

# 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

## 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
- 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, 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, 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, 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(TM) Processor or newer with Flexible Launch Control support\*.
  - Intel® Atom(TM) 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 1.1 file's location is:

<https://download.01.org/intel-sgx/dcap-1.1/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 PCK Caching Service. About how to install and configure PCK Caching Service, please refer [SGXDataCenterAttestationPrimitives](#).
- Ensure the PCK Caching Service is setup correctly by local administrator or data center administrator. Also make sure that if the PCK Caching Service server is not on local machine, the configure file (/etc/sgx\_default\_qcnl.conf) needs to be consistent with the real environment, for example: PCS\_URL=https://your\_pcs\_server:8081/sgx/certification/v1/

### 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

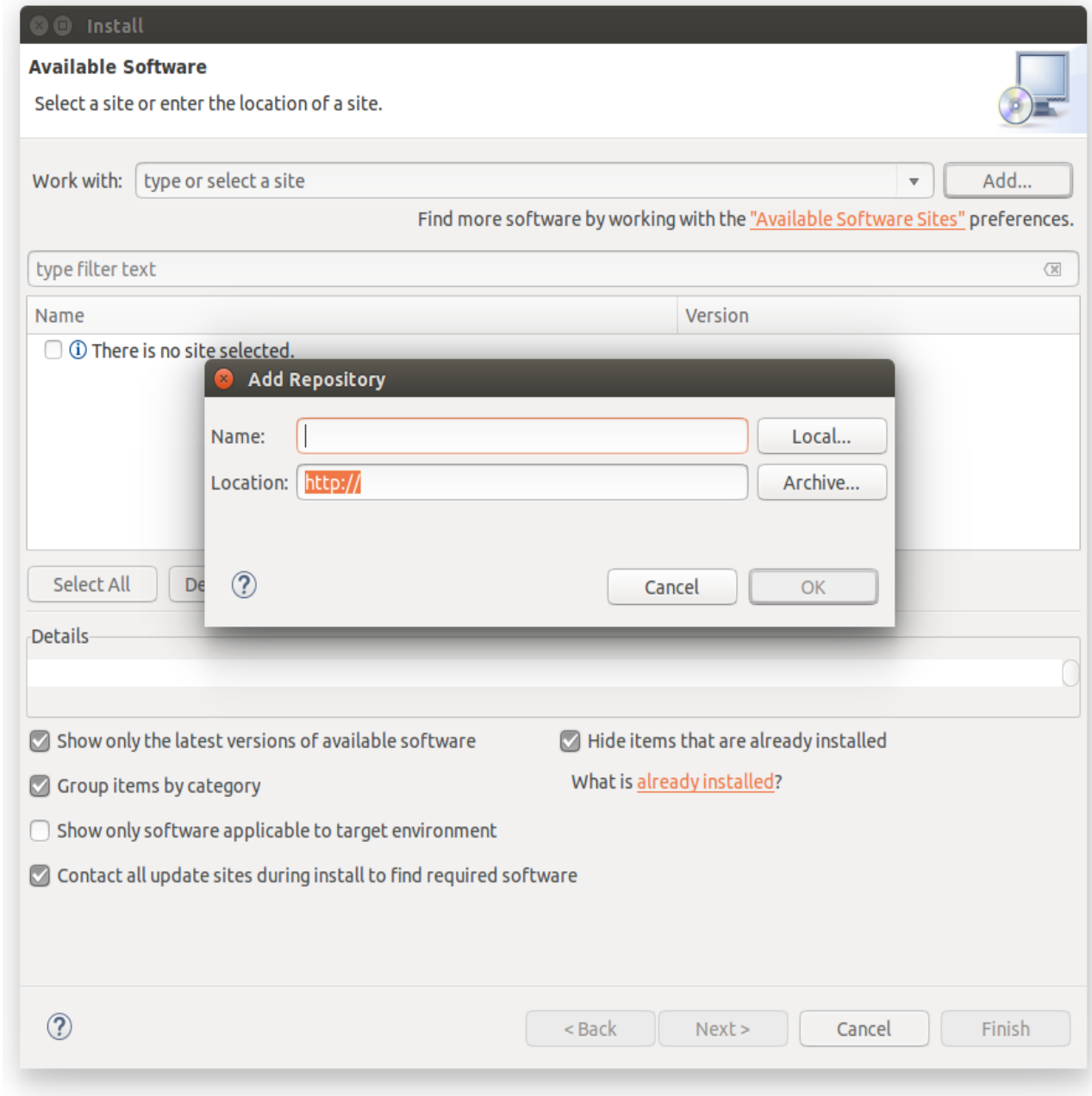
To use Intel(R) Software Guard Extensions Eclipse Plug-in, install the following softwares:

