Dynamic Acceleration Kernel

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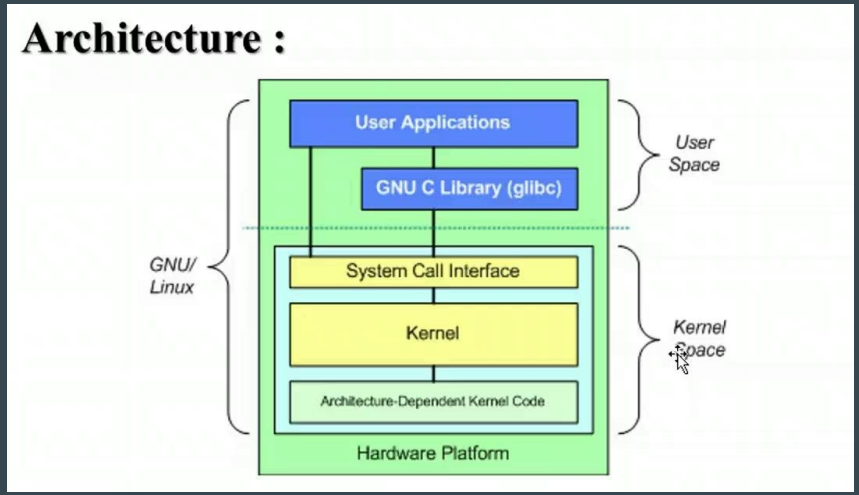
Linux Kernel Overview

The Linux kernel is the core interface between system processes and the computer's hardware in Linux operating system (OS).

It exists within the OS, managing hardware functions and communication between layers as fast and efficiently as possible.

A Kernel is responsible for:

- Memory management
- Process management
- Device drivers
- System calls and security



https://www.youtube.com/watch?v=OOqgM6ycEgs&ab_channel=AkankshaThorat

Problem Statement

Some tests require a lot of time to complete and find all the edges, bugs and incompleteness in a software.

These tests cannot be skipped or reduced as it directly impacts the quality of a given piece of computer software.

A solution to the problem would be an **ACCELERATION**.

https://www.scnsoft.com/software-testing/software-testing-trends

Our* Solution

We cannot effortlessly accelerate the hardware such as CPU, Drives and Network devices, but we can speed up the Kernel's clock programmatically.

Definition of acceleration:

Acceleration = jiffies/timeout * (speedup),
Where speedup is a ratio of 1, 2, 3, etc
And jiffies is the duration of one tick of the system timer interrupt.

The Dynaccel Linux Kernel that can speed up the long-term testing process through accelerated kernel's flow of time.

* The idea originated from the Toshiba's work on Kernel clock acceleration

Our* Solution cont'd

```
@@ -3587,9 +3588,9 @@ int ata_wait_ready(struct ata_link *link, unsigned long deadline,

    /* choose which 0xff timeout to use, read comment in libata.h */
    if (link->ap->host->flags & ATA_HOST_PARALLEL_SCAN)
-       nodev_deadline = ata_deadline(start, ATA_TMOUT_FF_WAIT_LONG);
+       nodev_deadline = ata_deadline(start, ATA_TMOUT_FF_WAIT_LONG * speedup_ratio);
    else
-       nodev_deadline = ata_deadline(start, ATA_TMOUT_FF_WAIT);
+       nodev_deadline = ata_deadline(start, ATA_TMOUT_FF_WAIT * speedup_ratio);

@@ -599,7 +600,7 @@ static void atkbd_event_work(struct work_struct *work)
         * rescheduling till reconnect completes.
         */
        schedule_delayed_work(&atkbd->event_work,
-                             msecs_to_jiffies(100));
+                             msecs_to_jiffies(100 * speedup_ratio));
    } else {
        if (test_and_clear_bit(ATKBD_LED_EVENT_BIT, &atkbd->event_mask))
            atkbd_set_leds(atkbd);
```

```
[deezzir@dynaccel ~]$ sudo sysctl --write kernel.accel=5
kernel.accel = 5
[deezzir@dynaccel ~]$ cat /proc/sys/kernel/accel
5
```

The Dynaccel Kernel is based on the upstream CentOS 8s kernel version 4.18.0.

The speedup_ratio (acceleration) can be changed with **sysctl**.
Example: sysctl --write kernel.accel=50.

The current acceleration ratio can be accessed through cat /proc/sys/kernel/accel.

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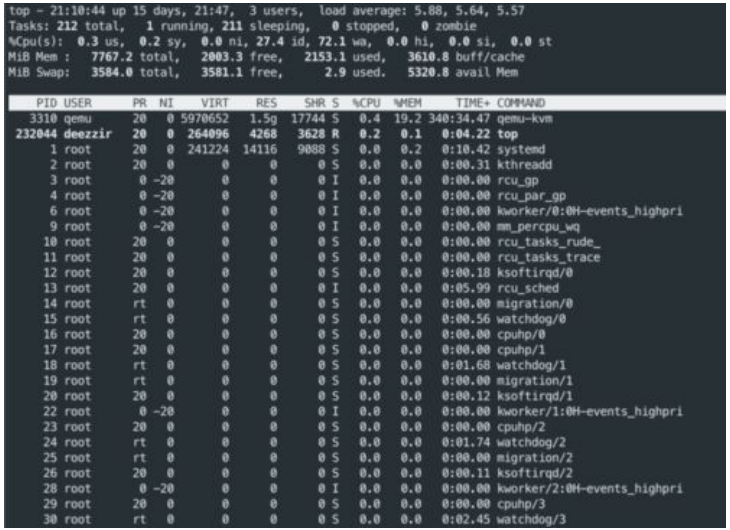
Acceleration works

Even inner VMs inherit the accelerated time flow



GIF of top command

Dynaccel Kernel SRC.RPMs

The Dynaccel Kernel can be wrapped into an RPM package and hosted as a repository for easy distribution and installation.

