Introduction to Oracle VM (Xen) Networking

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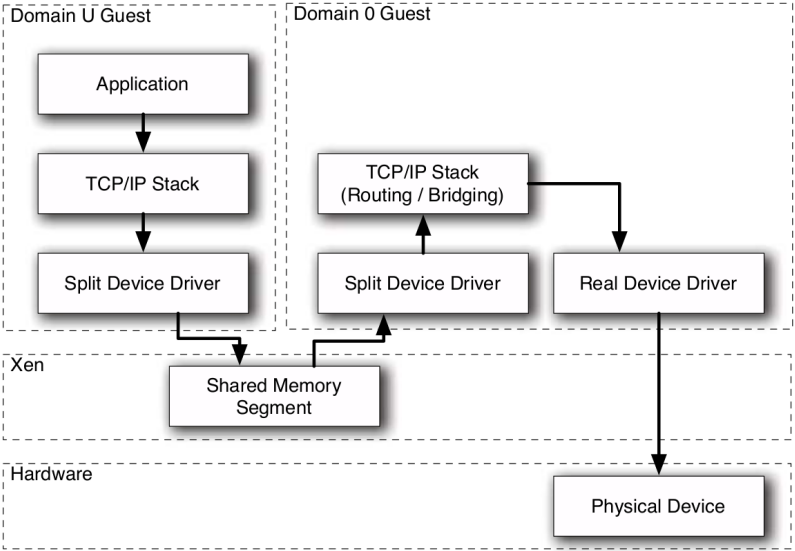
Plan

- Paravirtualized Networking
  - vif, bridge, bond
- Emulated Networking
- Environment:
  - xen: Oracle VM server 3.3.3 with xen-4.3.0-55.el6.47.33.x86_64
  - dom0: Unbreakable Enterprise Kernel v4.1.12-89
  - domU: Unbreakable Enterprise Kernel v4.1.12-89
- Prerequisite Knowledge: http://finallyjustice.github.io/xen-arch.pdf
  - xen framework
  - PVM vs. HVM vs. PVHVM
  - event channel, grant table
  - xen admin hands-on experience (preferred)

Paravirtual xen-netfront/xen-netback framework



xen-netfront/xen-netback source code

Unbreakable Enterprise Kernel v4.1.12-89

- drivers/net/xen-netfront.c
- drivers/net/xen-netback/xenbus.c
- drivers/net/xen-netback/netback.c
- drivers/net/xen-netback/interface.c