- 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

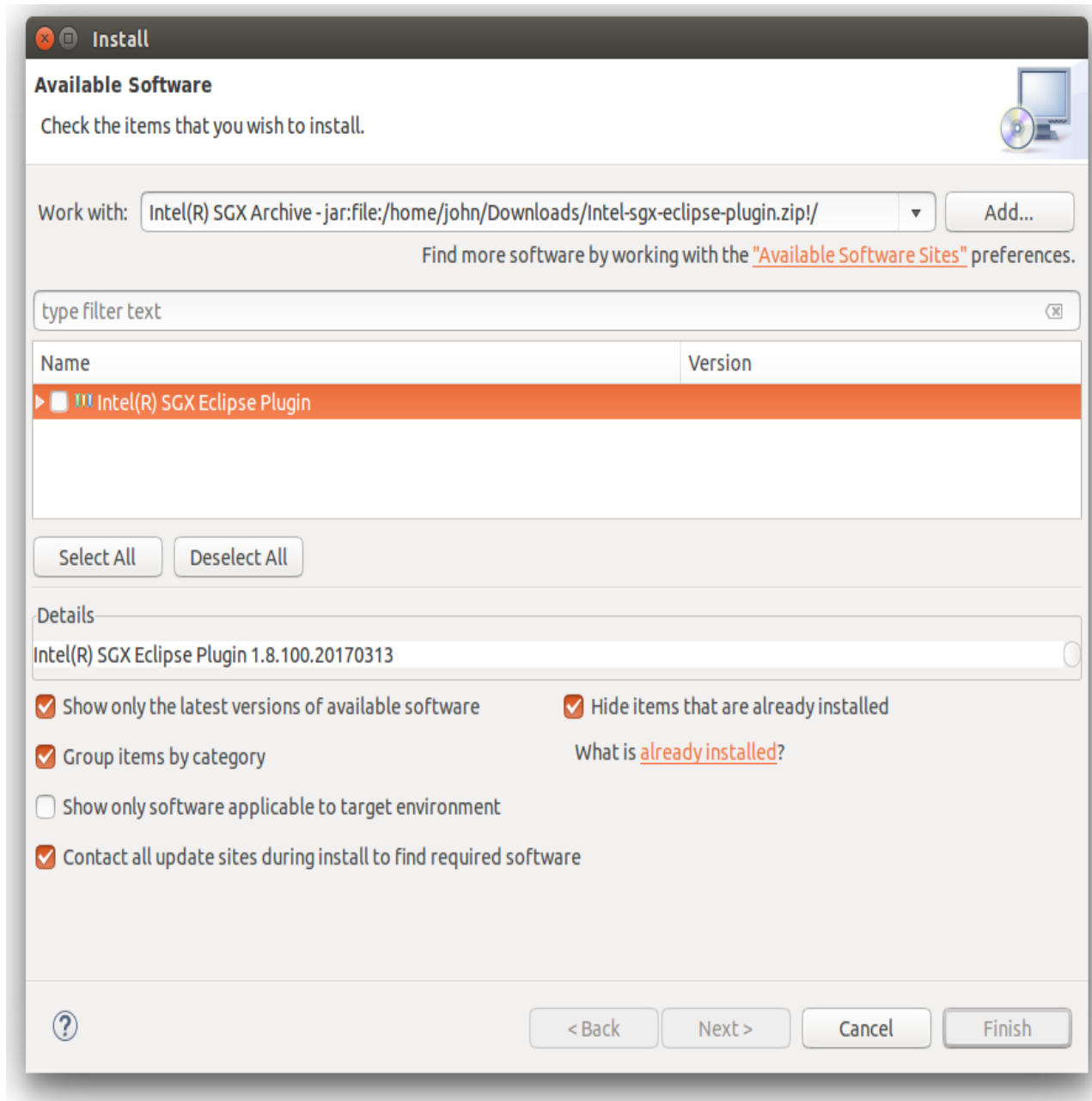
Install Intel(R) Software Guard Extensions Eclipse\* Plug-in as a regular Eclipse Plugin:

