Version History/Revision History
These are the main releases of Intel® SDK for OpenCL™ applications:

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>2016</td>
<td>GPU Kernel debugger Beta and standalone release for Linux</td>
</tr>
<tr>
<td>Nov. 17, 2016</td>
<td>2015 R3</td>
<td>Standalone release for Windows</td>
</tr>
<tr>
<td>April 28, 2015</td>
<td>2015 R2</td>
<td>Visual Studio 2015 support</td>
</tr>
<tr>
<td>Jan 22, 2015</td>
<td>2015 R1</td>
<td>Released as part of Intel® Integrated Native Developer Experience (Intel® INDE)</td>
</tr>
</tbody>
</table>

Customer Support
For technical support, including answers to questions not addressed in this product, visit the technical support forum, FAQs, and other support information at: Intel OpenCL Support or http://www.intel.com/software/products/support/.

Please remember to register your product at https://registrationcenter.intel.com/ by providing your email address. Registration entitles you to free technical support, product updates and upgrades for the duration of the support term. It also helps Intel recognize you as a valued customer in the support forum.

To provide feedback and suggestions or submit an issue, go to the Intel OpenCL Forum.
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1 Introduction

Intel® SDK for OpenCL™ applications assists with creating, building, debugging, and analyzing PC and mobile applications developed with OpenCL™ API on Windows®, Linux® and Android® OSes.

This document contains information about new features, system requirements, installation instructions, fixed bugs, limitations and known issues.

To learn more about this product, see:

- New features listed in the New in This Release section below, or in the help.
- Reference documentation listed in the Related Documentation section below
- Installation instructions can be found at: Installation Notes
2 New in This Release

2.1 New Features

- **Beta release of Source and Assembly level GPU Kernel Debugging** on Windows* operating system
  - Seamless debugging experience of OpenCL Kernels as they are being executed on Intel® Processor Graphics with real-time inspection of variable and registers across the hardware execution units threads
  - Supported by GDB and Microsoft* Visual Studio 2015
  - Supported only on 6th Generation Intel Core™ Processors with Intel Iris™, Intel Iris Pro and HD Graphics
- **Standalone distribution of Intel® SDK for OpenCL Applications for Linux** including standalone OpenCL driver for 5th and 6th Generation Intel® Core Processors with Intel Iris™ Pro and HD Graphics.
  - Also supporting open source implementation of the OpenCL specification for Intel Processor Graphics ([https://01.org/beignet](https://01.org/beignet))
  - Advanced features set in Kernel Development Framework – Eclipse plug-in
- Full support for Microsoft* Visual Studio 2015 (added missing features)
- New kernel and host level analysis features
  - New kernel analysis report with compute matrices and deep level analysis views in Kernel Development Framework
  - SVM support and Build from Binary in Kernel Development Framework
  - Cross mapping support in Intel Processor Graphics assembly view (from assembly code to OpenCL code)
  - UI improvement and functional stabilizations
- Intel® SDK for OpenCL™ Applications 2016 includes all the features for OpenCL development for Android and Windows* previously available in Intel® INDE OpenCL™ Code Builder 2015 R2 and all features for Linux* development which available in Code Builder for Intel® Media Server Studio.
- For a full list of features, refer to the [Intel® SDK for OpenCL™ Applications Developer Guide](#).
3 Known Issues

3.1 General Limitations
- To work with the Android® NDK, the path to the SDK installation should not contain spaces.
- When working with the default Intel OpenCL Platform together with OpenCL 2.0 experimental platform there may be performance issues.
- If you are using Visual Studio 2012 and install "vs_android," Visual Studio might crash when you change the "Platform Toolset" to one of the available "x86 icc" toolchains.

