

# Intel<sup>®</sup> Software Guard Extensions (Intel<sup>®</sup> SGX) SDK for Linux\* OS

## **Installation Guide**

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## Revision History

Revision Number	Description	Revision Date
1.5	Intel® SGX Linux 1.5 release	May 2016
1.6	Intel® SGX Linux 1.6 release	September 2016
1.7	Intel® SGX Linux 1.7 release	December 2016
1.8	Intel® SGX Linux 1.8 release	March 2017
1.9	Intel® SGX Linux 1.9 release	July 2017
2.0	Intel® SGX Linux 2.0 release	November 2017
2.1	Intel® SGX Linux 2.1 release	December 2017
2.1.1	Intel® SGX Linux 2.1.1 release	March 2018
2.1.2	Intel® SGX Linux 2.1.2 release	March 2018
2.1.3	Intel® SGX Linux 2.1.3 release	April 2018
2.2	Intel® SGX Linux 2.2 release	July 2018
2.3	Intel® SGX Linux 2.3 release	September 2018
2.4	Intel® SGX Linux 2.4 release	November 2018
2.5	Intel® SGX Linux 2.5 release	March 2019
2.6	Intel® SGX Linux 2.6 release	June 2019
2.7	Intel® SGX Linux 2.7 release	September 2019

## Intel® Software Guard Extensions SDK and Platform Software Installation

This document provides the instructions on how to install the Intel® SGX SDK and platform software. You can see the details in the following topics:

- [Install Intel® Software Guard Extensions SDK and Platform Software](#)
- [Install Intel\(R\) Software Guard Extensions Eclipse\\* Plug-in](#)

### Install Intel® Software Guard Extensions SDK and Platform Software

The current Linux\* OS installation packages include three binary installers packaged separately:

- Installation package for the Intel® Software Guard Extensions (Intel® SGX) driver
- Installation package for the Intel® SGX platform software (Intel® SGX PSW)
- Installation package for the Intel® SGX SDK.

Download the following installation packages:

- Intel® SGX driver: `sgx_linux_x64_driver.bin`
- Intel® SGX PSW: `libsgx-enclave-common_${version}-${revision}_amd64.deb` or `sgx_linux_<os>_x64_psw_<version>.bin`
- Intel® SGX SDK: `sgx_linux_<os>_x64_sdk_<version>.bin`

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#### **NOTE**

Only 64-bit installation packages are available.

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#### **NOTE**

If Secure Boot is enabled, the Intel® SGX driver needs to be signed. Please consult the distribution documentation on how to sign drivers for Secure Boot.

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#### **Hardware Requirements**

- 6th Generation Intel® Core™ Processor or newer
- Intel® SGX option enabled in BIOS.

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#### **NOTE**

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This is required when you install the Intel® SGX driver or Intel® SGX PSW, but not required when you install the Intel® SGX SDK installer.

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### Prerequisites

Ensure that you have one of the following operating systems:

- Ubuntu\* 16.04 LTS 64-bit Desktop version
- Ubuntu\* 16.04 LTS 64-bit Server version
- Ubuntu\* 18.04 LTS 64-bit Desktop version
- Ubuntu\* 18.04 LTS 64-bit Server version
- Red Hat\* Enterprise Linux Server release 7.4 64bits
- Red Hat\* Enterprise Linux Server release 8.0 64bits
- CentOS\* 7.5 64bits
- Fedora 27 Server 64bits
- SUSE Linux Enterprise Server 12 64bits.

