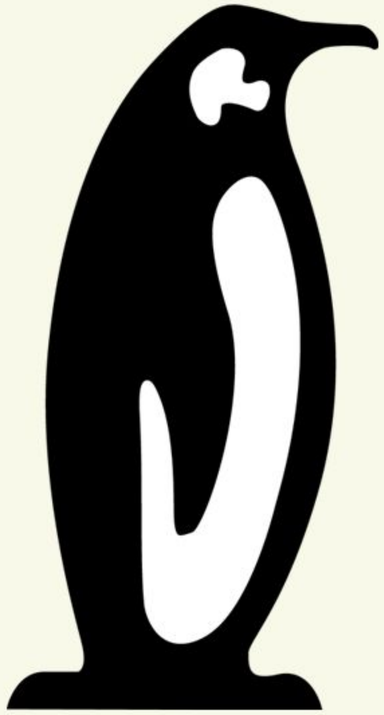

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PCI Endpoint Subsystem Open Items

Manivannan Sadhasivam
Senior Kernel Engineer
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Agenda

- Virtio EPF drivers for Interoperability
- Devicetree Integration
- Genalloc for Outbound Window Memory Allocation

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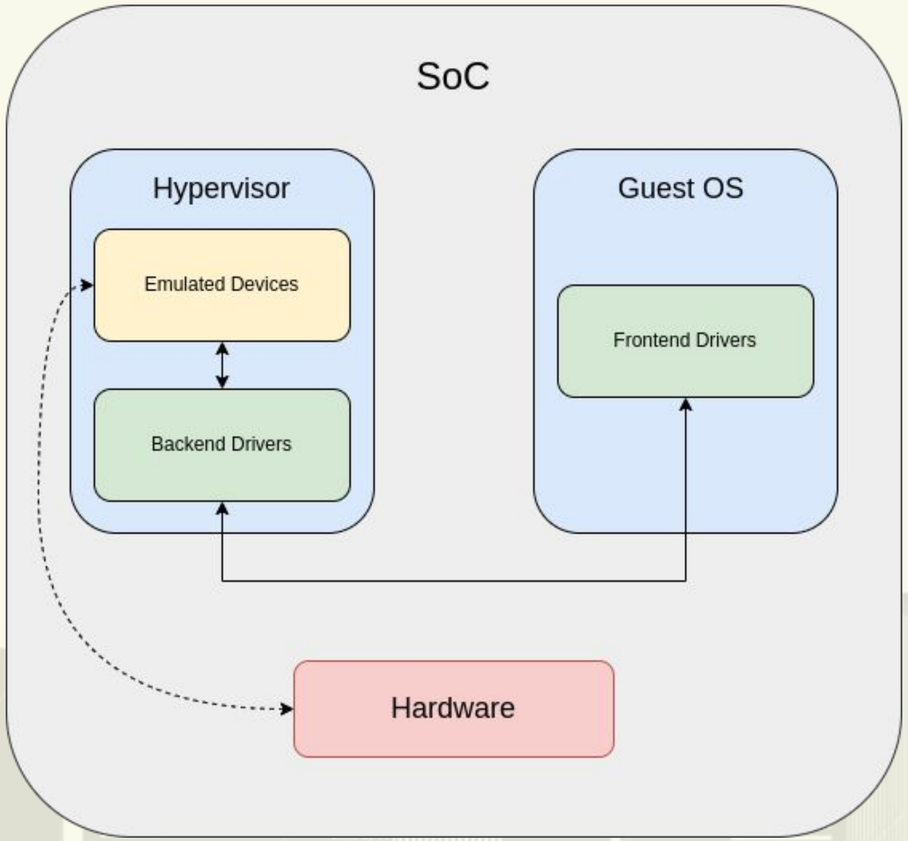
Virtio EPF drivers for Interoperability

Virtio - Overview

- Open standard for communication between drivers and devices of different types
- Initially developed by Rusty Russell
- Now maintained by a standards body
  - https://docs.oasis-open.org/virtio/virtio/
- Primarily used as an I/O virtualization framework
  - Exposing I/O devices to guests by the hypervisor
  - Used by hypervisors such as KVM, Iguest, ACRN etc…
- Also used for inter chip communication within the SoC
  - RPMSG

