The Future of Linux Graphics: Wayland

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Who am I?

- Professional technologist
- Humble maintainer of a handful of packages in the Fedora Project
- Packager for Mageia Linux
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Brief overview of the Linux graphics subsystem

An overview of graphics on Linux...

The current Linux graphics subsystem is made up of several components:

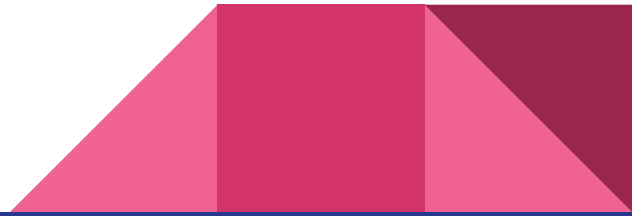
- Direct Rendering Infrastructure (DRI)
  - Kernel Mode-setting (KMS)
  - Mesa
  - Gallium3D
- X Server (Xorg)
- Window manager/compositor (Mutter, Kwin, Compiz, etc.)

Direct Rendering Infrastructure

- Introduced in 1998 by Tungsten Graphics (now part of VMware) and maintained by freedesktop.org.
- Framework to bypass multiple levels of indirection to allocate and utilize memory buffers for storing and manipulating graphics data.
- Originally for supporting 2D accelerator graphics cards, it has been extended many times to support 3D.
- Current version is DRI 3.0. DRI 2.0 is supported by freedesktop.org, mainly due to older long-term support Linux distributions.

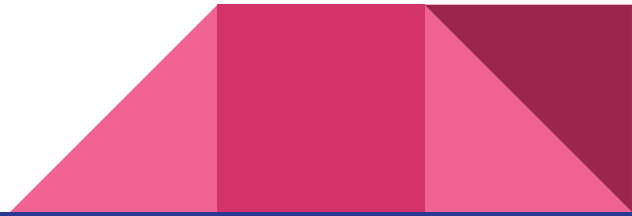
Kernel Mode-setting

- Introduced in 2009, this component initializes the screens attached to the graphics card in the kernel.
- Prior to this, initialization occurred in userspace, which led to unusual issues when it failed.
- The screen buffer and the display dimensions are determined very early in boot because it occurs when the kernel starts up.
- In the latest kernels, it is possible for the entire process to occur *atomically*, thus if any part of it fails, it always triggers fallback mechanisms.



Mesa

- This provides the OpenGL APIs for Linux. It also operates as a software-rendered OpenGL implementation when there’s no supported hardware.
- Mesa is often considered the “reference” implementation even though it isn’t certified as such, since certification requires paying the Khronos Group (stewards of OpenGL and other standards) to get it done.
- Mesa also includes the code for the 3D drivers for all graphics cards supported on Linux using the Mesa implementation of the OpenGL API.



Gallium3D

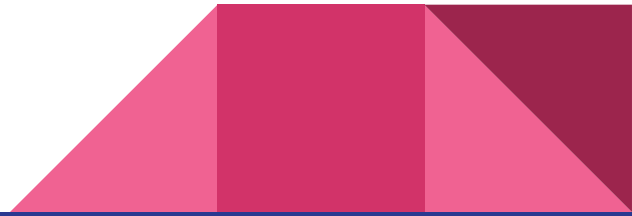
- The Gallium3D framework provides the infrastructure for supporting APIs that can be driven by graphics cards.
- Gallium3D splits the implementation of drivers into three components:
  - WinSys - Operating System interface driver
  - State Tracker - API driver
  - Pipe Driver - hardware interface driver
- The split permits API and OS level abstraction. This allows for drivers to be easily ported to other operating systems or for new 3D APIs to be supported without reworking drivers.
- Only the driver for Intel graphics hardware does not use it.

X Server

- The fundamental bedrock of Linux graphics is the X server, which supports the X Window System that is used to do the low-level drawing operations.
- Unlike most graphics subsystems, the X server offers a “network transparent” graphical subsystem. This means that it is possible to redirect the actual draw operations over a network connection to another computer without the application being aware of it.
- The X Window System predates Linux, being originally introduced in 1984 by MIT, and multiple implementations have existed for many operating systems.

Window managers and compositors

- The X server does not provide support for “windows” itself, and requires a separate application to do this. This is done by a “window manager”. The window manager enables “windows” of applications by defining boundaries for drawing surfaces and allowing the manipulation of those bounded surfaces.
- The concept of a compositing window manager was introduced to Linux by Novell and SUSE in 2006 with Compiz, a window manager that relied on OpenGL to render surfaces instead of regular drawing operations on the CPU. Today, most desktop environments include one.



Introduction to Wayland

What is Wayland?

- Development of Wayland was started by Kristian Høgsberg as a “spare time” project while he worked at Red Hat.
- It is designed as a system that massively culls the features and capabilities implemented by the display server and display protocol.
- The reason for refactoring in this manner is because so much of the functionality traditionally provided by the X Window System has been taken over by other toolkits, libraries, or even the kernel in some respects.

How does Wayland fit into the Linux stack?

- Wayland is both a protocol and a display server.
- The Wayland protocol replaces the X Window System's X11 protocol, which differs significantly in two key ways:
  - Network transparency is eliminated in favor of tighter integration with hardware
  - 2D-specific operations are eliminated in favor of implementing 2D on top of 3D surfaces
- The Wayland display server replaces the X server to provide the implementation of the Wayland protocol.
- The Wayland system is designed for an era where most of the functionality provided by the X Window System is not even used anymore.

How well is Wayland supported today?

The major toolkits used for graphical applications (Qt 5, GTK+ 3) fully support operating on top of a Wayland environment.

As a consequence of most desktop environments in Linux using either one of those toolkits, they (mostly) work on top of a Wayland environment already.

For example, GNOME 3.18 (released in late September) is functionally complete on Wayland support. Mutter and GDM (the window and login managers) support it very well. KDE’s Kwin and SDDM are mostly complete now, and are expected to be fully functional by the end of the year.

Demo

Fedora 23 Workstation Edition running Wayland

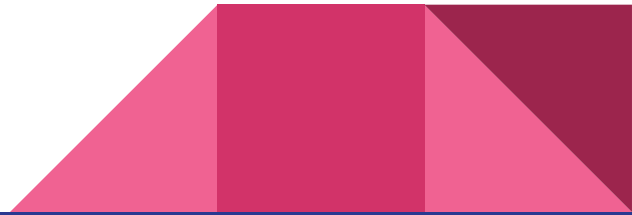
How can I use Wayland?

Today, only GNOME easily exposes the ability to run in a Wayland environment, though KDE will support it in the Plasma 5.5 release expected in December. Only a couple of distributions currently offer a fully working Wayland environment.

At this time, my recommended choices of distributions to try out Wayland are:

- Fedora 23 Workstation Edition
- openSUSE Tumbleweed (as of October 30, 2015)

Next spring, more desktops (MATE, LXQt, Xfce, etc.) and distributions (Mageia, etc.) will join the party!



The End

Any Questions?