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:



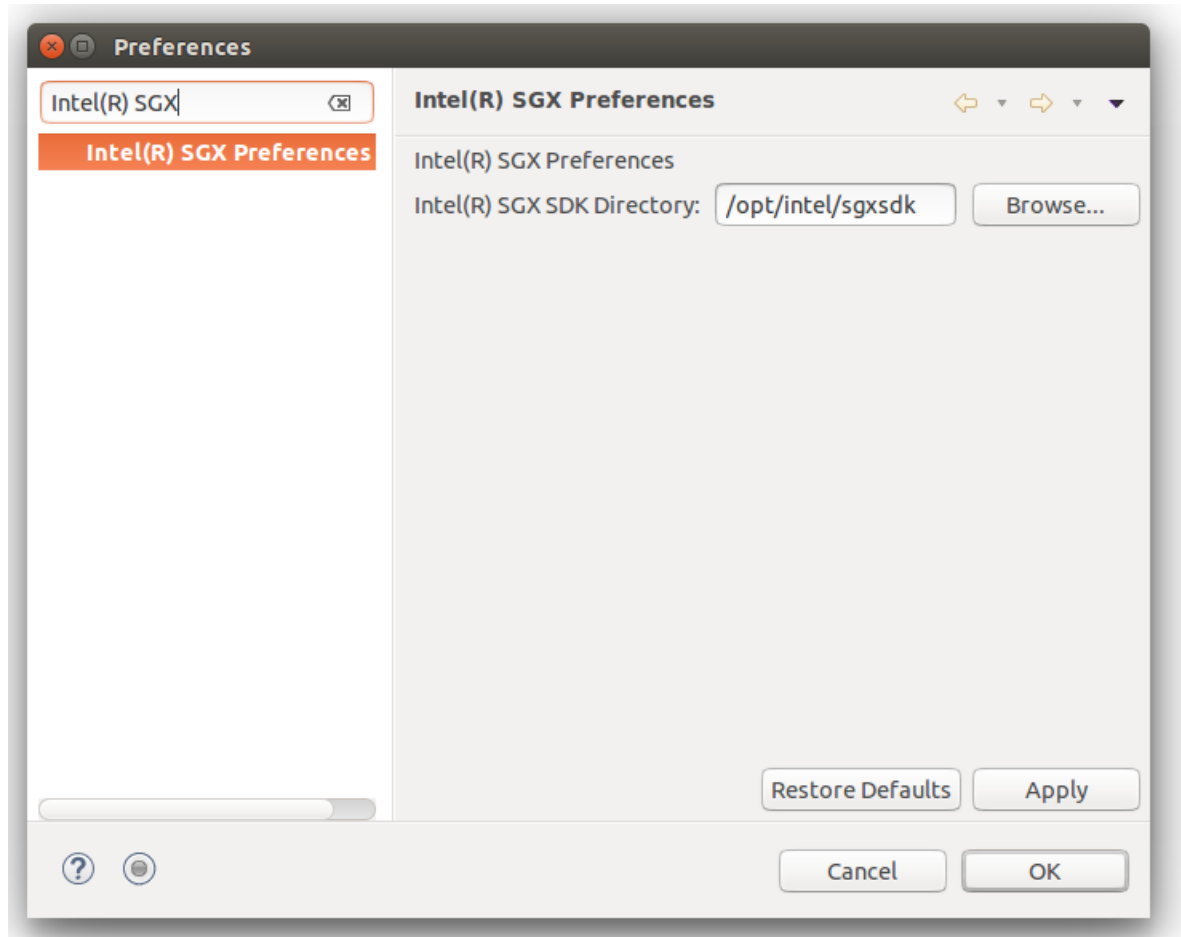
### The Location of the Plugin zip Archive

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.