kernel upstream v4.9-rc8

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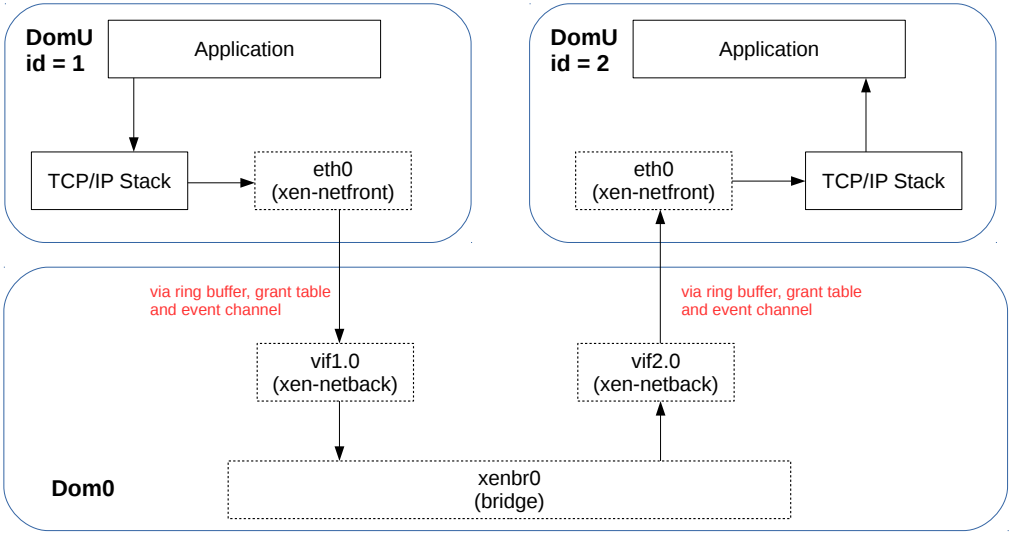
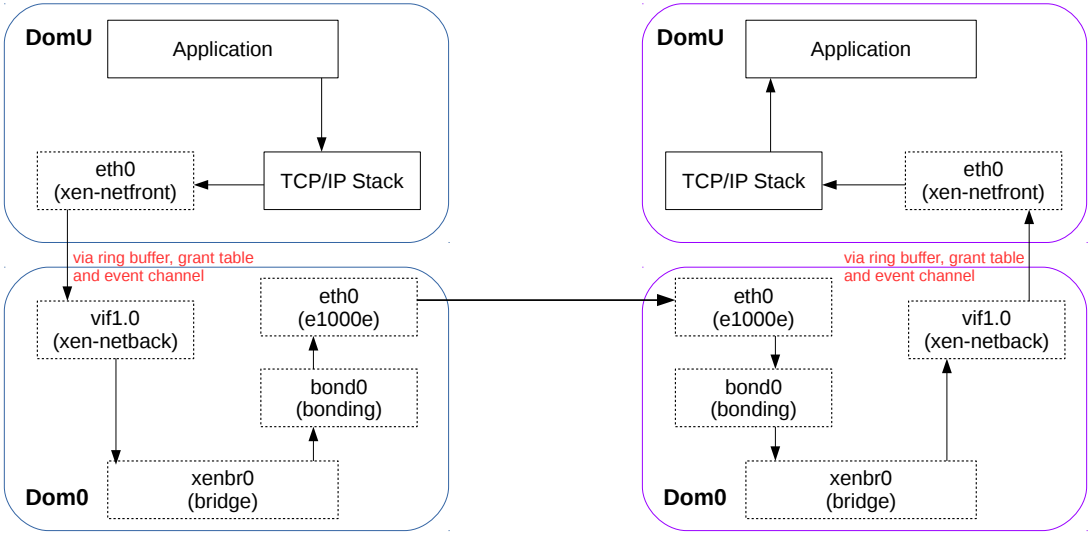
- drivers/net/xen-netback/rx.c
- drivers/net/xen-netback/hash.c

Paravirtual networking scenario 1/2



Paravirtual networking scenario 2/2



PV driver vs. PCI driver

	PCI driver	PV driver
device abstraction	pci_device, pci_driver	
device discovery	PCI Tree	
device configuration	PCI Config Space (IO/MMIO)	
data flow	DMA Ring Buffer	
shared memory	N/A or IOMMU	
interrupt	IOAPIC, MSI, MSI-X	