3.2 Code Builder IDE Plug-in Limitations
- Build feature limitations
  - To work with the OpenCL Code Builder - Offline Compiler plug-in for Microsoft Visual Studio® IDE on 64-bit OS, configure the Visual Studio for 64-bit applications (64-bit compiler and tools).
  - LLVM view for Intel Processor Graphics device in the Offline Compiler plug-in for Visual Studio IDE is not supported on “Compile” and “Link” options. To see the Intel Processor Graphics LLVM code, use the Build option.
  - To use the Create a New OpenCL Project feature for Android® you need Android® NDK, version android-ndk-r10e or greater, and vs-android, version vs-android-0.964 or greater, installed on your system.
  - In order to work with Kernel Builder tool on Ubuntu 14.04.3 version, need to set:
    export LD_PRELOAD=/usr/lib/x86_64-linux-gnu/mesa/libGL.so.1
    (more information here: http://ubuntuforums.org/showthread.php?t=2247911)
- Kernel Debugger Framework plug-in for Eclipse® IDE
  - On Ubuntu® 14.04.x, if you encounter the following error:
    Inconsistency detected by ld.so: dl-version.c: 224:
    _dl_check_map_versions: Assertion `needed != ((void *)0)' failed!
    To fix this issue: set the following environment variable:
    LD_PRELOAD=/usr/lib/x86_64-linux-gnu/mesa/libGL.so.1
- GPU Kernel Debugger for Visual Studio IDE
  - The GPU kernel debugger is supported on 64-bit applications only.
  - In order to work with the GPU Kernel debugger, you need disable the Firewall on the target system.
- CPU Kernel Debugger for Visual Studio IDE does not support:
  - Edit and continue capability
  - Multithreaded debugging
  - Two instances of Visual Studio running simultaneously
  - Unions
- OpenCL API Debugger
  - Concurrent debug sessions with API Debugger are not supported. This includes attaching the Visual Studio debugger to more than one process, or opening multiple instances of Visual Studio and debugging processes concurrently.
- Code Analyzer Limitations:
  - Kernel analysis features are not supported on:
    - 6th generation of Intel® Core Processor with Intel® HD graphics 510/515/520/530
3rd Generation Intel Core processors with Intel HD Graphics 4000

- Latency and occupancy reports cannot be generated for built-in kernels which are generated with clCreateProgramWithBuiltInKernels
- Calling the API clCreateProgramWithBuiltInKernels or clCreateAcceleratorINTEL generates additional OpenCL API’s in the API Analyze report, these APIs do not appear in the code
- Occupancy analysis is not supported on an application that includes a call to Microsoft D3D11 API GetData(). Running Occupancy analysis on such an application leads to application crash with an exception
- Kernel analysis, HW counters and some of the hints are available only for kernels that run on GPU (shared context is not supported)
- Host and kernel level analysis are not supported on an application that uses the motion estimation extension

3.3 Standalone Code Builder Limitations:
- For kernel analysis purposes user-defined types (typedef) are not supported. You cannot create and assign variables to an argument of a user defined type.
- Parsing issues with typedef and/or atomic instructions. OpenCL has built-in vector types, for example: uint3, float4, char16. Kernel Builder tries to parse uint32 as a vector type but 32 is not a valid size, so we get an error. For more information see Intel OpenCL forum entry https://software.intel.com/en-us/forums/topic/529122
- Struct support has the following limitations
  - #pragma pack is not supported.
  - Arrays are not available for struct fields (only basic OpenCL types and other structs).
  - Unions are not supported.
  - The struct object that you create in the system must have the same name as the struct in the code, otherwise you are not able to assign a buffer to that argument

3.4 Known Installation and Configuration Issues
- During the installation of the SDK you may get an “Invalid Command Line…” message dialog from Microsoft* Visual Studio. To proceed with the installation click on the Close button.
- In case the PATH environment variable exceeds 256 character length upon installation, you might encounter issues related to System32 directory use.
- In case of uninstallation through Control panel > Uninstall a program you may face the "Error opening installation log file. Verify that the specified log file location exists and is writable" error. It is a known issue in the Microsoft* data base at http://support.microsoft.com/kb/2564571. Use uninstallation icon in the Start menu or reboot the machine to proceed with the uninstallation.

3.5 Intel Processor Graphics Device Limitations
- For details on known issues with the OpenCL™ standard on the Intel Processor Graphics, refer to the relevant driver release notes.
- TDRs may be observed when running OpenCL™ benchmarks including Kishonti CLBenchmark, Kishonti CompuBench CL, and SiSoftware Sandra (GP (GPU/CPU/APU) Processing OpenCL™ benchmarks). Also some OpenCL™ workloads may cause TDRs, especially workloads with complex, time-consuming kernels and large local work size or workloads that use profiling feature. Increase the
TDR delay to avoid the TDRs. For details, refer to the article at http://msdn.microsoft.com/en-us/library/windows/hardware/gg487368.aspx

- The OpenCL™ Driver is available on systems with Intel® Processor Graphics and discrete graphics cards (Windows® OS only):
  - Capabilities of both discrete and integrated graphics are available if display is connected to:
    - Integrated graphics card display port.
    - Discrete and integrated graphics cards simultaneously.
  - Capabilities of a discrete card only are available if the display is connected to:
    - Discrete graphics card display port.
    - Integrated graphics card, and a discrete graphics card without display ports.
4 Related Documentation

Here is the documentation related to Intel SDK for OpenCL Applications:

- [Getting Started with Intel® Code Builder for OpenCL™ API](#)
- [Developer Guide for Intel® SDK for OpenCL™ Applications](#)
5 Where to Find the Release
To download the product: https://software.intel.com/en-us/intel-opencl
6 System Requirements

6.1 Supported Architectures and Terminology
For an explanation of architecture names, see http://software.intel.com/en-us/articles/intel-architecture-platform-terminology/.