The kernel.spec specifies EPOCH 1 for Dynaccel to take precedence over the latest kernel present in DNF.

4.18.0 version overtakes the most recent 5.18.11

```
[deezzir@greenland ~]$ sudo dnf update
[sudo] password for deezzir:
Last metadata expiration check: 0:08:06 ago on Wed 10 Aug 2022 05:17:00 PM EDT.
Dependencies resolved.
================================================================================
 Package                 Architecture  Version                  Repository  Size
================================================================================
Installing:
 kernel                  x86_64        1:4.18.0-394.el8.dynaccel  dynaccel   8.3 M
 kernel-core             x86_64        1:4.18.0-394.el8.dynaccel  dynaccel    40 M
 kernel-modules          x86_64        1:4.18.0-394.el8.dynaccel  dynaccel    32 M
 kernel-modules-extra    x86_64        1:4.18.0-394.el8.dynaccel  dynaccel   8.9 M
Upgrading:
 code                    x86_64        1.70.1-1660113182.el7      code       115 M
 kernel-headers          x86_64        1:4.18.0-394.el8.dynaccel  dynaccel   9.6 M
Removing:
 kernel                  x86_64        5.18.11-100.fc35           @updates      0
 kernel-core             x86_64        5.18.11-100.fc35           @updates     92 M
 kernel-modules          x86_64        5.18.11-100.fc35           @updates     57 M
 kernel-modules-extra    x86_64        5.18.11-100.fc35           @updates    3.3 M

Transaction Summary
================================================================================
Install  4 Packages
Upgrade  2 Packages
Remove   4 Packages

Total size: 213 M
Total download size: 115 M
Is this ok [y/N]:
```

The Dynaccel RPM shows during dnf update

Steps to Build the Dynaccel RPM package

1. Install RPM Developer tools.
2. Set up the RPM build tree.
3. Copy the *src.rpm to the SRPMS folder and install the RPM.
4. Build the RPM
    a. The output will be a list of kernel RPMs
5. Create and sign an RPM repository.

```
[deezzir@fedora rpmbuild]$ tree .
.
├── BUILD
├── RPMS
├── SOURCES
├── SPECS
└── SRPMS

5 directories, 0 files
```

RPM build tree

```
[deezzir@dynaccel ~]$ cat /etc/yum.repos.d/dynaccel.repo
[dynaccel]
name=dynaccel
baseurl=file:///var/www/html/dynaccel
gpgcheck=1
gpgkey=file:///etc/pki/rpm-gpg/RPM-GPG-KEY-dynaccel
enabled=1
```

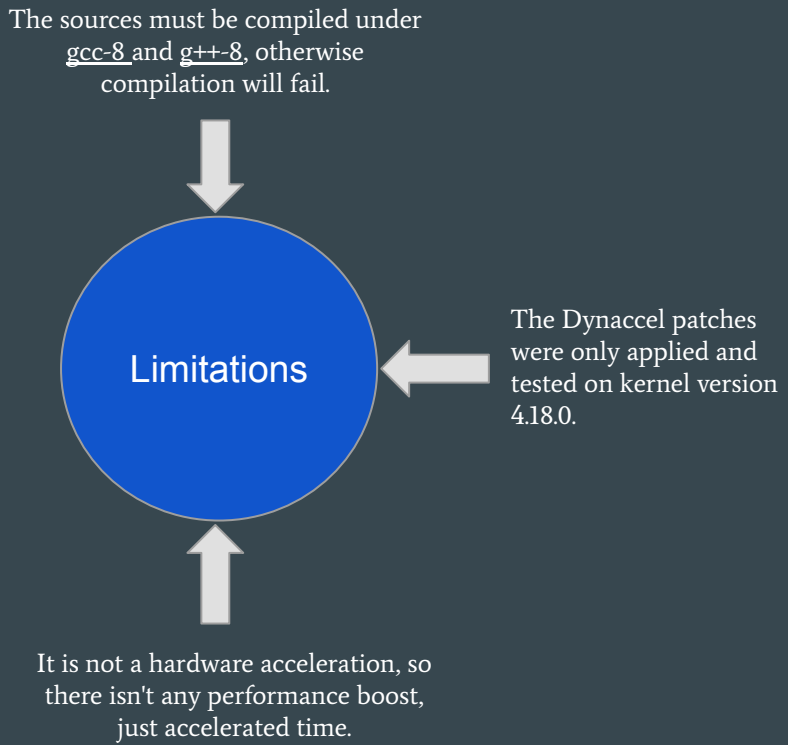
RPM Repository definition

Conclusion

The Dynaccel Kernel makes long-term testing easier by accelerating the flow of time.

A programmer can handily deploy the Dynaccel Kernel RPM packages within an environment to speed up the testing process.

The project can be maintained and improved with the help of an open-source community.



Sources

- A slides by the original authors (Toshiba) https://elinux.org/images/6/6d/Linux_Kernel_Acceleration_for_Long-term_Testing.pdf
- What is the Linux kernel? Redhat https://www.redhat.com/en/topics/linux/what-is-the-linux-kernel
- Dynaccel-kernel-4.18.0 Documentation https://github.com/Seneca-CDOT/dynaccel-kernel-4.18.0/blob/main/README.md
- CDOT Wiki page on how to create and sign RPM repository https://wiki.cdot.senecacollege.ca/wiki/Signing_and_Creating_a_Repository_for_RPM_Packages
- Fedora Wiki page on how to create a custom Kernel RPM package https://www.fedoraproject.org/wiki/Building_a_custom_kernel/Source_RPM