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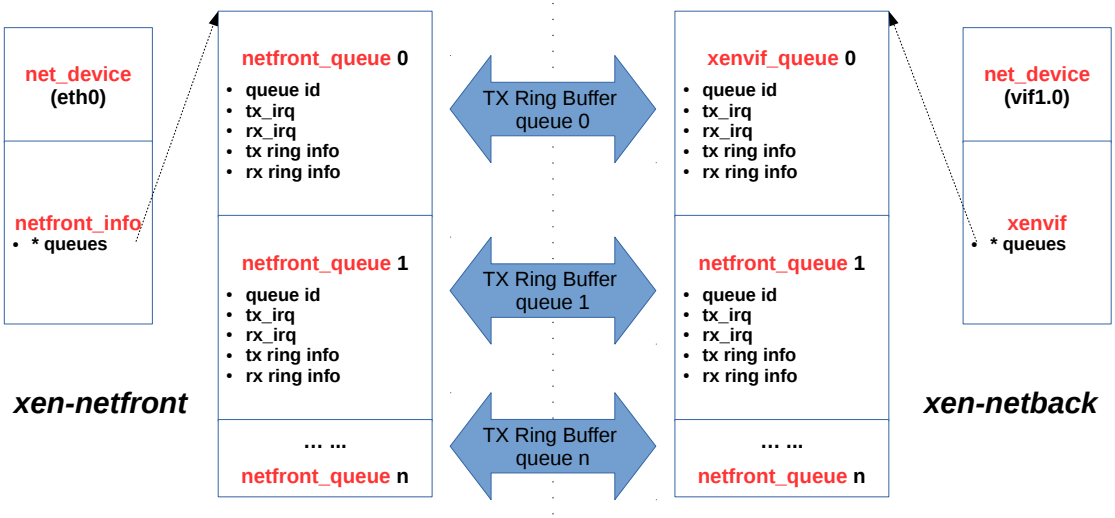
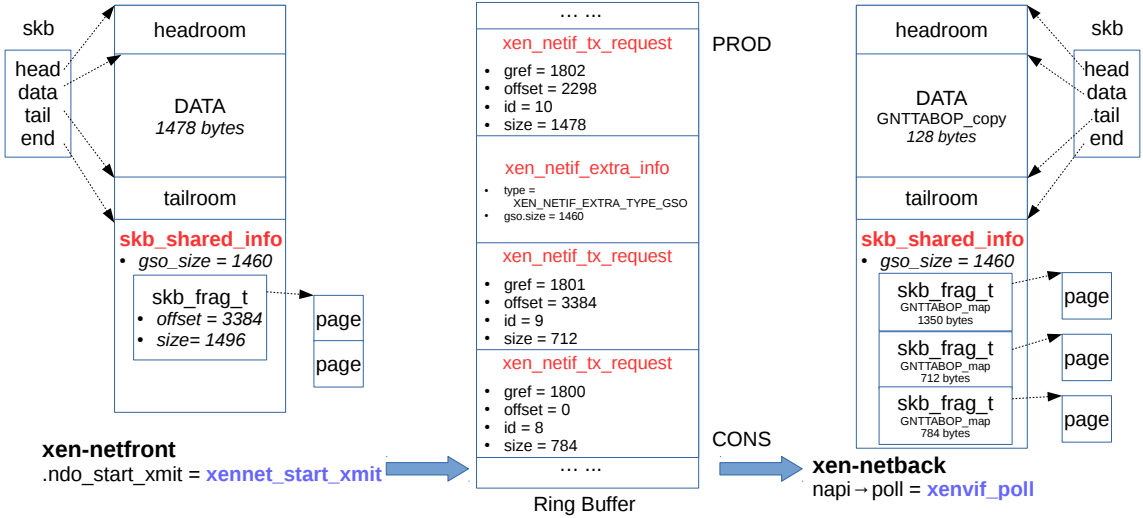
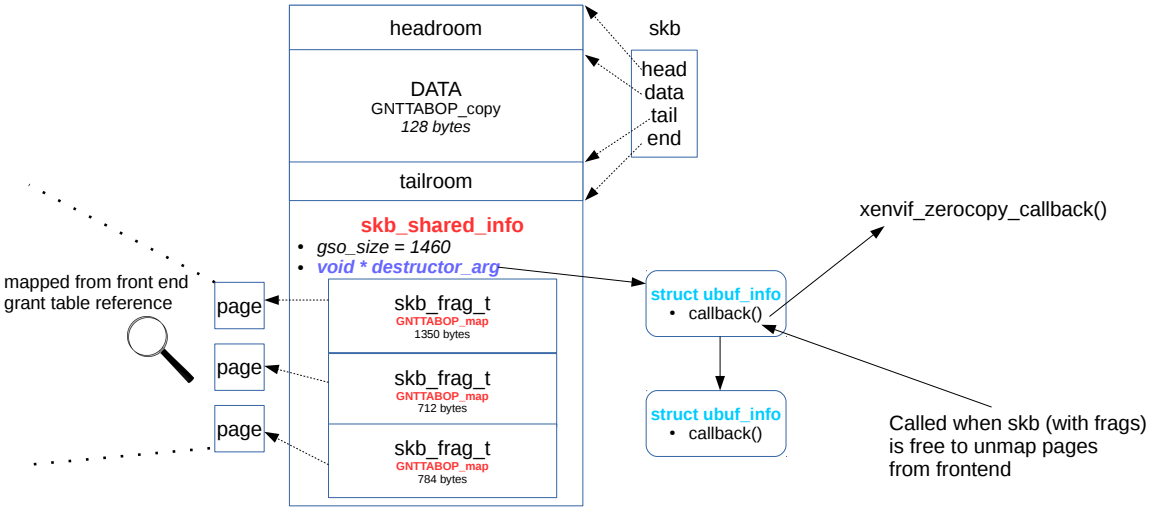
pv xmit: front —> backend 1/3



