Performance Evaluation of Open Virtual Routers

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Outline

- Network Virtualization
- PC based Virtual Routers
- Challenges
- Virtual Router Design
- Performance Evaluation
- Conclusion

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Network Virtualization

- A solution to provide network researchers to run experiments on a shared substrate network
- Network virtualization means to virtualize all network components (Hosts, Links and Routers)
- A major challenge is to virtualize the actual network elements, Switches and Routers

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Open Virtual Routers

- Commodity hardware, Open source softwares
- Run multiple independent virtual instances in parallel on the same hardware
- A virtualization technology enforces resource limiting among virtual routers
- Each virtual router maintains its own set of virtual network interfaces, protocols, routing tables, packet filtering rules (i.e. separate data and control planes)

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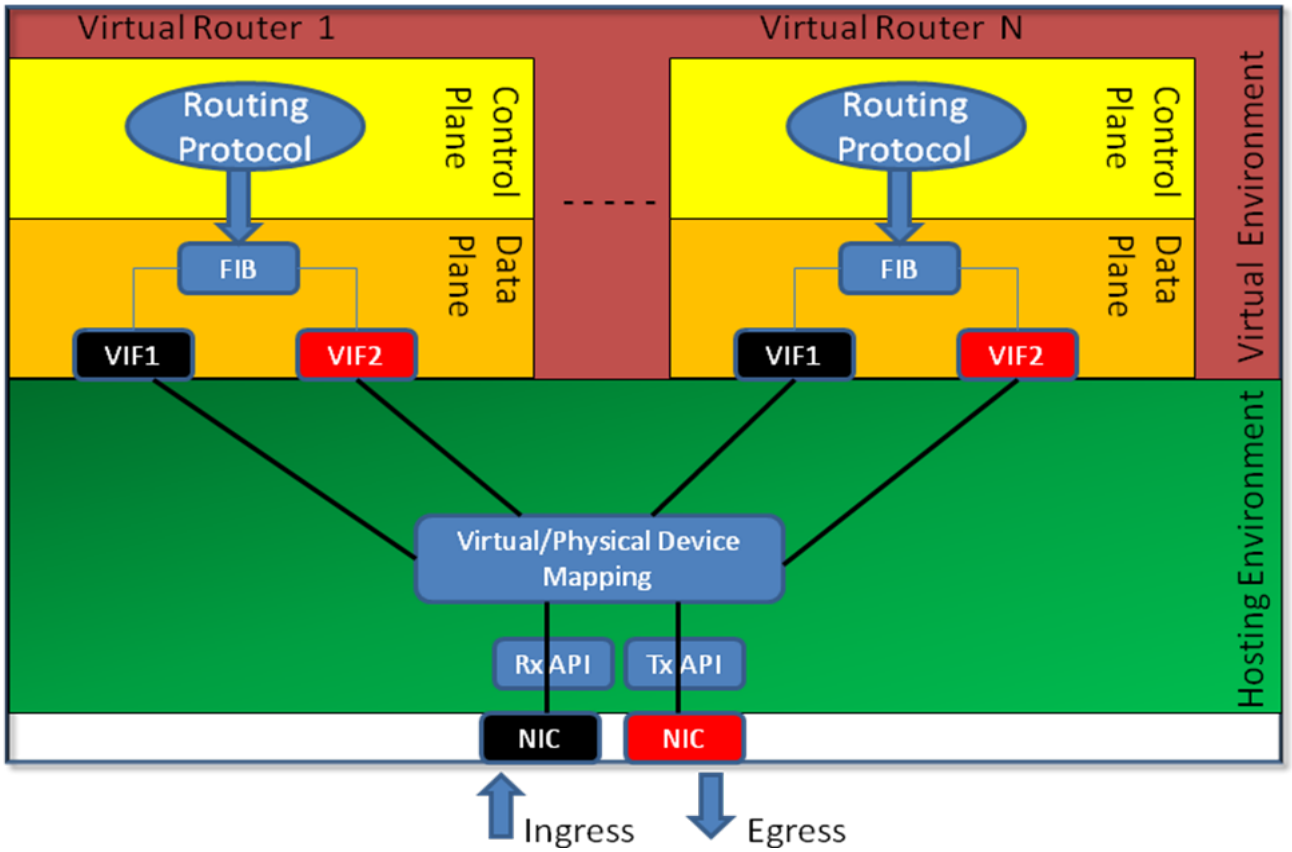
Challenge

- Router virtualization is associate with performance penalties
- Virtualization overhead is introduced in terms of how packets are processed in the router
- How to combine software modules to form an open virtual router with minimum virtualization penalty

Linux Virtual Routers



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Virtualization Technologies

- Hypervisor: It runs on top of the physical hardware and it virtualizes hardware resources to be shard among multiple guest operating systems

  E.g. VMware, Xen

- Container: The operating system resources are virtualized (e.g. files, system libraries) to create multiple isolated execution environment on top of a single operating system.

