News in Qemu graphics

the 2016 update

Gerd Hoffmann <kraxel@redhat.com>

KVM Forum 2016, Toronto

Outline.

- virtio-gpu
  - guest support
  - host support
- opengl rendering
- gpu assignment and vgpu

virtual hw: virtio-gpu

virtio-vga vs. virtio-gpu-pci

- virtio-vga = virtio-gpu-pci + stdvga
  - set scanout virtio command switches to virtio-gpu mode
  - device reset switches back to vga mode
- vga mode for backward compatibility and firmware framebuffer
  - used by seavgabios, OVMF (x86) and SLOF (ppc)
- vga mode not working on arm (cache coherency issues)
  - use virtio-gpu-pci instead
  - edk2 gfx output WIP by László

virtio-vga mmio bar

```
fc800000-fcffffff (prio 1, RW): virtio-pci
  fc800400-fc80041f (prio 0, RW): vga ioports remapped
  fc800500-fc800515 (prio 0, RW): bochs dispi interface
  fc800600-fc800607 (prio 0, RW): qemu extended regs
  fcbfd000-fcbfdfff (prio 0, RW): virtio-pci-common
  fcbfe000-fcbfefff (prio 0, RW): virtio-pci-isr
  fcbff000-fcbfffff (prio 0, RW): virtio-pci-device
  fcc00000-fcffffff (prio 0, RW): virtio-pci-notify
```

virtio-gpu guest support

- virtio-gpu.ko linux kernel drm driver
  - 2d mode: linux 4.2
  - 3d/virgl mode: linux 4.4
  - multihead fixes: linux 4.8-rc1
- userspace driver: mesa 11.1
- xorg-x11-server support (using glamor)
  - commit "5627708 dri2: add virtio-gpu pci ids" (master branch)
  - backported to fedora xorg-x11-server-1.18 rpms
- **almost completely upstream**

virtio-gpu/3d distro support

- Fedora 24
- Fedora 23, with updates
- Android (android-x86.org)
  - has mesa-based opengl es stack.
- Other distros should follow as they pick up upstream updates.
  - check kernel: `dmesg | grep virgl`
  - check mesa: `glxinfo | grep virgl`

virtio-gpu emulation

- virtio-gpu 2d mode: qemu 2.4
- virtio-gpu 3d/virgl mode: qemu 2.5
  - needs virglrenderer library
  - needs qemu ui with opengl support
- virtio-gpu multihead fixes: qemu 2.7
- virtio-gpu 2d mode live migration: qemu 2.7

virglrenderer

- created by David Airlie
- mesa gallium command stream (from guest) => opengl (for host gpu)
- pretty complex and security sensitive
- sandboxing: WIP by Marc-André Lureau
- approach: use virtio-user to run virglrenderer in a separate process

opengl support in qemu UIs

- gtk: qemu 2.5
  - different code for 3.16+ (GtkGlArea).
- sdl2: qemu 2.6
- spice, local only: qemu 2.6
- spice, remote display: in progress
- not (yet) playing nice with selinux

spice: local display

- uses render node (/dev/dri/render*) for headless opengl
  - no display server dependency (unlike sdk2/gtk)
- passes guest display as dma-buf to spice client
- qemu: needs libepoxy 1.3.1, mesa 10.6
- qemu: needs spice-server 0.13.1 (devel release)
  - qemu flatpaks don't play nice with libvirt (nested sandbox)
- virt-viewer: needs spice-gtk 0.32 (0.31 for gtk2)
- needs unix socket connection for dma-buf fd passing
  - use `virt-viewer --attach`