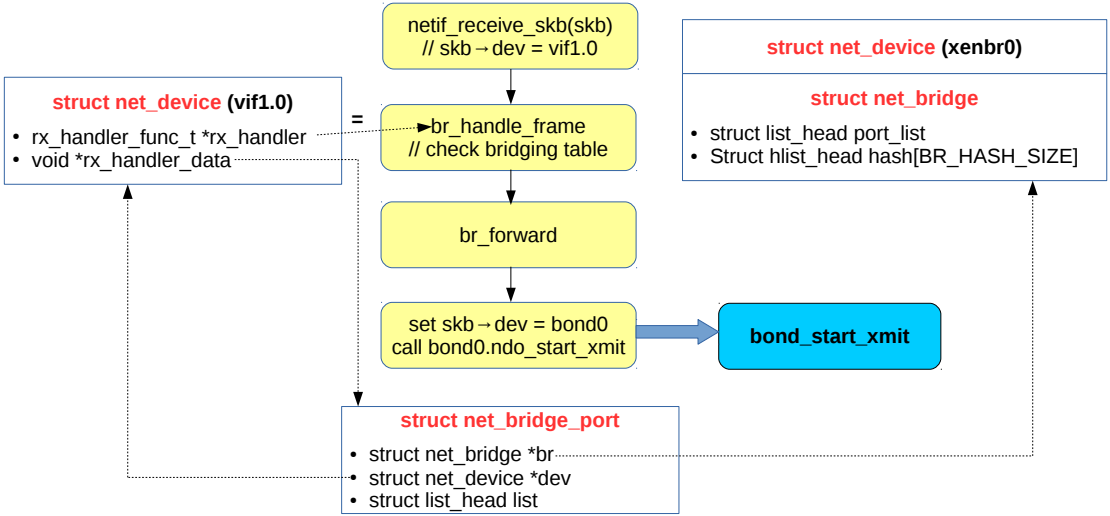
pv xmit: front —> backend 2/3



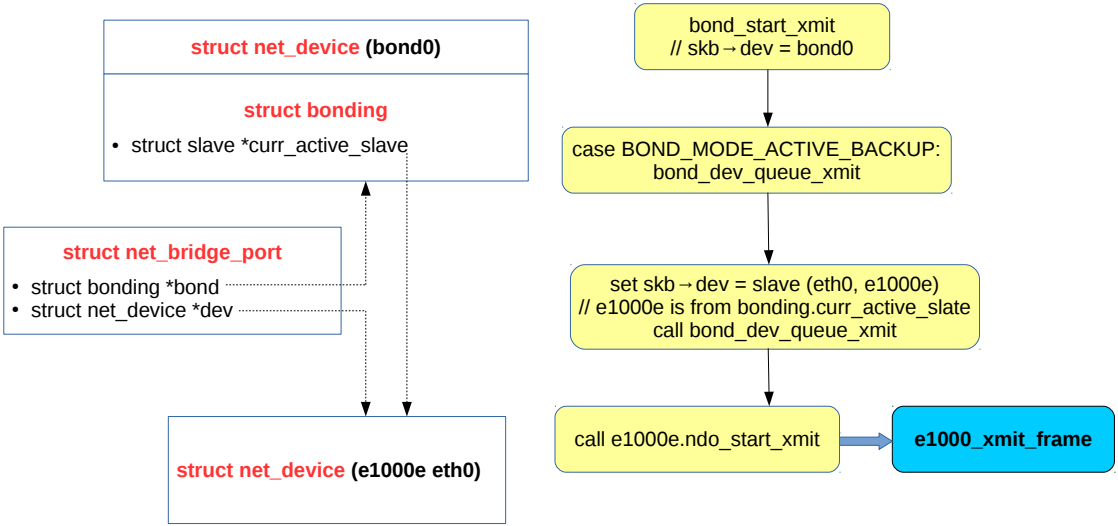
pv xmit: front —> backend 3/3



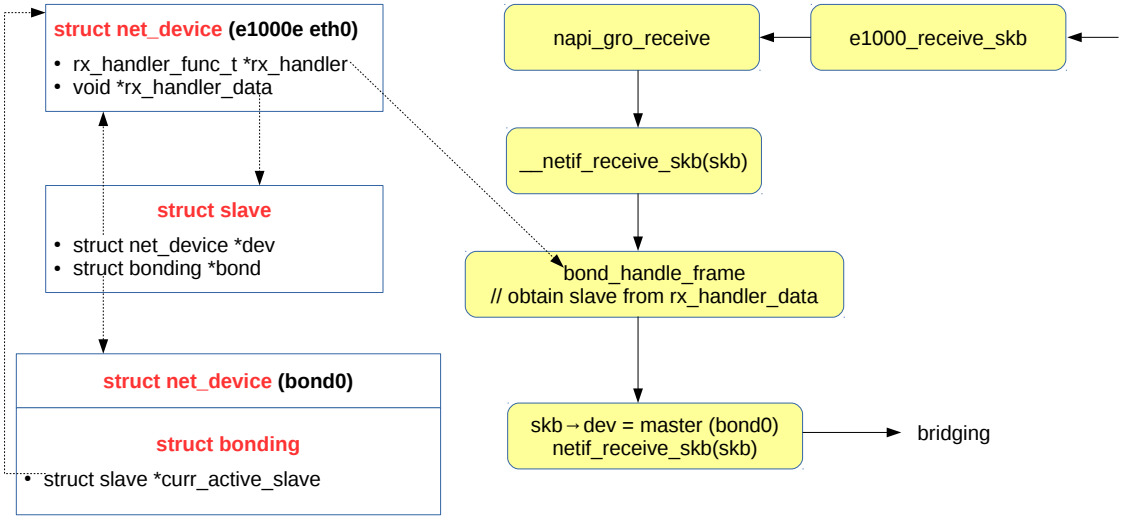
pv xmit: backend —> bridge



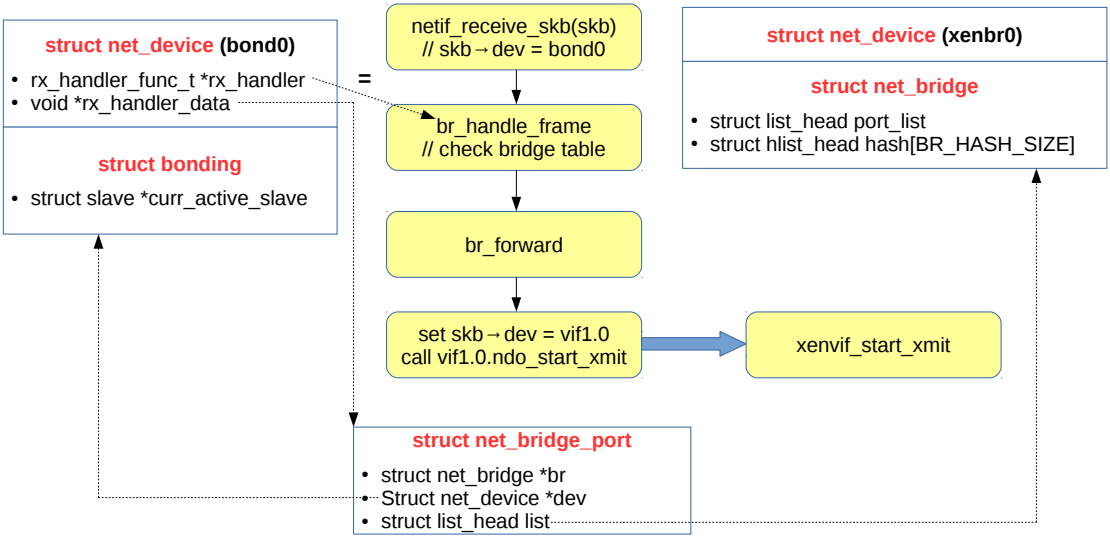
