection from different columns has become described as a "Chinese menu system".
3. Security Considerations

This document is a profile of, and simplification of, [TLS-ECC]. No further security considerations are introduced beyond those present in [TLS-ECC].
4. IANA Considerations

This document defines new cipher suites for TLS [to be allocated in the currently unallocated range { 0x00, 0xC6 } - { 0x00, 0xD1 }].
5. Normative References


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