Virtio Architecture - Simplified



PCI Endpoint Subsystem - Overview

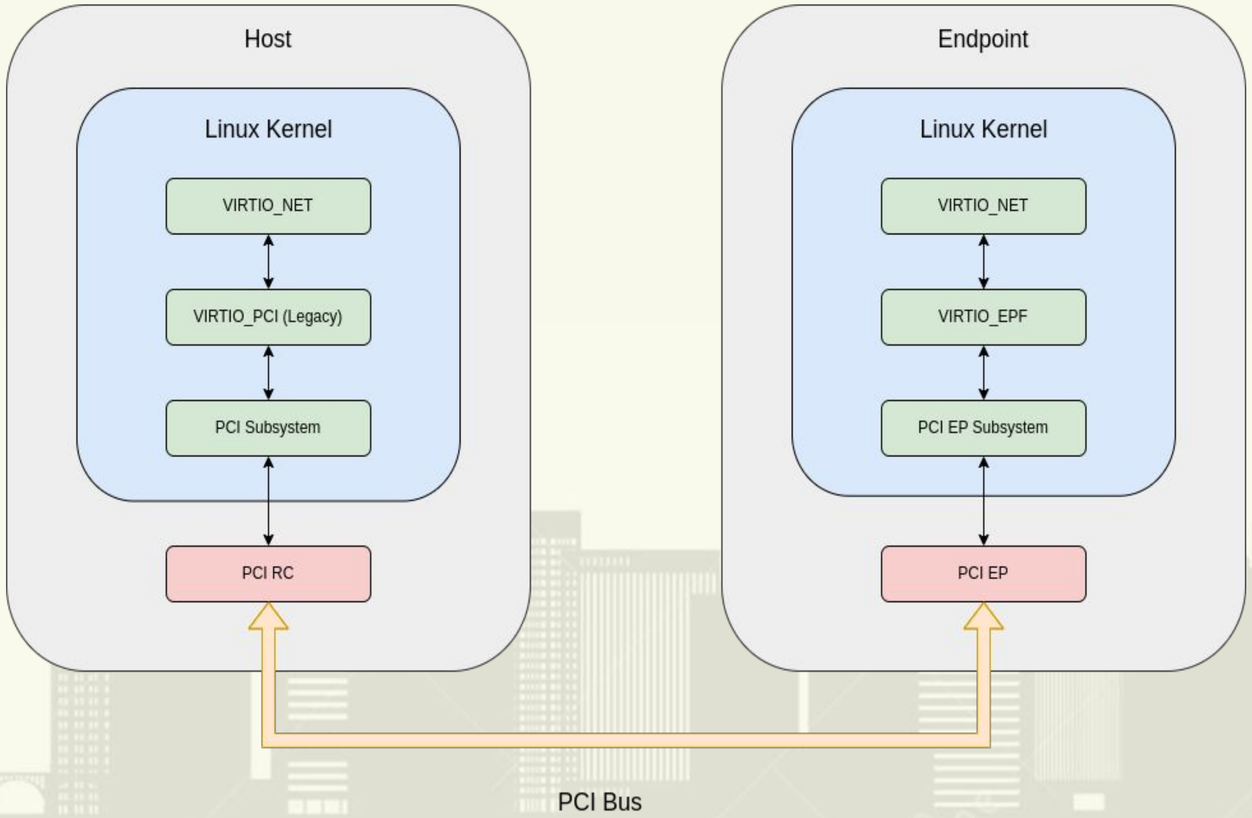
- Used to make Linux run on PCI(e) Endpoint devices (NVMe, WLAN, Modems, etc…)
- Added as a separate subsystem/framework under PCI
  - *drivers/pci/endpoint/*
- Endpoint Controller (EPC) drivers manages the PCI transport
  - *drivers/pci/controllers/*
- Endpoint Function (EPF) drivers define the behavior of the device
  - *drivers/pci/endpoint/functions/*
- Needs equivalent drivers on the host for functionality
  - *drivers/misc/pci_endpoint_test.c*
  - For devices like NVMe, existing driver can be reused
    - *drivers/nvme/host/pci.c*

Virtio for PCI Endpoint Subsystem

- Idea mooted around 2019
  - https://lore.kernel.org/all/20190823213145.2016-1-haotian.wang@sifive.com/
- Existing Virtio frontend drivers on the host (Linux Kernel) can be reused
  - PCI Endpoint vendors can just develop Virtio backend drivers
- Reduces fragmentation and lead time drastically