pv xmit: bridge —> bond —> physical NIC



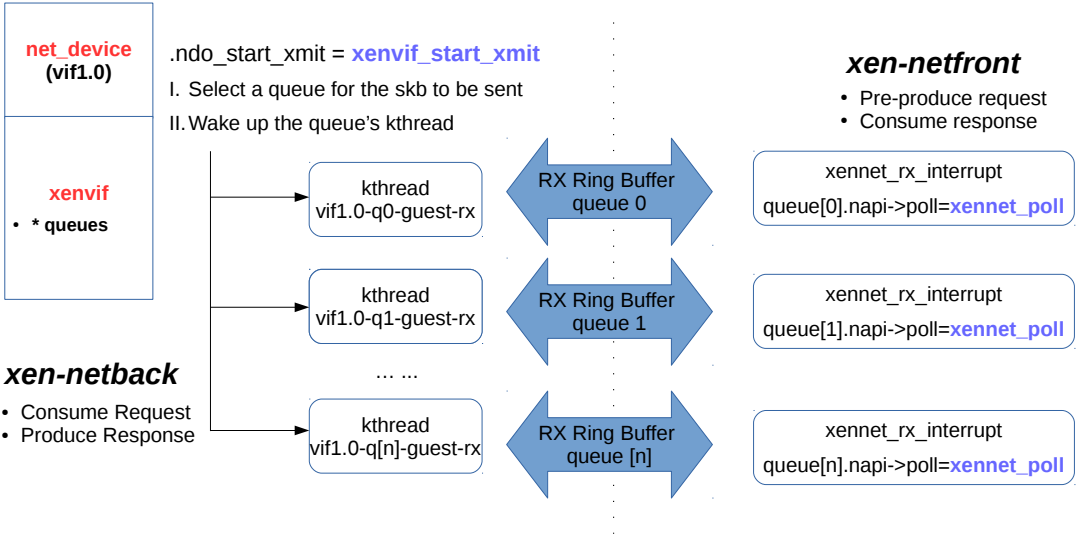
pv recv: physical NIC —> bond —> bridge



pv recv: bridge —> backend



pv recv: backend —> frontend



xen-netfront/xen-netback summary: req/rsp protocol

netfront to netback (produce req)

1. 1st page of linear data (skb->data)
2. extra info (xen_netif_extra_info)
3. the rest of linear data (skb->data)
4. all skb fragments (skb_shinfo(skb)->frags)

netback to netfront (produce rsq)

