TECH TIP

OpenStack* on Intel® Architecture

Using Openstack* UEFI Boot Support to Enhance Security in Multi-Tenant Cloud Applications

Abstract

GRUB[1] boot has been around for years, but it is being deprecated in favor of the Unified Extensible Firmware Interface (UEFI).[2] Windows* systems are well on their way to discontinuing support for GRUB in the future. OpenStack[3], one of the leading open-source cloud operating systems, will start to support UEFI boot in its Mitaka release, scheduled for release April 2016. In so doing, it will support the launch of newer OS images that have eschewed GRUB boot support altogether, such as the Clear Linux* OS for Intel® architecture.

This white paper explains the motivation for supporting UEFI boot and details the changes that were necessary in OpenStack Nova, Libvirt, and Glance to provide this support. We conclude with the benefits that the Clear Linux OS has unlocked within the OpenStack platform.

Why UEFI boot support?

The Unified Extensible Firmware Interface (UEFI) is a specification that defines a software interface between an operating system and the platform firmware. It replaces the Basic Input / Output System (BIOS) firmware interface and provides the following advantages:

- Hard drive partitions can be larger than two terabytes
- Supports more than four hard drive partitions
- Faster operating system boot
- More efficient power and system management
- Supports remote diagnostics and repair
- More robust, with better fault management

Support for UEFI boot only is quickly becoming the norm. The Windows OS is well on the way to deprecating traditional GRUB boot support in favor of UEFI, and Clear Linux OS for Intel architecture only supports UEFI boot.

Bringing UEFI Boot Support to OpenStack

OpenStack, one of the leading open-source, hypervisor-agnostic, cloud operating systems, utilizes libvirt to launch virtual machines (VMs). Although libvirt has supported UEFI boot since version 1.2.8, the libvirt version bundled with the OpenStack Nova project did not carry UEFI boot support. To resolve this gap, Intel proposed a blueprint[4] and delivered an implementation.[5]

OpenStack* Virtual Machine Launch Flow

Let's take a look at the steps involved in launching a virtual machine (VM) in OpenStack.

1. The Glance service is used to upload any VM image and its associated metadata. Metadata can span whether the VM is to be public or protected (meaning the VM cannot be modified), in addition to possibly containing launch time suggestions for placement constraints to get optimal performance.
2. A VM launch request begins with the OpenStack Nova service retrieving the image requested from Glance along with its metadata. The two are combined to generate an XML file that specifies the launch parameters.
3. The Nova libvirt driver then boots the VM using the generated XML file as input.

To support UEFI boot in OpenStack in the most straightforward manner, Intel first introduced a new property called "hw_firmware_type". When uploading an image using the Glance service, the property is specified as shown below.

```
property="hw_firmware_type=uefi"
```

When the Glance service perceives the property, it attaches property to the Glance image metadata. The Glance image create command with the UEFI property specified is shown below:

```
glance image-create –file cloud-2730.
qcow  --disk-format qcow2 \
    --container-format bare
      –property="hw_firware_
      type=uefi" \
    --name clear-linux-image
```

In the Glance database, the metadata is visible as shown:

Property	Value
checksum	None
container_format	bare
created_at	2016-01-27T10:13:16Z
disk_format	qcow2
hw_firmware_type	uefi
id	acf0e994-c110-4657-9c31-ad61b1437aa1
min_disk	0
min_ram	0
name	clear-linux-image
owner	6b2797e0bf794383b3055331a6fc8c74
protected	False
size	None
status	queued
tags	[]
updated_at	2016-01-27T10:13:17Z
virtual_size	None
visibility	private

Next, Intel introduced a new global variable named DEFAULT_UEFI_LOADER_PATH for use by the Nova libvirt driver. This variable captures the absolute file path to the UEFI firmware that exists on the Nova compute node. The path will be added into the generated VM XML launch file.

```
DEFAULT_UEFI_LOADER_PATH=
{"x86_64":"/usr/share/OVMF/OVMF_
CODE.fd"}
```

With these two new attributes in place, when a VM boot request is initiated, the image metadata is transferred from the Glance service to the Nova service. During the VM preparation stage, the libvirt driver in the Nova service checks to determine if the image metadata carries the special property hw_firmware_type, and upon finding it, constructs the launch XML file to include the path to the UEFI firmware. This provides the support necessary to boot using UEFI.

Unlocking the Benefits of Clear Linux OS for Intel® Architecture and Intel® Clear Containers through UEFI Boot Support in OpenStack

The Clear Linux Project for Intel Architecture is focused on delivering lightweight Linux OS distributions for cloud use cases. It showcases the best of Intel architecture technology, from low-level kernel features to more complex features in the OS. Further, the distribution includes multiple OpenStack software components and features such as Autoproxy, Function Multiversioning (FMV), Telemetry, AutoFDO, and others, making it a drop-in, ready-to–use distribution on an OpenStack compute node.

Clear Linux OS for Intel architecture[6] also supports Intel Clear Containers.[7] Traditional containers, popular for their small memory footprint and fast launch, do not provide the security of address space isolation that VMs provide. Intel® Clear Containers do provide this security. They are essentially double-bagged containers; that is, they are containers in a lightweight VM that take advantage of Intel® Virtualization Technology (Intel® VT). The memory footprint of Clear Linux OS for Intel architecture and Intel Clear Containers allows densely packed VMs on a compute node. The distribution's low launch latency stems from its UEFI firmware boot. All these benefits are unlocked through building UEFI launch support into OpenStack. The security of Intel Clear Containers addresses the number one concern for broader container adoption in multi-tenant cloud scenarios.

Summary

Intel developed UEFI boot support in OpenStack to provide boot support for non-legacy boot images. In doing so, Intel also facilitated the use of Clear Linux OS for Intel architecture and Intel Clear Containers in OpenStack.

These technologies bring features designed for the cloud to OpenStack, including small footprint, fast launch, and security features that enable multi-tenant cloud applications with greater security in OpenStack.

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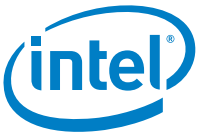
Additional Resources

OpenStack website. https://wiki.openstack.org/

Open Virtual Machine Firmware (OVMF) Status Report.
http://www.linux-kvm.org/downloads/lersek/ovmf-whitepaper-c770f8c.txt

Optimizing solutions with Clear Linux Project.
https://01.org/blogs/2015/optimizing-solutions-intel-clear-linux



[1] GNU GRUB: https://www.gnu.org/software/grub/

[2] Unified Extensible Firmware Interface Specification: http://www.uefi.org/sites/default/files/resources/UEFI%202_5.pdf

[3] Unified Extensible Firmware Interface, Wikipedia definition: https://en.wikipedia.org/wiki/Unified_Extensible_Firmware_Interface

[4] OpenStack UEFI support specification: https://review.openstack.org/#/c/235983/

[5] OpenStack UEFI support implementation: https://review.openstack.org/#/c/262930/

[6] Clear Linux Project Wraps Containers in Speedy VMs. https://blogs.intel.com/evangelists/2015/05/19/clear-linux/

[7] Contain(er-ize) yourself, it's Intel Clear Linux, ComputerWeekly.com. 2015. http://www.computerweekly.com/blogs/open-source-insider/2015/05/contain-yourself-its-the-intel-clear-linux-project.html

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