



# Intel® Software Guard Extensions SSL (Intel® SGX SSL) Library

**Windows Developer Guide**

---

# Legal Information

No license (express or implied, by estoppel or otherwise) to any intellectual property rights is granted by this document.

Intel disclaims all express and implied warranties, including without limitation, the implied warranties of merchantability, fitness for a particular purpose, and non-infringement, as well as any warranty arising from course of performance, course of dealing, or usage in trade.

This document contains information on products, services and/or processes in development. All information provided here is subject to change without notice. Contact your Intel representative to obtain the latest forecast, schedule, specifications and roadmaps.

The products and services described may contain defects or errors known as errata which may cause deviations from published specifications. Current characterized errata are available on request.

Intel technologies features and benefits depend on system configuration and may require enabled hardware, software or service activation. Learn more at Intel.com, or from the OEM or retailer.

Copies of documents which have an order number and are referenced in this document may be obtained by calling 1-800-548-4725 or by visiting [www.intel.com/design/literature.htm](http://www.intel.com/design/literature.htm).

Intel, the Intel logo, Xeon, and Xeon Phi are trademarks of Intel Corporation in the U.S. and/or other countries.

## Optimization Notice

Intel's compilers may or may not optimize to the same degree for non-Intel microprocessors for optimizations that are not unique to Intel microprocessors. These optimizations include SSE2, SSE3, and SSSE3 instruction sets and other optimizations. Intel does not guarantee the availability, functionality, or effectiveness of any optimization on microprocessors not manufactured by Intel. Microprocessor-dependent optimizations in this product are intended for use with Intel microprocessors. Certain optimizations not specific to Intel microarchitecture are reserved for Intel microprocessors. Please refer to the applicable product User and Reference Guides for more information regarding the specific instruction sets covered by this notice.

Notice revision #20110804

\* Other names and brands may be claimed as the property of others.

Table of Contents

Legal Information ..... 2

1. Package Content ..... 4

2. Using Intel® SGX SSL Library ..... 5

3. Supported APIs ..... 7

4. Appendix A: Supported APIs ..... 10

# 1. Package Content

---

The release package contains relevant include files (both header and edl files), libraries and relevant documentation.

The following table lists the libraries provided in the release package:

Library Name	Description
libsgx_tsgxssl_crypto.lib	Intel® SGX SSL* cryptographic library, built based on OpenSSL 1.1.1 crypto library
libsgx_tsgxssl.lib	Trusted library, providing implementation for missing system APIs required by Intel® SGX SSL cryptographic library
libsgx_usgxssl.lib	Untrusted library, providing implementation for system calls outside an enclave required to resolve external dependencies of Intel® SGX SSL* cryptographic and TLS libraries.

All the libraries are built for Windows Win32 and X64 configuration. And the libraries with CVE-2020-0551 Mitigation enabled, 2 levels, X64 release only, are also available at the corresponding installation paths.

Intel® SGX SSL\* cryptographic library is OpenSSL libraries built with a few changes needed to work inside an enclave.

## 2. Using Intel® Software Guard Extensions SSL Library

---

If you already have a basic application and an enclave project, to use the Intel® SGX SSL library in an Intel® Software Guard Extensions (Intel® SGX) application project, follow the listed steps:

- Use following steps to set up generating proper interface between trusted and untrusted components

In visual studio you will need to do the following (assuming you already have basic App + Enclave project):