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2. extra info (xen_netif_extra_info)
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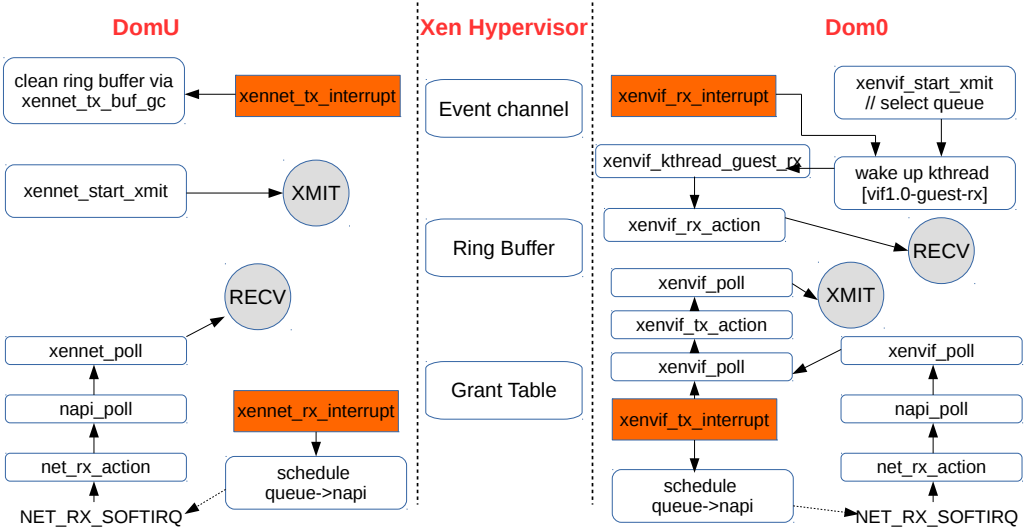
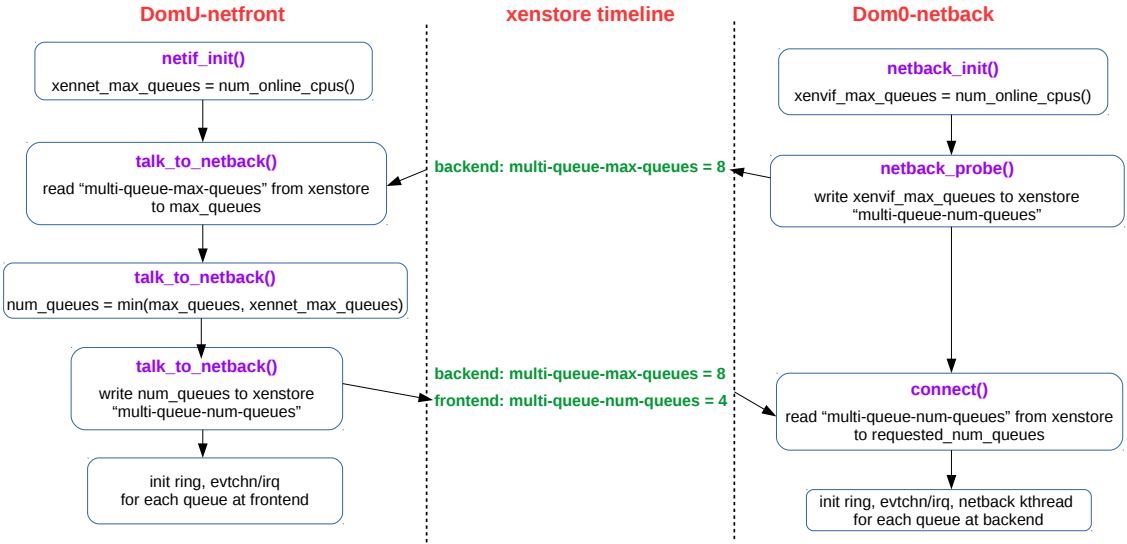
xen-netfront/xen-netback summary: irq and napi



features: multiqueue (default)