To install the Intel® SGX PSW, first install the following tools:

#### 1. On Ubuntu\* 16.04 and Ubuntu\* 18.04:

```
$ sudo apt-get install libssl-dev libcurl4-openssl-dev  
libprotobuf-dev
```

#### 2. On Red Hat\* Enterprise Linux 7.4, Red Hat Enterprise Linux 8.0, CentOS\* 7.5 and Fedora 27:

```
$ sudo yum install openssl-devel libcurl-devel protobuf-  
devel
```

#### 3. On SUSE Linux Enterprise Server 12:

```
$ sudo zypper install libopenssl-devel libcurl-devel pro-  
tobuf-devel
```

To install the Intel® SGX SDK, install the following:

#### 1. On Ubuntu\* 16.04 and Ubuntu\* 18.04:

```
$ sudo apt-get install build-essential python
```

#### 2. On Red Hat\* Enterprise Linux 7.4, Red Hat\* Enterprise Linux 8.0, CentOS\* 7.5, and Fedora 27:

```
$ sudo yum groupinstall 'Development Tools'
```

```
$ sudo yum install python
```

### 3. On SUSE Linux\* Enterprise Server 12:

```
$ sudo zypper install --type pattern devel_basis
```

```
$ sudo zypper install python
```

#### Installation

To install the driver, PSW, and SDK packages, you need the root (or sudo) privilege. Install the components in following order:

1. Intel® SGX driver
2. Intel® SGX PSW
3. Intel® SGX SDK

Use the following steps to install these packages:

#### 1. Install the Intel® SGX driver package:

- Using following command to install Intel® SGX driver without ECDSA attestation:

```
$ sudo ./sgx_linux_x64_driver.bin
```

The installer also loads the driver and sets it to `auto-load` when the system reboots.

- Please refer [install Intel® Software Guard Extensions Driver for Data Center Attestation Primitives \(Intel® SGX DCAP\)](#) to install ECDSA attestation enabled Intel® SGX driver.

#### 2. Install the Intel® SGX PSW package using the following command: On Ubuntu\* 16.04 and Ubuntu\* 18.04:

- Install Debian packages with dpkg:

```
$ sudo dpkg -i ./libsgx-enclave-common_${version}-${revision}_amd64.deb
```

To debug with `sgx-gdb`, install the debug symbol package:

```
$ sudo dpkg -i ./libsgx-enclave-common-dbgsym_${version}-${revision}_amd64.ddeb
```

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#### **NOTE**

Only Ubuntu\* 18.04 requires installing this debug symbol package.

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- Install Debian packages from the Intel® SGX repository:
  1. Connect your system to the network with internet access and open a terminal.

2. Add the repository to your sources:

On Ubuntu\* 16.04:

```
$ echo 'deb [arch=amd64] https://-  
download.01.org/intel-sgx/sgx_repo/ubuntu xenial  
main' | sudo tee /etc/apt/sources.list.d/intel-  
sgx.list
```

On Ubuntu\* 18.04:

```
$ echo 'deb [arch=amd64] https://-  
download.01.org/intel-sgx/sgx_repo/ubuntu bionic  
main' | sudo tee /etc/apt/sources.list.d/intel-  
sgx.list
```

3. Add the key to the list of trusted keys used by the apt to authenticate packages:

```
$ wget -qO - https://download.01.org/intel-  
sgx/sgx_repo/ubuntu/intel-sgx-deb.key | sudo  
apt-key add -
```

4. Update the apt and install the package:

```
$ sudo apt-get update
```

```
$ sudo apt-get install libsgx-enclave-common
```

- To debug with `sgx-gdb`, install the debug symbol package:

```
$ sudo apt-get install libsgx-enclave-com-  
mon-dbgsym
```

On Red Hat\* Enterprise Linux 7.4, Red Hat\* Enterprise Linux 8.0,  
CentOS\* 7.5, Fedora 27, and SUSE Linux Enterprise Server 12:

```
$ sudo ./sgx_linux_<os>_x64_psw_<version>.bin
```

The Intel® SGX platform software package includes user space libraries such as uRTS and AESM. After installation, the libraries are installed to the directory `/usr/lib`.