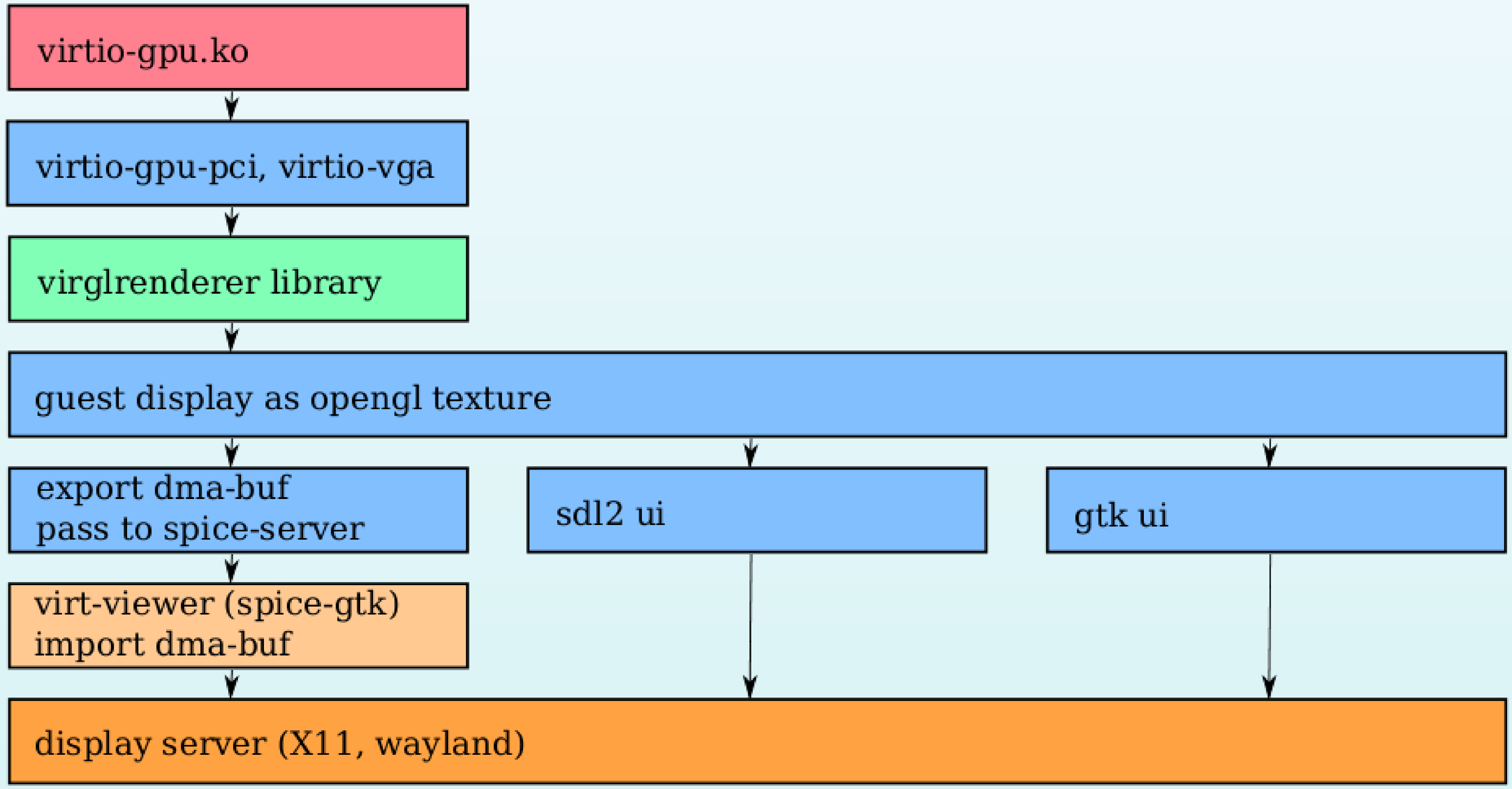
pass display dma-bufs

- qemu
  - render guest display into texture
  - eglCreateImageKHR: texture -> image
  - eglExportDMABUFImageMESA: image -> dma-buf filehandle
  - send filehandle via unix socket (SCM_RIGHTS)
- spice client
  - eglCreateImageKHR (using target=EGL_LINUX_DMA_BUF_EXT): dma-buf filehandle -> image
  - glBindTexture: bind image to texture