The following matrix determines Intel processors support on Windows, Linux and Android operating systems.

### 6.1.1 Intel® SDK for OpenCL™ Applications for Windows:

<table>
<thead>
<tr>
<th>Intel® Platform</th>
<th>OpenCL version</th>
<th>SDK Platform</th>
<th>Target Application Platform</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5th and 6th Generation Intel® Core Processors with Intel Iris™ Pro and HD Graphics.</td>
<td>2.0</td>
<td>✓</td>
<td>CPU</td>
<td>GPU</td>
</tr>
<tr>
<td>Intel® Core™ M processors with Intel® HD graphics 5300</td>
<td>2.0</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Intel Atom™ Processors Z3400/Z3500 series with PowerVR® G6400/G64300</td>
<td>1.2e</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Intel Atom™ Processors Z3600/Z3700 series with Intel® HD Graphics</td>
<td>1.2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4th Generation Intel® Core™ Processors with:</td>
<td>1.2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>• Intel® HD Graphics 4200/4400/4600/5000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Intel® Iris™ Graphics 5100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Intel® Iris™ Pro graphics 5200</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd Generation Intel® Core™ Processors with Intel® HD Graphics 4000/2500</td>
<td>1.2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>1st and 2nd Generation Intel® Core™ Processors</td>
<td>1.2</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Intel® Xeon® Processor E3-128x v3 and v4 product family with C226 chipset</td>
<td>1.2</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## 6.1.2  Intel® SDK for OpenCL™ Applications for Linux*:

<table>
<thead>
<tr>
<th><strong>Intel® Platform</strong></th>
<th><strong>OpenCL version</strong></th>
<th><strong>SDK Platform</strong></th>
<th><strong>Target Application Platform</strong></th>
<th><strong>CPU</strong></th>
<th><strong>GPU</strong></th>
<th><strong>CPU</strong></th>
<th><strong>GPU</strong></th>
<th><strong>CPU</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>4th and 5th Generation Intel® Core Processors with Intel Iris™ Pro and HD Graphics.</td>
<td>1.2</td>
<td>Ubuntu 14.04</td>
<td>CentOS 7.1 Including support for RHEL and SLES</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Intel® Xeon® Processor E3-128x v3 and v4 product family with C226 chipset</td>
<td>1.2</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st, 2nd and 3rd Generation Intel® Core™ Processors</td>
<td>1.2</td>
<td>Ubuntu 14.04</td>
<td>CentOS* 7.1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intel® Xeon Phi™ coprocessor Product Family</td>
<td>1.2</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Intel® Xeon® Processor E5/E7 Product Family</td>
<td>1.2</td>
<td>Ubuntu 14.04</td>
<td>Ubuntu* 14.04</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red Hat* Enterprise Linux* (RHEL) 6.1 or higher</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUSE* Linux Enterprise Server (SLES) 11.2 or higher</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Intel® Xeon Phi™ coprocessor</td>
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</tr>
</tbody>
</table>

Note the following:

- For more information on OpenCL platforms and OSs support, go to Intel’s OpenCL technology page at [https://software.intel.com/en-us/intel-opencl](https://software.intel.com/en-us/intel-opencl).
- To run and use the Code Builder IDE plug-in, you must have a PC based on an IA-32 or Intel 64 architecture processor.
- Incompatible or proprietary instructions in non-Intel processors may cause the analysis capabilities of this product to function incorrectly. Any attempt to analyze code not supported by Intel processors may lead to failures in this product.
- You must have administrator privileges to install and use the Intel® SDK for OpenCL Applications 2016 on Microsoft Windows operating systems.
- Intel® SDK for OpenCL™ Applications for Linux* is compatible with the following OpenCL drivers and runtimes:
  - OpenCL™ 1.2 Driver for Intel® HD, Iris™, and Iris™ Pro Graphics for Linux (64-bit)
  - OpenCL™ Runtime 15.2 for Intel® Core™ and Xeon™ processors
  - OpenCL™ Runtime 14.2 for Intel® CPU and Intel® Xeon Phi™ coprocessor for Linux
  For more information on the supported runtime and drivers, go to Intel’s [OpenCL™ Drivers and Runtimes for Intel® Architecture](https://software.intel.com/en-us/articles/opencl-drivers)
- Intel SDK for OpenCL Applications provides Android* OS support only on rooted devices with Intel processors.
6.2 Driver Requirements