The AESM service executable and the AE libraries are installed to the directory:

- Intel® SGX PSW is installed with `sgx_linux_<os>_x64_psw_<version>.bin`:  
`/opt/intel/sgxpsw/aesm`
- Intel® SGX PSW is installed with `libsgx-enclave-common_<version>-<revision>_amd64.deb`:  
`/opt/intel/sgx_enclave_common`

The installer also configures the AESM service as a system daemon, which starts with the user ID `aesmd`. The default home directory of the AESM service is `/var/opt/aesmd`.

After installing the platform software, you may need to setup an http proxy server for the AESM service. You can use the file `/etc/aesmd.conf` as a reference. This file shows an example on how to setup the proxy but it is commented out.

3. Install the Intel® SGX SDK using the following command:

```
$ ./sgx_linux_<os>_x64_sdk_<version>.bin
```

This command starts the setup program in the interactive mode on the command line. When the question **Do you want to install in current directory? [yes/no]** appears, type **yes** and press **Enter** to install in the current directory and type **no** and press **Enter** to enter another path for installation.

After the installation, the Intel® SGX SDK package is installed into the directory `[User Input Path]/sgxsdk`. Run the command `source [User Input Path]/sgxsdk/environment`, which also sets all the environment variables.

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**NOTE**

The default installation directories for Intel® SGX PSW and Intel® SGX SDK are different:

- The Intel® SGX PSW binary package installs the user space libraries in `/usr/lib`.
  - The Intel® SGX PSW debian package installs the user space libraries in `/usr/lib/x86_64-linux-gnu`.
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- The Intel® SGX SDK package installs the corresponding shell libraries in `[User Input Path]/sgxsdk/lib64`.

Shell libraries contain the declaration of the public APIs and are only needed for building Intel® SGX applications. At runtime, the standard user-space libraries in `/usr/lib` or `/usr/lib/x86_64-linux-gnu` are loaded automatically.

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### **NOTE**

Sample code is installed under `[User Input Path]/sgxsdk/SampleCode` directory with read-only permissions for normal users. Each user can make separate copies to modify, build and experiment with the sample codes.

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### **Uninstallation**

To uninstall the driver, PSW, and SDK packages, you need the root (or sudo) privilege. Uninstall the components in the following order:

1. Intel® SGX driver
2. Intel® SGX PSW
3. Intel® SGX SDK

Use the following steps to uninstall these packages:

1. Uninstall the Intel® SGX driver package:

After the installation, a generated script `uninstall.sh` appears in the `/opt/intel/sgxdriver` directory. You can use this script to uninstall the driver.

2. Uninstall the Intel® SGX PSW package:

- Intel® SGX PSW is installed with `sgx_linux_<os>_x64_psw_<version>.bin`:

After the installation, a generated script `uninstall.sh` appears in the `/opt/intel/sgxpsw` directory. You can use this script to uninstall the platform software.

- Intel® SGX PSW is installed with `libsgx-enclave-common_${version}-${revision}_amd64.deb`:

- Intel® SGX PSW installed with `dpkg`:

To uninstall the Intel® SGX PSW debian package, run the following command:

```
$ sudo dpkg -P libsgx-enclave-common
```

To uninstall the Intel® SGX PSW debian debug symbol package if installed, run the following command:

```
$ sudo dpkg -P libsgx-enclave-common-dbgsym
```

- Intel® SGX PSW Installed from the Intel® SGX repository:  
To uninstall the Intel® SGX PSW debian package, run the following command with the root privilege:

```
$ sudo apt-get remove libsgx-enclave-common
```

To uninstall the Intel® SGX PSW debian debug symbol package if installed, run the following command:

```
$ sudo apt-get remove libsgx-enclave-common-dbgsym
```

### 3. Uninstall the Intel® SGX SDK package:

After installation, a generated script `uninstall.sh` appears in the `[User Input Path]/sgxsdk` directory. You can use it to uninstall the Intel® SGX SDK.

