Getting Started with OpenEnclave

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1. Introduction

This document provides a step-by-step tutorial to begin using the OpenEnclave SDK. It explains how to obtain, build, and install the SDK. It also describes how to build a few simple enclave applications.

2. Licenses

Microsoft plans to release the OpenEnclave SDK under the MIT license, included here in the source distribution.

https://github.com/Microsoft/openenclave/blob/master/LICENSE

OpenEnclave builds on various third-party packages. It modifies and redistributes **libunwind** and in addition downloads other third-party packages on-the-fly during the build process. Licensing details for all third-party packages shown in the table below.

Package	License
dlmalloc	https://github.com/Microsoft/openenclave/blob/master/3rdparty/dlmalloc/LICENSE
musl libc	https://github.com/Microsoft/openenclave/blob/master/3rdparty/musl/COPYRIGHT
OpenSSL	https://github.com/Microsoft/openenclave/blob/master/3rdparty/openssl/LICENSE
libcxx	https://github.com/Microsoft/openenclave/blob/master/3rdparty/libcxx/LICENSE
libcxxrt	https://github.com/Microsoft/openenclave/blob/master/3rdparty/libcxxrt/LICENSE
libunwind	https://github.com/Microsoft/openenclave/blob/master/3rdparty/libunwind/LICENSE

3. Obtaining the source distribution

OpenEnclave is available from Github. Use the following command to download the source distribution.

```
# git clone https://github.com/Microsoft/openenclave
```

This creates a directory called **openenclave**.

4. Prerequisites

The following are prerequisites for building and running OpenEnclave.

- Intel® X86-64bit architecture with SGX1 or SGX2
- Ubuntu Desktop-16.04-LTS 64bits
- Various packages: build-essential, ocaml, automake, autoconf, libtool, wget, python, libssl-dev, libcurl4-openssl-dev, protobuf-compiler, libprotobuf-dev, build-essential, python, libssl-dev, libcurl4-openssl-dev, libprotobuf-dev, uuid-dev, libxml2-dev, cmake, pkg-config
- Intel® SGX Driver (/dev/isgx)
- Intel® SGX AESM Service (from the Intel® SGX SDK)

Once Linux and the various packages are installed, it is necessary to install the SGX driver and the SGX AESM service. These can be obtained from the following Github repositories.

- https://github.com/01org/linux-sgx-driver
- https://github.com/01org/linux-sgx

Both contain detailed instructions about building and installing these pieces. As a convenience, OpenEnclave provides a script for building and installing both the driver and the AESM service. From the root of the OpenEnclave source tree, type the following command:

```
# make prereqs
```

After this completes, verify that the AESM service is running as follows.

```
# service aesmd status
```

Look for the string “active (running)”, usually highlighted in green.

5. Building

To build the OpenEnclave SDK, type the following command from the root of the source tree.

```
# ./configure
.
.
.
Configured for x86_64-ubuntu-linux-gnu
```

Once configured, just type make.

```
# make
```

This builds the entire OpenEnclave SDK, creating the following files.

Filename	Description
lib/host/liboehost.a	Library for building host applications
lib/enclave/liboecore.a	Core library for building enclave applications
lib/enclave/liboelibc.a	C runtime library for enclave
lib/enclave/liboelibcxx.a	C++ runtime library for enclave
bin/oesign	Utility for signing enclaves
bin/oegen	Utility for generating ECALL and OCALL stubs from IDL
bin/oeelf	Utility for examining enclaves

6. Installing

To install the OpenEnclave SDK, type this command.

```
# make install

Created /opt/microsoft/openenclave/lib/openenclave
Created /opt/microsoft/openenclave/bin/openenclave
Created /opt/microsoft/openenclave/include/openenclave
Created /opt/microsoft/openenclave/share/openenclave
Created /opt/microsoft/openenclave/share/openenclave/enclave.mak
Created /opt/microsoft/openenclave/share/openenclave/host.mak
Created /opt/microsoft/openenclave/share/openenclave/samples
Created /opt/microsoft/openenclave/share/openenclave/environment

Source /opt/microsoft/openenclave/share/openenclave/environment to
initialize the OpenEnclave environment
```

By default, this installs under **/opt/Microsoft/openenclave**. The location of install files may be modified with the configure command.

The **/opt/microsoft/openenclave/share/openenclave/environment** script can be sourced as follows to initialize the OpenEnclave environment.

```
# source /opt/microsoft/openenclave/share/openenclave/environment
```

This script adds /opt/microsoft/openenclave/bin/openenclave to the PATH and defines the OPENENCLAVE_DATADIR environment variable which refers to the following directory:

- /opt/microsoft/openenclave/share/openenclave

This environment variable is used by the sample applications.