6.2.1 Windows* Driver Requirements:

For OpenCL™ support on Intel® processors with Intel® Processor Graphics you must have the Intel Graphics Driver (version 15.33.3 or higher) installed.

The following Intel graphics devices support the OpenCL technology:

- Intel® Iris™ Graphics 540, 550
- Intel® HD graphics 510/515/520/530
- Intel® Iris™ Pro Graphics 6200
- Intel® Iris™ Graphics 6100
- Intel® HD graphics 5300/5500/5600/6000
- Intel® Iris™ Pro Graphics 5200
- Intel® Iris™ Graphics 5100
- Intel® HD Graphics 4200/4400/4600/5000
- Intel® HD Graphics 4000/2500

Intel® HD Graphics of the Intel Atom processors formerly codenamed “Bay Trail”

6.2.2 Linux* Driver and Runtime Requirements:

For OpenCL™ support on Intel® processors with Intel® Processor Graphics you must have the OpenCL driver or runtime installed. Installation of a relevant runtime or driver enables OpenCL applications to run on a target hardware set.

The OpenCL™ Drivers and Runtimes for Intel® Architecture provide OpenCL support for:

- Intel® Atom™, Intel® Core™, Intel® Pentium®, Intel® Celeron®, and Xeon® processors
- Intel® Iris™ Graphics and Intel® HD Graphics family
- Intel® Xeon Phi™ coprocessors

For more information on the supported runtime and drivers on Linux*, go to Intel’s OpenCL™ Drivers and Runtimes for Intel® Architecture https://software.intel.com/en-us/articles/opencl-drivers

6.2.3 Eclipse* Plug-in Requirements

The Eclipse* plug-in requires Java runtime environment 1.7 or higher
7 Installation Notes
For OpenCL™ support on Intel® processors with Intel® Processor Graphics you must have the Intel Graphics Driver (version 15.33.3 or higher) installed.

You can obtain the latest driver version using the Intel® Driver Update Utility, or manually here.

7.1 Installation on Microsoft Windows* OS
You can obtain Intel® SDK for OpenCL Application installer from the SDK web page: https://software.intel.com/en-us/intel-opencl

You must have administrator privileges to install and use the SDK on Windows* operating systems.

Before installing the Intel SDK for OpenCL Applications for Windows* operating systems it is recommended to remove any previous version of the SDK from your computer.

To install the Intel SDK for OpenCL Applications on Windows* operating systems, run the installation package and follow the installer prompts.

The SDK installation includes the following components:

- OpenCL code C header files and libraries
- Kernel Builder standalone utility 32- and 64-bit version
- Offline Compilation command-line utility 32- and 64-bit version
- OpenCL Code Builder plug-in for Microsoft Visual Studio 2012 and higher including comprehensive environment for building, debugging and analyzing OpenCL applications.
- OpenCL Code Builder plug-in for Eclipse 4.2 and higher including Kernel Development Framework for building OpenCL applications.

**NOTE:** Intel graphics driver includes OpenCL support for both CPU and Intel Processor Graphics.

7.1.1 Uninstalling Intel® SDK for OpenCL Applications
To remove SDK components use the Control Panel or select Start > All Programs > Intel SDK for OpenCL Applications 2016 > Uninstall

7.1.2 Setting Environment Variables on Microsoft Windows* OS Manually
The product installation process makes a few system environment modifications. If the environment variables become corrupted on the installed system, you can correct this issue by ensuring that the environment variables are defined as follows.

The INTELOCLSDKROOT variable must be set to the target installation directory. The default installation directory is C:\Program Files (x86)\Intel\OpenCL SDK\6.0

Also make sure that the installation folder is in the system PATH environment variable.

7.1.3 Default Installation Folders
The default top-level installation folder for this product is:

- C:\Program Files (x86)\Intel\OpenCL SDK
If you are installing on a system with a non-English language version of Windows OS, the name of the Program Files folder may be different. On Intel® 64 systems, the directory name is Program Files (X86) or the equivalent.