## ECDSA attestation

To enable ECDSA attestation:

- Ensure that you have the following required hardware.
  - 8th Generation Intel® Core™ Processor or newer with Flexible Launch Control support\*.
  - Intel® Atom™ Processor with Flexible Launch Control support\*.
- To use ECDSA attestation, you must install Intel® Software Guard Extensions Driver for Data Center Attestation Primitives (Intel® SGX DCAP). Please follow the Intel® SGX DCAP Installation Guide for Linux\* OS to install the driver. You can find the documentation here:

<https://download.01.org/intel-sgx/dcap-<version>/linux/docs/>

- As example: Intel® SGX DCAP 1.3 file's location is:

<https://download.01.org/intel-sgx/dcap-1.3/linux/docs/>

Filename is `Intel_SGX_DCAP_Linux_SW_Installation_Guide.pdf`, in section "Intel® SGX Driver".

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### **NOTE**

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If you had already installed Intel® SGX driver without ECDSA attestation, please uninstall the driver firstly.

Or the newly installed ECDSA attestation enabled Intel® SGX driver will unworkable.

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- Install Provisioning Certificate Caching Service(PCCS). About how to install and configure PCCS, please refer [SGXDataCenterAttestationPrimitives](#).
- Ensure the PCCS is setup correctly by local administrator or data center administrator. Please also setup /etc/sgx\_default\_qcnl.conf for Default Quote provider library according to your real environment:  
USE\_SECURE\_CERT=TRUE  
PCCS\_URL=https://your\_pccs\_server:8081/sgx/certification/v2/
- PCCS\_URL is the URL of your PCCS caching service. Set USE\_SECURE\_CERT to FALSE if PCCS uses self-signed certificates, and TRUE for a production PCCS with authenticated certificates.

### **Install Intel(R) Software Guard Extensions Eclipse\* Plug-in**

The Intel(R) Software Guard Extensions Eclipse\* Plug-in for Linux\* OS helps the enclave developer to maintain enclaves and untrusted related code inside Eclipse\* C/C++ projects.

This section contains steps to set up your Intel(R) Software Guard Extensions Eclipse\* Plugin on a Linux\* system, including necessary softwares, steps to install the product, and steps to configure your preferred product directory.

- [Prerequisites](#)
- [Installation](#)
- [Configuration](#)

#### **Prerequisites**

To use Intel(R) Software Guard Extensions Eclipse Plug-in, install the following softwares:

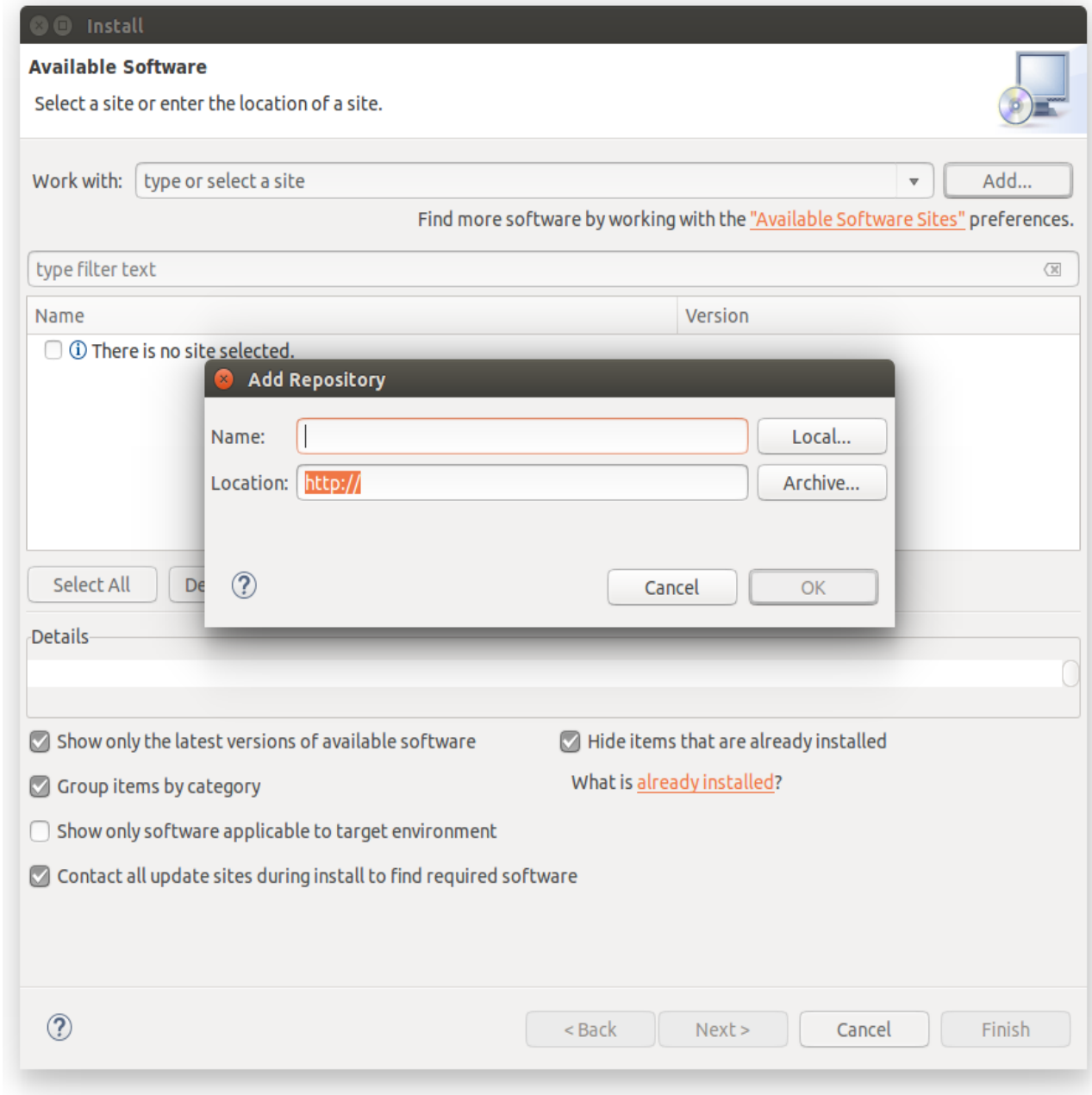
- Eclipse\* Mars 1 with CDT IDE for C/C++ Developers (version 4.5.1). To use this version, install Java\* Development Kit (JDK) or Java\* Runtime Environment (JRE) version 1.8 or above.