- As a start, you may extract Intel® SGX SSL package to solution's directory. (You may also extract it into Intel® SGX SDK directory, or any other location, as long as you refer to the right location in projects' settings)
- In your EDL file add:  
from "sgx\_tsgxssl.edl" import \*;
- Before using any OpenSSL API, you must include OpenSSL header that declares it. (e.g. <openssl\crypto.h>, <openssl\sha.h>, <openssl\ripemd.h>)
- Add "#include <windows.h>" before the "#include <openssl\xxx>" statements. The "windows.h" file is found in the Intel® SGX SSL include directory, and contains several definitions required by many of the OpenSSL headers.
- In the **Enclave** project (do these steps to all of your build environments):
- Select **Properties->Linker->Input->Additional Dependencies**:  
Add "libsgx\_tsgxssl\_crypto.lib; libsgx\_tsgxssl.lib;"
- Select **Properties->Linker->General->Additional Library Directories**:  
Add the folder where you placed the libraries. You'd better use the built-in macros like \$(SolutionDir)\$(Platform)\\$(Configuration)\ etc., so you can control the different builds. To take the CVE-2020-0551 Mitigation enabled library, you can create either of the configuration based on the release configuration for your solution: CVE-2020-0551-Load-Release or CVE-2020-0551-CF-Release.
- To add the folder where you placed the EDL file, right click your EDL file, then select **Properties->Custom Build Tool->Command Line**:  
Add the EDL file path to the '--search path' separated with ';'.
- Select **Properties->C/C++->General->Additional Include Directories** and add the folder where Intel® SGX SSL header files are located. (<path to the package>\include)
- In the **Application** project, use the following steps to set up the environment for the Intel® SGX SSL library:
- Select **Properties->Linker->Input->Additional Dependencies**:  
Add ``libsgx\_usgxssl.lib;Ws2\_32.lib``
- Select **Properties->Linker->General->Additional Library Directories**:

Add the folder where you placed the libraries (you better use the built in macros like \$(SolutionDir)\$(Platform)\\$(Configuration)\ etc. so you can control the different builds)

- To add the folder where you placed the EDL file, right click your EDL file, then select **Properties->Custom Build Tool->Command Line:**  
Add the EDL file path to the ' --search path' separated with ';'.
- If your project does not use Intel compiler, add the path to the Intel compiler libraries through **Properties->Linker->General->Additional Library Directories**
- Please note that in the current Intel® SGX SDK, the 'release' mode does not generate the enclave.signed.dll but rather prepare a signing material (since it should be signed in a secure machine that protects the private key etc.). Enclaves signed with single-step signing method using ISV's test private key can only be launched in 'debug' or 'prerelease' modes.

## 3. Supported APIs

The Intel® SGX SSL Library exposes two different set of APIs:

- Supported OpenSSL APIs - representing a subset of the OpenSSL APIs supported by the Intel® SGX SSL library. They are fully compliant with unmodified OpenSSL APIs. Other APIs are neither validated, not filtered out. All supported OpenSSL APIs are listed in [Appendix A](#).
- Manageability APIs are exposed by our trusted library to provide following services:

API	Description
<code>SGXSSLSetPrintToStdoutStderrCB</code>	Set callback function to intercept printouts sent by Intel® SGX SSL cryptographic and TLS libraries to <code>stdout/stderr</code> . If not used, the printouts will be silently omitted.
<code>SGXSSLGetSgxSSLVersion</code>	Get the Intel® SGX SSL library version.
<code>SGXSSLSetUnreachableCodePolicy</code>	Set unreachable code policy. Unreachable code consists of functions and flows that under our implementation should never be reached. That is why, by default, reaching unreachable code will cause an enclave to be aborted.

### SGXSSLSetPrintToStdoutStderrCB

The `SGXSSLSetPrintToStdoutStderrCB` function sets callback function to intercept Intel® SGX SSL cryptographic and TLS libraries printouts sent to `stdout/stderr`. If not used, the printouts will be silently omitted.

#### Syntax

```
void SGXSSLSetPrintToStdoutStderrCB(
    PRINT_TO_STDOUT_STDERR_CB cb
);
```

#### Parameters

##### **cb [in]**

Callback function to intercept OpenSSL printouts to `stdout/stderr`.

#### Return value

This function does not return a value.

#### Description

The `SGXSSLSetPrintToStdoutStderrCB` function registers a callback function to intercept Intel® SGX SSL cryptographic and TLS printouts sent to `stdout/stderr`.

If not used, the printouts will be silently omitted.

