

Modern Graphics from Boot to Shutdown and Retiring fbdev

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Linux has many display systems to choose from.

- Linux originally started with VGA text mode, which is still supported
- Plenty of display drivers on Linux: DRM, fbdev, X11 (, svgalib, HW libraries)
- Plus tons of userspace: X11, several Wayland compositors, 'raw mode'
- Porting drivers and software among various systems not always trivial
- Only relevant is DRM drivers plus Wayland compositing (plus X11 for upwards compatibility)



DRM is the kernel subsystem for modern graphics.

- Direct Rendering Manager (DRM) provides graphics output for modern devices
- Covers the last 15 yrs of hardware
- Modesetting for complex hardware: multiple outputs among multiple connectors or even across devices
- Designed for hardware-based rendering and decoding
- Multiplexes the system's graphics resources



Fbdev displays early-boot output and fallback graphics.

- DRM is huge: ~10% of the kernel, mostly in drivers (TW v5.19: compiled kernel 13 MiB, DRM drivers 8.5 MiB); plus userspace
- Does not fit into an initrd, but fbdev does
- Fbdev is a simple subsystem: set a display mode and draw into video memory
- Covers hardware older than 15 yrs
- Fbdev provides hardware-agnostic drivers for EFI, VESA, VGA, OpenFirmware; useful during early boot and on systems without DRM driver



DRM requires support for hardware-agnostic graphics drivers.

- System firmware or boot loader initializes graphics hardware: display mode, color format, scanout buffer
- Various standards: VGA, VESA, UEFI graphics drivers, SoC + DeviceTree
- Linux acquires information during initial booting steps; creates a platform device for the graphics hardware
- Hardware-agnostic driver binds to the device
- Hardware driver is later loaded from disk and replaces the hardware-agnostic one



Userspace is slowly losing the ability to use fbdev.

- Support for fbdev is being phased out in userspace components
- Users on systems without DRM driver are stuck with the text-mode console
- *Solution: enable hardware-agnostic drivers within DRM.*



We enabled *simplifiedrm* for hardware-agnostic output via DRM.

- Simplifiedrm is a regular Linux driver within DRM subsystem
- Graphics output pre-configured by firmware
- No modesetting, only software rendering
- Built into the kernel, simplifiedrm provides early-boot graphics
- Covers also fall-back graphics if no hardware driver is available, including old hardware
- *Allows for modern desktops and productivity applications*



DRM multiplexes graphics among userspace with varying requirements.

- All graphics buffers are in system memory, copied to scanout buffer during pageflip; easily shareable among userspace programs
- DRM requires damage handling of draw screen areas by userspace; minimizes update overhead
- Userspace expects XRGB8888; simplifiedrm converts color formats during damage handling
- Not possible with fbdev



Framebuffer needs to be coordinated among drivers.

- Device handover done via hot-unplugging; never really worked reliably with fbdev
- New *aperture helpers* maintain ownership of video memory; now also used by VFIO to release ownership before assigning graphics to guest systems



Built-in DRM leads to better- organized DRM code.

- Kernel built-in DRM supposed to be minimal in size
- DRM helper modules were split to remove unnecessary code from kernel binary
- `drm_kms_helper.ko` changed from 447 KiB to 240 KiB by moving the DisplayPort code into a separate module. Only `drm_kms_helper.ko` is required by `simplifiedrm`



Several legacy components need workarounds.

- X server has limited ability to parse Linux device hierarchy; needed a patch to accept simpledrm (and others)
- Nvidia's proprietary driver is g§%?!&e and needs fbdev EFI driver for console; continues on top of fbdev for now.



**Fully DRM-based
graphics output
is the new
standard.**

- Tumbleweed switched with kernel 5.18
- Fedora 36
- Alpine Linux 3.15
- Ubuntu (soon?)
- Apple M1 graphics



DRM graphics will allow for new features.

- Ofdrm is a hardware-agnostic driver for PowerPC
- Text console can now run in userspace; allows for better fonts; right-to-left scripts; better UTF support; night mode; multi-screen output; Wayland compositing
- Kdump graphics support



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Live Demo

Q & A

- *> dmesg | grep drm*
- *Try booting the kernel with 'nomodeset'*