- gcc\*/g++ tools
- OpenSSL\*
- Intel(R) SGX SDK for Linux\* OS

### Installation

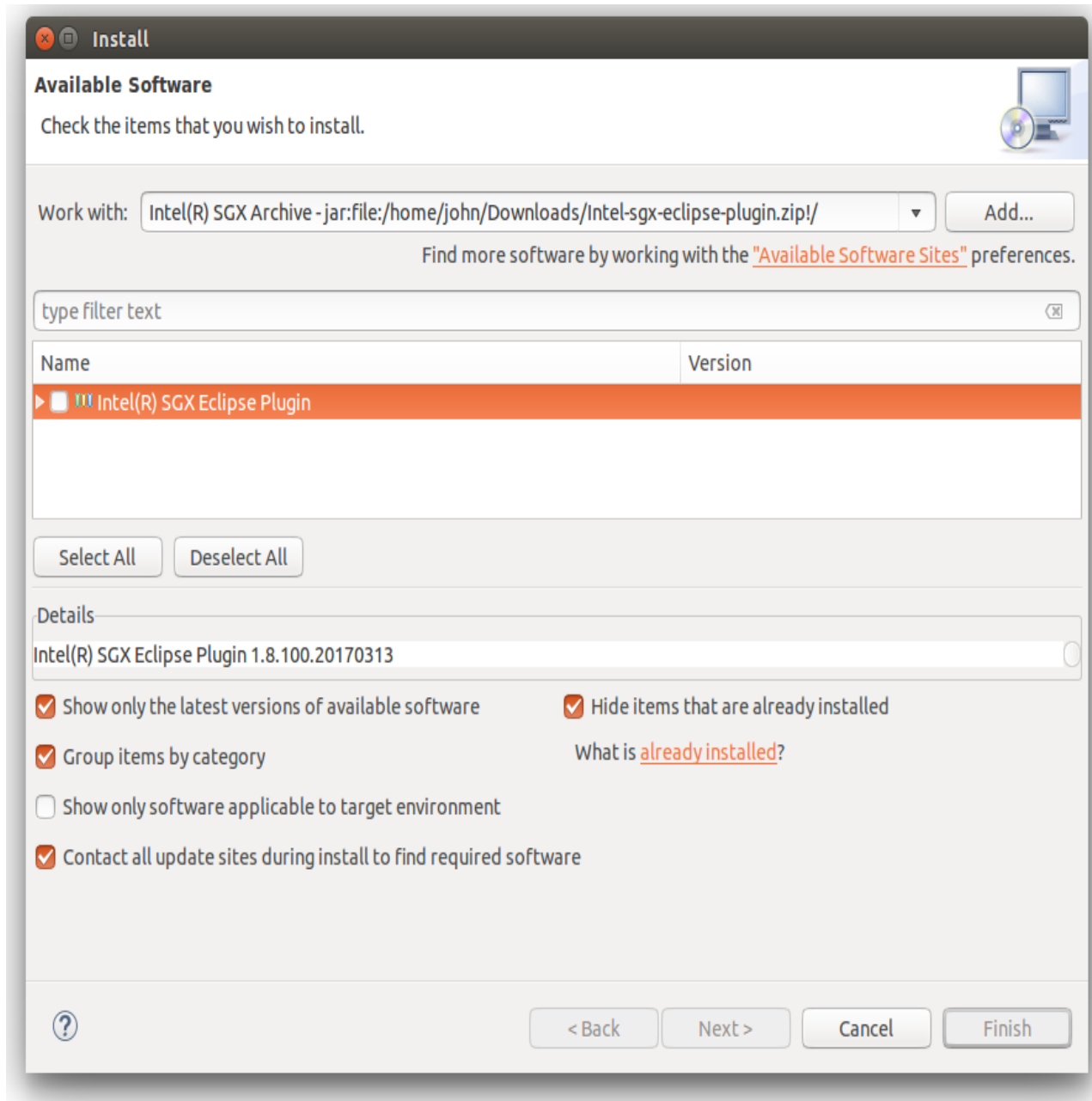
Install Intel(R) Software Guard Extensions Eclipse\* Plug-in as a regular Eclipse Plugin:

1. Download the zip archive of Intel(R) Software Guard Extensions Eclipse Plug-in from [[Intel Site](#)]
2. Go to **Help menu -> Install New Software**. Click the **Add** button for the **Work with** field to open the **Add Repository** dialog as shown in the following graphic:



### Add Repository Dialog

3. Enter Intel (R) SGX Archive in the **Name** field . Click the **Archive...** button and select the location of the downloaded archive as shown in the following graphic:



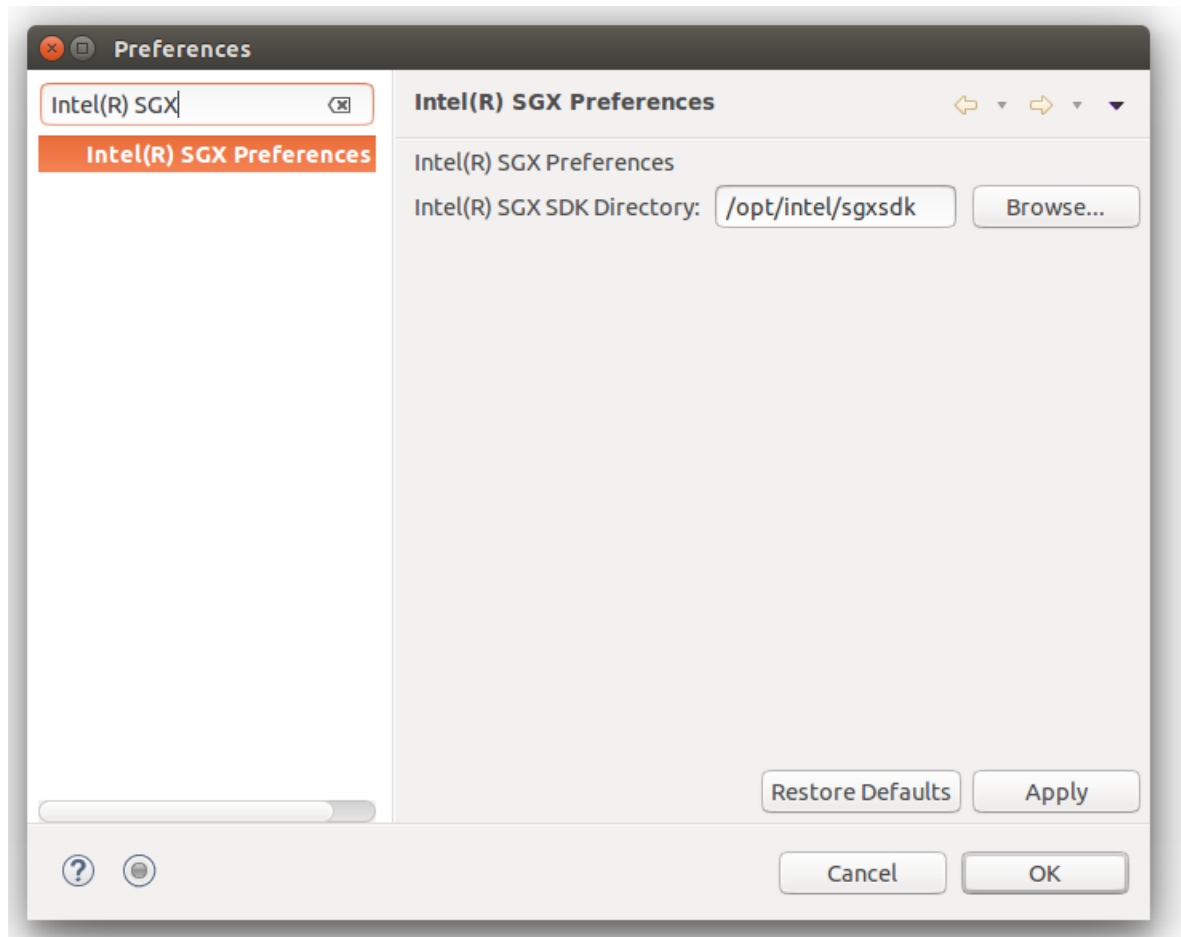
### The Location of the Plugin zip Archive

4. Press **OK** to add the archive as a repository.
5. In the **Install** dialog, select the **Intel(R) Software Guard Extensions Plugin** check-box and proceed with the usual steps.

## Configuration

If you do not install Intel(R) SGX SDK for Linux\* OS in the default location, you need to specify the path for Intel(R) SGX SDK using the following steps:

1. Go to **Window menu ->Preferences**. Enter Intel(R) SGX in the filter text field to quickly locate the **Intel(R) SGX Preferences** page.



### Intel(R) SGX Preference Page

2. Enter the path for Intel(R) SGX SDK for Linux OS in the **Intel(R) SGX SDK Directory** field.