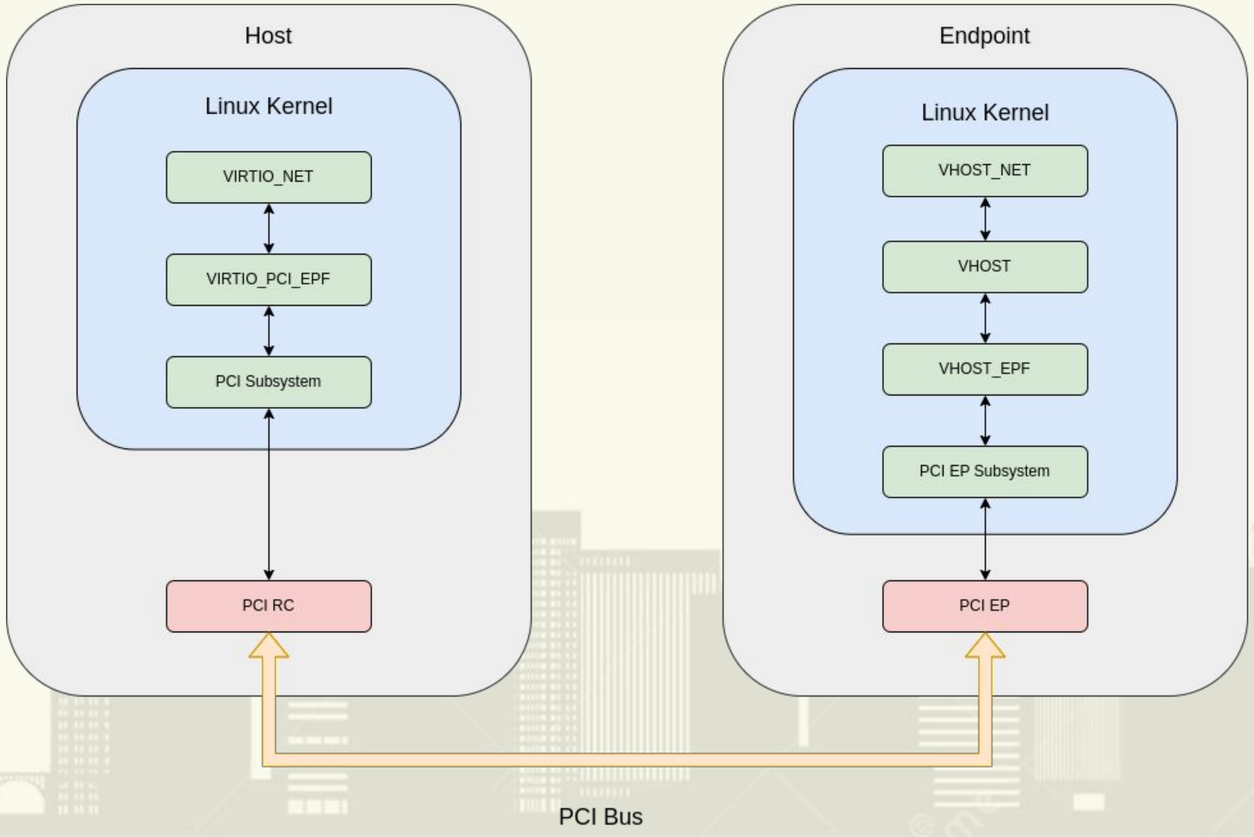
Proposals

- Haotian Wang - 2019



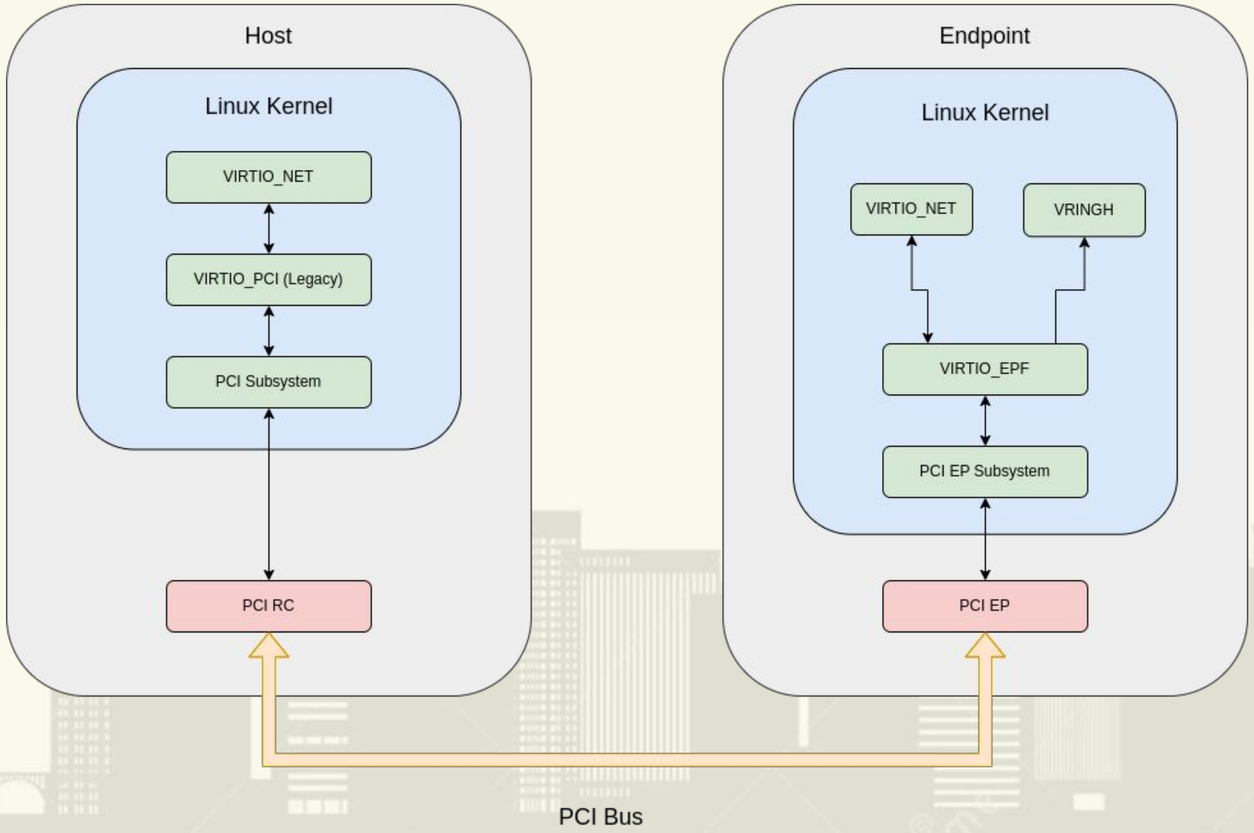
Proposals

- Kishon Vijay Abraham - 2020



Proposals

- [Shunsuke Mie - 2023]



Final Implementation

- Moving forward with the proposal from Shunsuke Mie?
  - Simple yet scalable one
    - Can be extended to virtio-scsi, virtio-console, etc…
  - Involving VHOST seems be an overkill
    - Drawback of proposal 2
  - Vringh offloads the virtqueue management work
    - Drawback of proposal 1

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Devicetree Integration

Problem Statement

- Binding between EPC (Endpoint Controller) and EPF (Endpoint Function) happens through ConfigFS
- No devicetree integration so far as the EPF drivers are software blocks
- But there are EPF drivers that has relevant hardware blocks
- MHI (Modem Host Interface) on Qualcomm chipsets is one example
  - MHI is a Qualcomm specific protocol using PCI as the physical layer
  - Used for transferring data packets between PCI host and endpoint
  - MHI has a hardware implementation in Qualcomm chipsets supporting PCI Endpoint mode
  - Currently, PCI Endpoint Controller (EPC) devicetree node is used for fetching EPF specific resources like BAR region, interrupt etc…

Proposal

- A devicetree node for MHI function