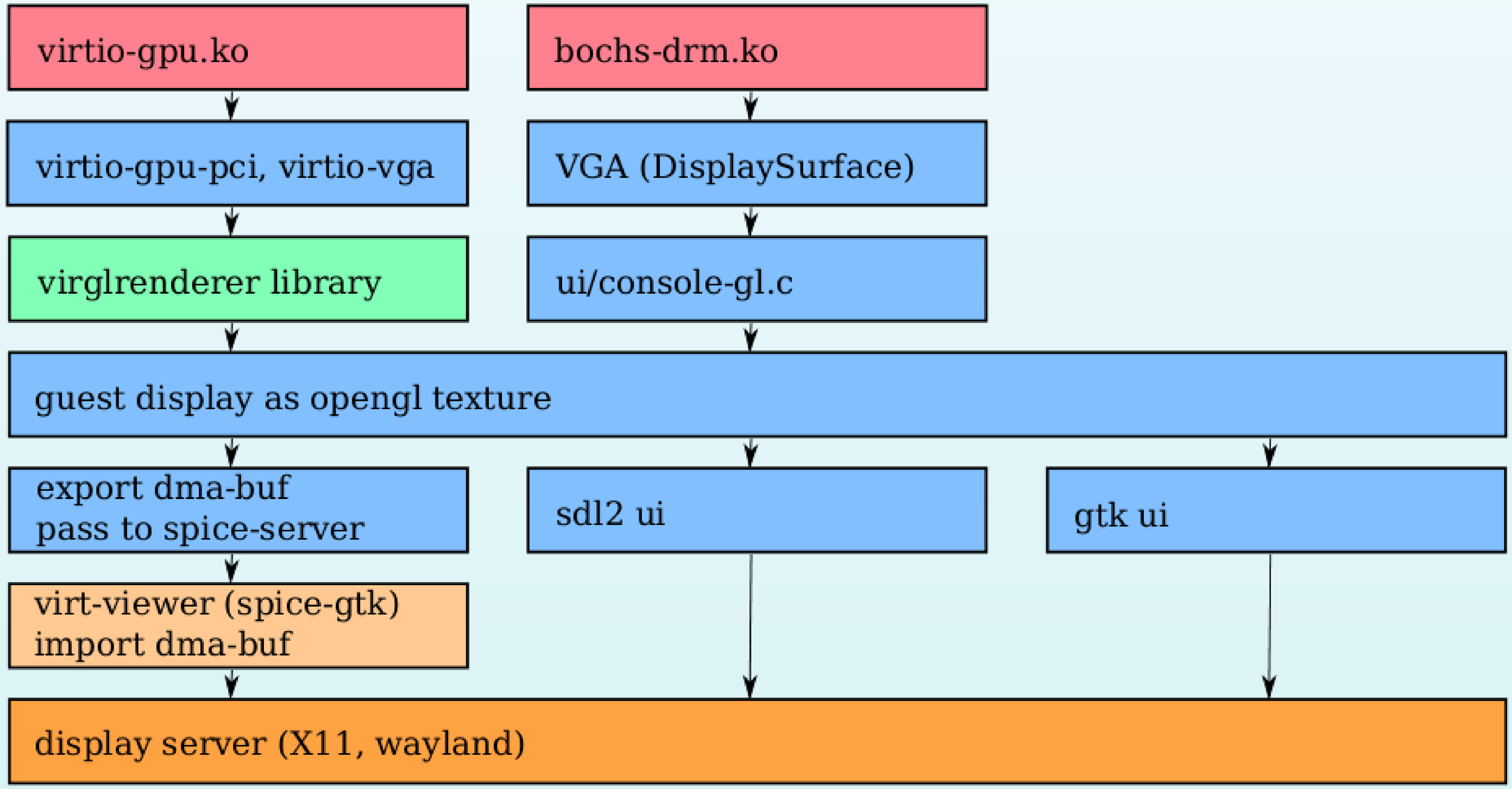
spice: libvirt config

```
<graphics type='spice'>
  <listen type='none'/>
  <gl enable='yes'/>
</graphics>
<video>
  <model type='virtio'/>
</video>
```

virgl opengl display



vga opengl display



spice: remote display

- plan is to encode video and send that
- experimental patches exist
  - using gstreamer support merged in spice-server recently
- hardware encoding support is tricky
  - vaapi: created by intel, encode + decode
  - vdpau: created by nvidia, also supported by others, decode only
  - nvidia supports encoding via proprietary library (nvenc)
- patent issues around H.264 + H.265
  - ciscos openh264 codec might help here
  - recent intel hardware supports vp8 and vp9 too

physical hw: vfio & vgpu

vfio with gpus

- Not new for standalone gpus
  2014 KVM Forum talk by Alex
- IGD support added (chipset quirks)
  - needs: linux 4.6, qemu 2.7
  - useful for intel vgpu too
- input-linux support added
  - read input directly from linux evdev devices
  - removes the need to have a otherwise unused emulated gfx device and sdl/gtk/spice window for kbd+mouse input.
  - needs: qemu 2.6