#### Requirements

Header	tSgxSSL_api.h
Library	libsgx_tsgxssl.lib

## SGXSSLGetSgxSSLVersion

The SGXSSLGetSgxSSLVersion function returns the Intel® SGX SSL libraries version.

### Syntax

```
const char* SGXSSLGetSgxSSLVersion(
    void
);
```

### Parameters

None

### Return value

This function returns the Intel® SGX SSL libraries version string.

### Description

The SGXSSLGetSgxSSLVersion function returns the Intel® SGX SSL libraries version string.

### Requirements

Header	tSgxSSL_api.h
Library	libsgx_tsgxssl.lib

## SGXSSLSetUnreachableCodePolicy

The SGXSSLSetUnreachableCodePolicy function sets unreachable code policy.

If not used, reaching unreachable code will cause an enclave to be aborted.

### Syntax

```
void SGXSSLSetUnreachableCodePolicy(
    UnreachableCodePolicy_t policy
)
```

### Parameters

**policy [in]**

The valid value is `UNREACH_CODE_ABORT_ENCLAVE` or `UNREACH_CODE_REPORT_ERR_AND_CONTINUE`.

- `UNREACH_CODE_ABORT_ENCLAVE` value means that reaching unreachable code will cause an enclave to be aborted. This is the default policy, applied by Intel® SGX SSL library.
- `UNREACH_CODE_REPORT_ERR_AND_CONTINUE` value means that reaching unreachable code will cause reporting an error through return value and/or setting last `error/errno`.

### Return value

None.

### Description



The `SGXSSLSetUnreachableCodePolicy` function sets unreachable code policy. Unreachable code consists of functions and flows that under our implementation should never be reached. Reaching them may indicate that severe error/memory corruption happened. That is why, by default, reaching unreachable code will cause an enclave to be aborted.

For customers, which in any case prefer to continue execution, additional mode, reporting an error through return value and/or setting last `error/errno`, is supported.

#### Requirements

Header	<code>tSgxSSL_api.h</code>
Library	<code>libsgx_tsgxssl.lib</code>

## 4. Appendix A: Supported APIs

Intel® SGX SSL library supports the following APIs:

Purpose	Type	OpenSSL APIs
Digest	MD5 SHA-1 SHA-2 (224, 256, 384, 512) SM3	EVP_MD_CTX_new EVP_MD_CTX_free EVP_DigestInit_ex EVP_DigestUpdate EVP_DigestFinal_ex EVP_md5 EVP_sha1 EVP_sha224, EVP_sha256, EVP_sha384, EVP_sha512 EVP_sm3
Keyed Hash	HMAC	HMAC_CTX_init HMAC_CTX_cleanup HMAC_Init_ex HMAC_Update HMAC_Final
Public Key Cryptography	RSA 1024, 2048, 4096 ECDSA NIST P-256, P-384, P-521 ECDH NIST P-256, P-384, P-521	EC_KEY_new_by_curve_name EC_KEY_set_asn1_flag EC_KEY_generate_key EC_KEY_free RSA_new RSA_free RSA_generate_key_ex RSA_private_decrypt EVP_PKEY_new EVP_PKEY_assign_EC_KEY EVP_PKEY_assign_RSA EVP_PKEY_free EVP_MD_CTX_create EVP_MD_CTX_destroy EVP_SignInit_ex EVP_SignUpdate EVP_SignFinal EVP_VerifyInit_ex EVP_VerifyUpdate EVP_VerifyFinal

Symmetric Encryption	AES-GCM 128, 256 SM4	EVP_CIPHER_CTX_init EVP_CIPHER_CTX_ctrl EVP_CIPHER_CTX_cleanup EVP_CipherInit_ex EVP_CipherUpdate EVP_CipherFinal_ex EVP_aes_128_gcm EVP_aes_256_gcm EVP_sm4_ecb EVP_sm4_cbc EVP_sm4_cfb128 EVP_sm4_ofb EVP_sm4_ctr
Other	Public key cryptography: RSA, EC, SM2	BN_new BN_set_word OBJ_txt2nid i2d_PublicKey I2d_PrivateKey