  - Child node of PCI Endpoint Controller (EPC) node
- EPF device will be created for each function and bound with EPF driver
- Properties
  - reg
  - function-name
  - bar-regions
  - Interrupts
- Linking between EPC and EPF possible without ConfigFS

Devicetree Binding

```
soc {
        ...

        pcie1_ep: pcie-ep@1c08000 {
                compatible = "qcom,sm8450-pcie-ep";
                #address-cells = <1>;
                #size-cells = <0>;
                ...

                func@0 {
                        reg = <0>;
                        function-name = "sdx55-mhi";
                        bar-regions = /bits/ 64 <0x01c0b000 0x1000>;
                        interrupts = <GIC_SPI 440 IRQ_TYPE_LEVEL_HIGH>;
                };
        };
};
```

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Genalloc for Outbound Window Memory Allocation

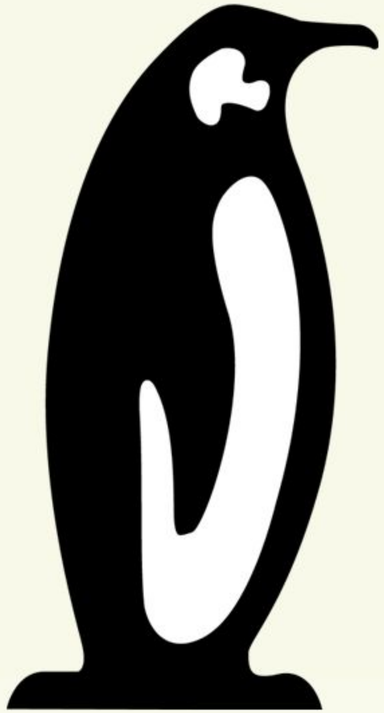
Problem Statement

- PCI Endpoint subsystem uses a custom memory allocator
  - *drivers/pci/endpoint/pci-epc-mem.c*
- Works well, but defeats the purpose of “Genalloc/Genpool” framework

Proposal

- Adapt “Genalloc/Genpool” framework for Endpoint subsystem
- Use existing “addr_space” region defined in EPC devicetree node
  - Backwards compatible with current allocator

Questions?



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