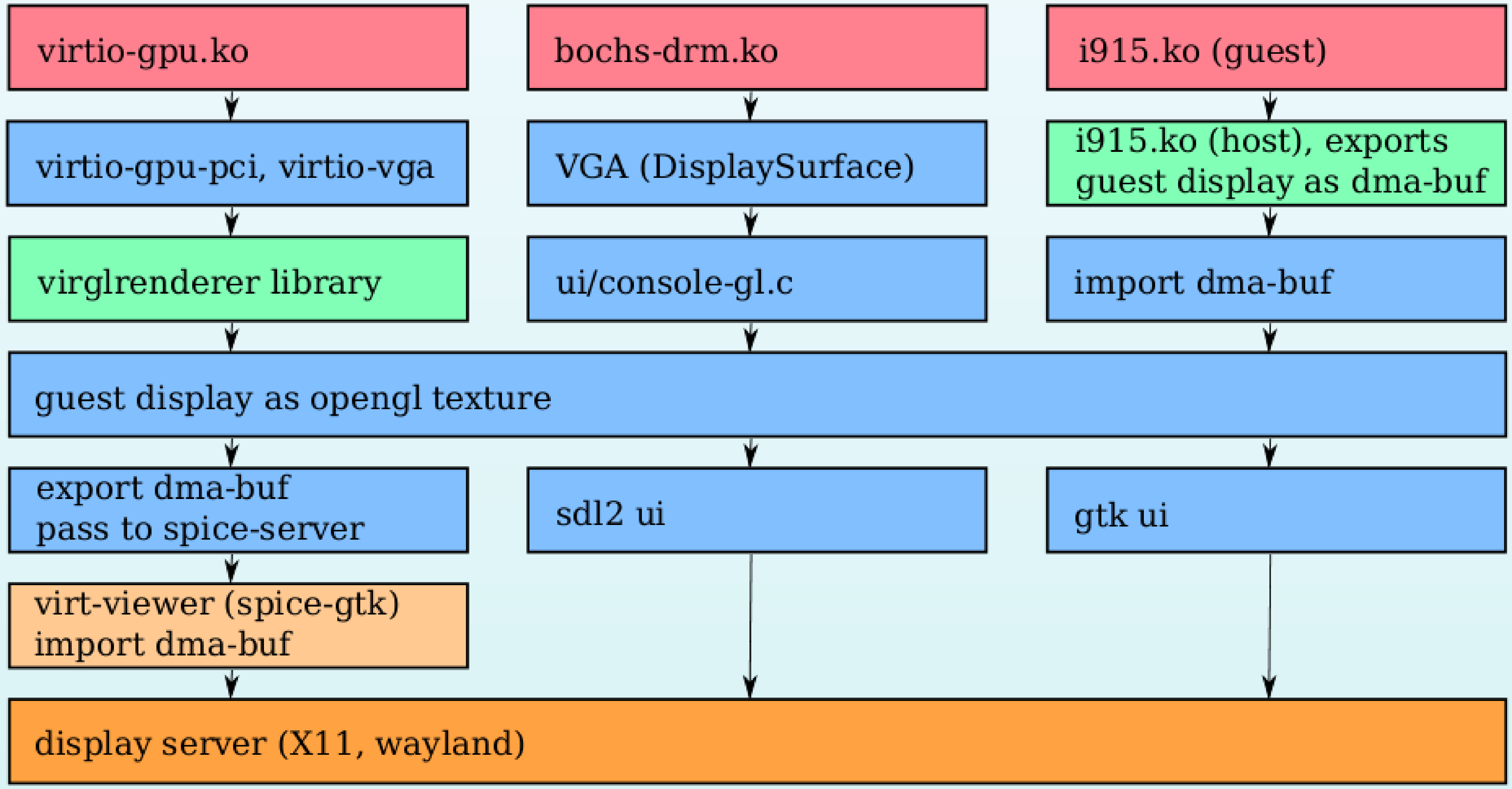
vfio with vgpu

- host gpu driver partitions hardware into multiple virtual gpus
  - roughly comparable to SR/IOV
  - separation & virtualization done by host gpu driver (instead of iommu)
- use well established vfio interface for vgpu too
  - `qemu -device vfio-pci` will just work
- in development: mdev driver, for common tasks such as guest memory tracking. TODO: link nvidia slides here.