### 7.2 Installation on Linux® OS


Intel® SDK for OpenCL™ Applications 2016 installation package is delivered in the form of archives containing RPM packages with installer scripts for easy installation/uninstallation procedures. Installer provides both common-line and graphical user interface modes. You can use any of the approaches (use command-line or graphical user interface directly).

All RPM packages of the Intel SDK for OpenCL Applications are digitally signed.

After downloading, you can verify the signature of the RPM package:

1. Download the public key from the download page of the product.
2. Import public key into rpm database by use of the following command:
   ```
   # sudo rpm --import Intel-E901-172E-EF96-900F-B8E1-4184-D7BE-0E73-F789-186F.pub
   ```
3. Verify signature of RPM package:
   ```
   # rpm --checksig <rpm name>.rpm
   ```

   where `<rpm name>` is the name of the RPM package.

   Expected output for RPM with a valid digital signature is:
   ```
   <rpm name>.rpm: rsa shal (md5) pgp md5 OK
   ```

To install the product:

1. Extract the TGZ archive contents:
   ```
   # tar xzf intel_sdk_for_opencl_2016_6.0.0.<VERSION>_x64.tgz
   # cd intel_sdk_for_opencl_2016_6.0.0.<VERSION>_x64
   ```
2. Run the following command (for command-line interface) and follow the installer prompts:
   ```
   # ./install.sh
   ```
3. Alternatively (for installation with graphical user interface) run the following command:
   ```
   # ./install_GUI.sh
   ```

### 7.2.1 Uninstalling from Linux® OS

To uninstall the product, do the following:

1. Go to the folder to which you extracted the TGZ archive content.
2. Run the following command (for command-line interface) from the installed product location and follow the installer prompts:

```
# /opt/intel/opencl-1.2-sdk-6.0.0.<VERSION>/uninstall.sh
```

4. Alternatively (for uninstallation with graphical user interface), run the following command from the installed product location and select uninstall option:

```
# /opt/intel/opencl-1.2-sdk-6.0.0.<VERSION>/uninstall.GUI.sh
```

7.3 Installing OpenCL™ on the Android* Emulator

To install the Intel's OpenCL runtime on the Android* Emulator using the script, do the following:

1. Go to the android-preinstall subfolder of the Intel SDK for OpenCL Applications installation folder.
2. Use the OpenCL_Android_Install script to configure the emulator or Android device or use the following options to start the emulator manually:

```
OpenCL_Android_Install -d <your device/emulator>
```

- Root permissions are required on Android devices and emulator.
- Note that on Windows only one device can be running at installation time.

To manually install the OpenCL runtime on the emulator, do the following:

1. Copy the following files from the SDK installation folder to /system/vendor/lib using the Android* Debug Bridge:

   - `__ocl_svm_l_g9.so`
   - `__ocl_svm_l_n8.so`
   - `__ocl_svm_l_s9.so`
   - `__ocl_svm_l_v8.so`
   - `clbltfng9.rtl`
   - `clbltfng9_img_cbk.o`
   - `clbltfng9_img_cbk.rtl`
   - `clbltfnn8.rtl`
   - `clbltfnn8_img_cbk.o`
   - `clbltfnn8_img_cbk.rtl`
   - `clbltfnv9.rtl`
   - `clbltfnv9_img_cbk.o`
   - `clbltfnv9_img_cbk.rtl`
   - `libcl_loggger.so`
   - `libclang_compiler.so`
   - `libcpu_device.so`
3. Use the following command to copy the files:

```
adb -s <Emulator-Name> push <file1> /system/lib
```

4. In the /system/lib folder on the Android* device, create two links:

```
adb -s <Emulator-Name> shell 'cd /system/vendor/lib; ln -s libOpenCL.so.1 libOpenCL.so; ln -s libOpenCL.so.1.2 libOpenCL.so.1'
```

5. Copy the intel.icd file to /system/vendor/Khronos/OpenCL/vendors folder. Use the following command:

```
adb -s <Emulator-Name> push intel.icd /system/vendor/Khronos/OpenCL/vendors
```

The file content is libintelocl.so

**NOTE:** If you close the emulator, you must reinstall the OpenCL runtime after you run it again.
8 Attributions

Android NDK

Android NDK is used for Android support, from ANDROID NDK distribution:

Terms and Conditions

This is the Android Software Development Kit License Agreement

DISCLAIMER OF WARRANTIES

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