

## Plumbers Conference

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## PCI Endpoint Subsystem Open Items

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### Agenda

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









#### Virtio EPF drivers for Interoperability









#### Virtio - Overview

- Initially developed by Rusty Russell
- Now maintained by a standards body
  - <u>https://docs.oasis-open.org/virtio/virtio/</u>
- 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**



#### • Open standard for communication between drivers and devices of different types









### 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
- Added as a separate subsystem/f
   *drivers/pci/endpoint/*
- Endpoint Controller (EPC) drivers manages the PCI transport
  - o 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
  - <u>https://lore.kernel.org/all/20190823213145.2016-1-haotian.wang@sifive.com/</u>
- - PCI Endpoint vendors can just develop Virtio backend drivers
- Reduces fragmentation and lead time drastically



• Existing Virtio frontend drivers on the host (Linux Kernel) can be reused







#### Proposals

Haotian Wang - 2019









#### Proposals

• <u>Kishon Vijay Abraham - 2020</u>









#### Proposals

• Shunsuke Mie - 2023





PCI Bus





### **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









#### **Devicetree Integration**









### **Problem Statement**

- Binding between EPC (Endpoint 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
  - $\circ~$  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...



#### • Binding between EPC (Endpoint Controller) and EPF (Endpoint Function) happens





### 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
  - o reg
  - function-name
  - bar-regions
  - Interrupts
- Linking between EPC and EPF possible without ConfigFS











```
compatible = "qcom, sm8450-pcie-ep";
```

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







### 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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