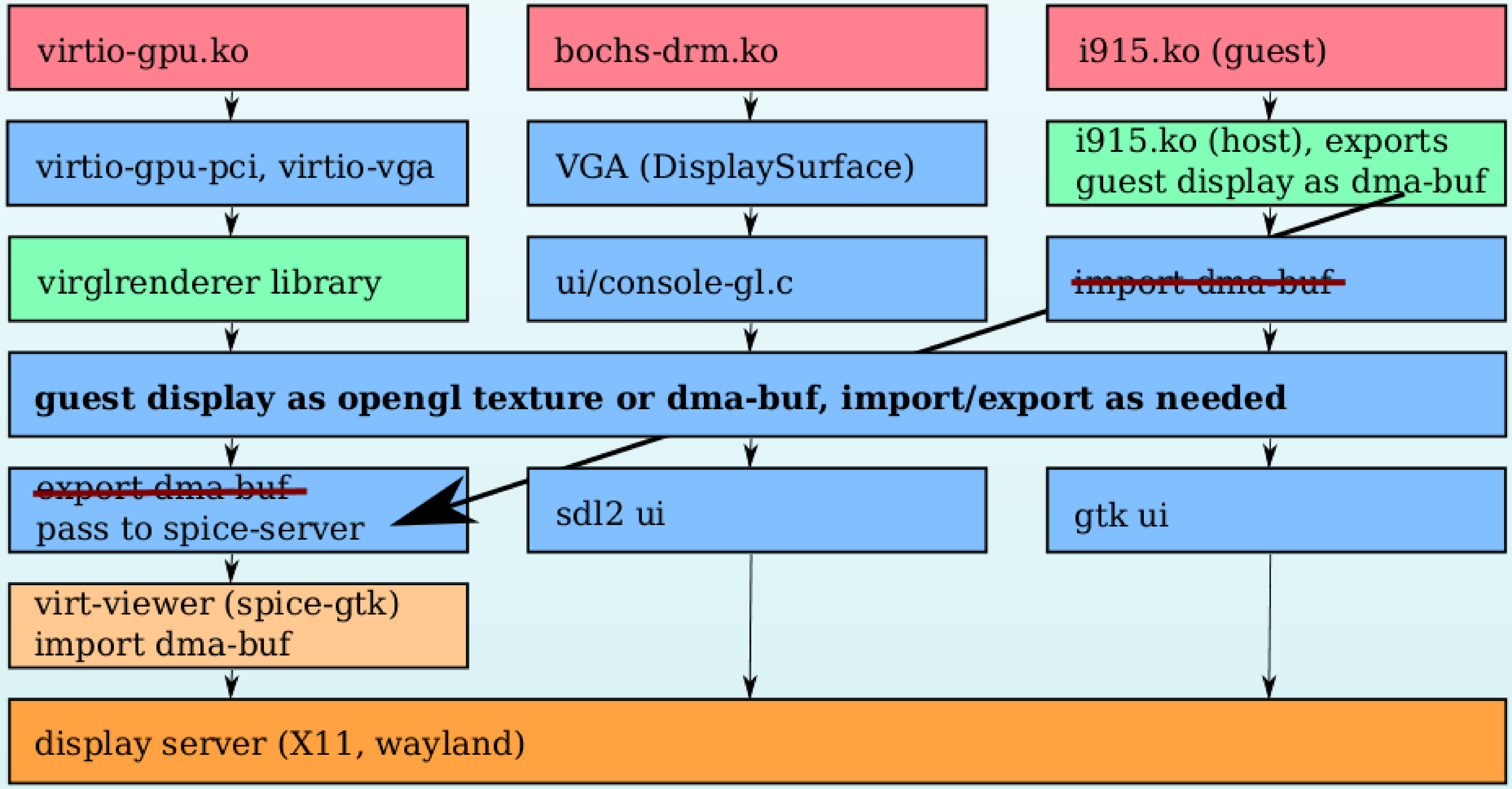
intel vgpu integration

- integrating into the i915 drm driver is in progress
  `0ad35fe drm/i915: gvt: Introduce the basic architecture of GVT-g` (4.8-rc1)
- kvm integration depends on mdev driver (previous slide)
- guest display will be exported as dma-buf

vgpu opengl display


virtio-gpu.ko
bochs-drm.ko
i915.ko (guest)
virtio-gpu-pci, virtio-vga
VGA (DisplaySurface)
i915.ko (host), exports guest display as dma-buf
virglrenderer library
ui/console-gl.c
import dma-buf
guest display as opengl texture
export dma-buf pass to spice-server
sdl2 ui
gtk ui
virt-viewer (spice-gtk) import dma-buf
display server (X11, wayland)

vgpu display, improved


virtio-gpu.ko

bochs-drm.ko

i915.ko (guest)

virtio-gpu-pci, virtio-vga

VGA (DisplaySurface)

i915.ko (host), exports guest display as dma-buf

virglrenderer library

ui/console-gl.c

~~import dma-buf~~

guest display as opengl texture or dma-buf, import/export as needed

~~export dma-buf~~
pass to spice-server

sdl2 ui

gtk ui

virt-viewer (spice-gtk)
import dma-buf

display server (X11, wayland)

guest video encoding

- with pci assigned gpu (also on bare metal)
- commercial solutions for that exist (game streaming)
- vgpu can do the same
- advantage: same setup on bare metal, assigned gpu, vgpu
- disadvantages:
    - not transparent to the guest
    - no spice integration
        - worth trying?
        - guest agent could send H.264 over virtio-serial ...
        - vfio/vgpu BoF

Slides online

https://www.kraxel.org/slides/qemu-gfx-2016/