features: gso/tso offload

- Segmentation Offload
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- TSO info is shared via "struct xen_netif_extra_info gso" in ring buffer
  - gso.gso->u.gso.size = skb_shinfo(skb)->gso_size;
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- TSO and other offload features are stored in xenstore (e.g., feature-gso-tcpv4)
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  - .ndo_fix_features = xennet_fix_features
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- checksum offload
  - XEN_NETTXF_csum_blank: Protocol checksum field is blank in the packet (hardware offload)
  - XEN_NETTXF_data_validated: Packet data has been validated against protocol checksum

features: multicast

DomU

Please support multicast

xenstore

request-multicast-control = 1

I will support multicast

Dom0

XEN_NETIF_EXTRA_TYPE_MCAST_ADD

XEN_NETIF_EXTRA_TYPE_MCAST_DEL

xen_netif_extra_info

struct list_head fe_mcast_addr

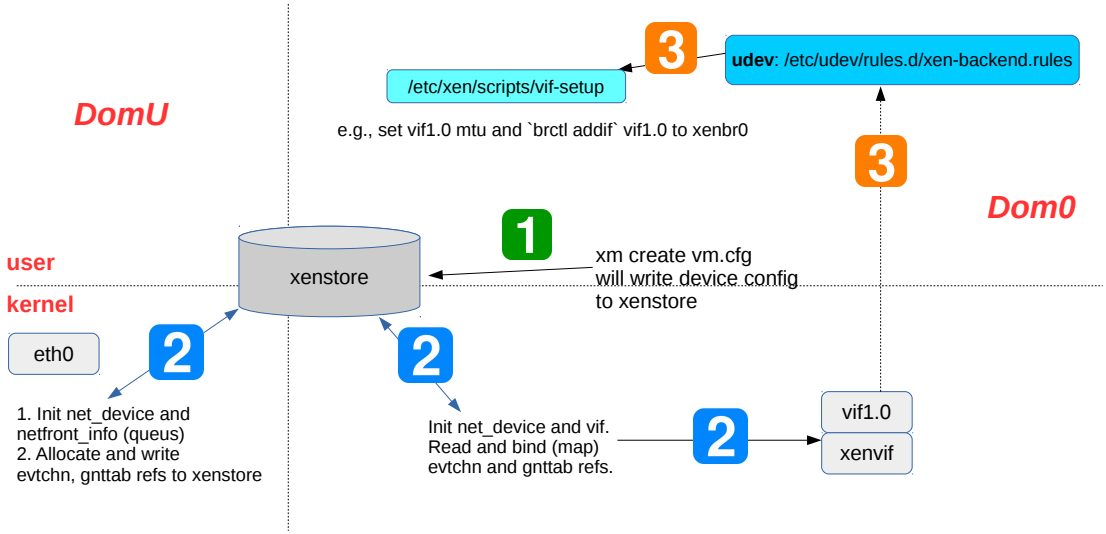
check registered multicast address
and drop if not registered

```
if (!xenvif_mcast_match(vif, eth->h_dest))
    goto drop;
```

xenvif_start_xmit()

SKB

xen-netfront/xen-netback init



performance tuning

- netfront/netback multiqueue
- Limit dom0 CPUs to first NUMA socket
- Interrupt affinity to reduce CPU 0 workload
- VCPU affinity to improve memory access performance
- Jumbo frame
- NIC offload
- TCP Parameter Settings

interesting works related to paravirtual I/O

- Achieving 10 Gb/s Using Safe and Transparent Network Interface Virtualization. VEE 2009
- Efficient and Scalable Paravirtual I/O System. USENIX ATC 2013
- A Comprehensive Implementation and Evaluation of Direct Interrupt Delivery. VEE 2015
- vRIO: Paravirtual remote I/O. ASPLOS 2016
- Hash, don't cache (the page table). SIGMETRICS 2016

Take-Home Message

- Xen paravirtual networking workflow

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