  E.g. OpenVZ, Linux Namespaces

OpenVZ based Virtual Routers

- Virtual devices

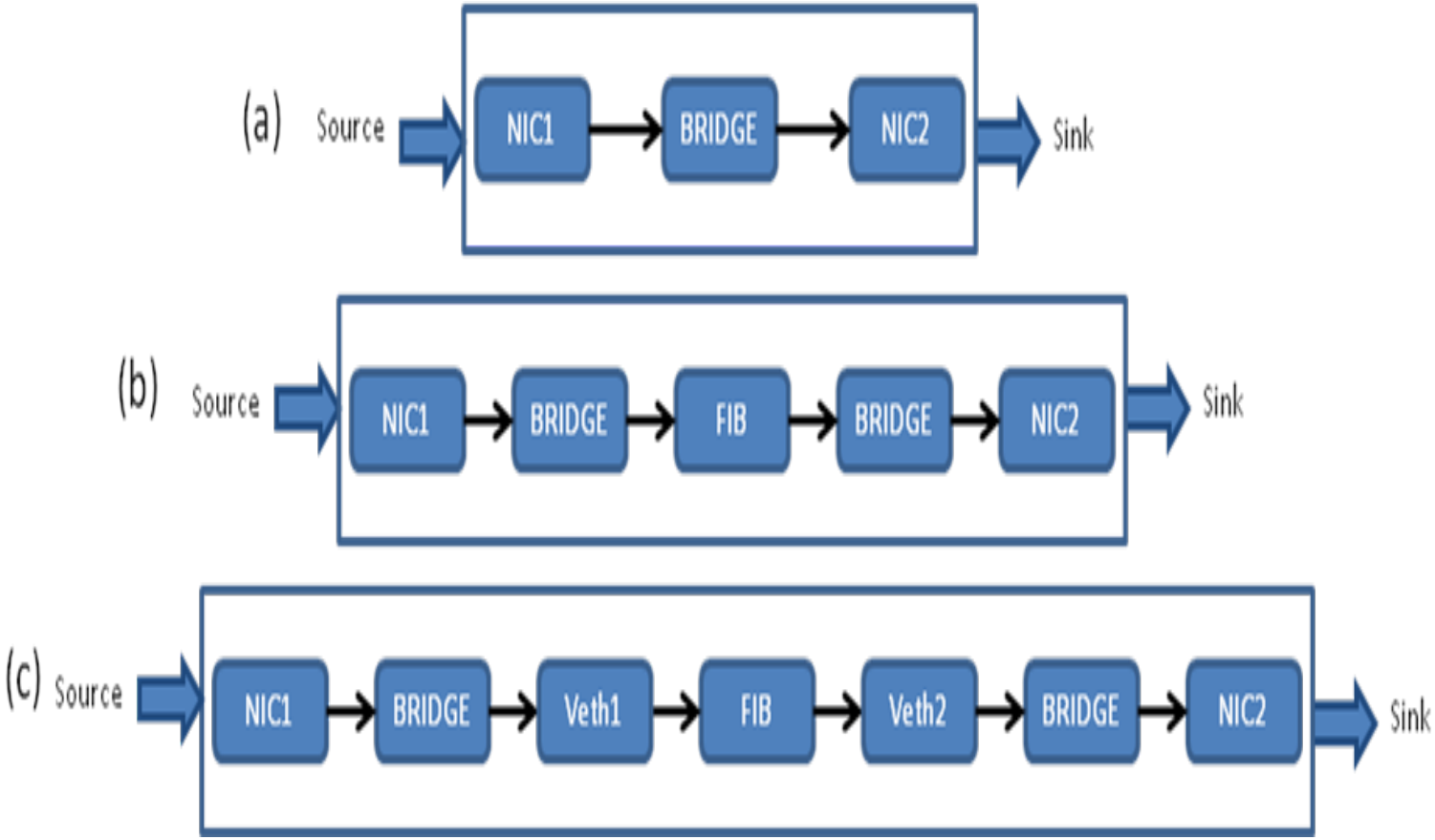
  Virtual Network Device (venet): Operates at layer 3. An IP address is local and unknown from external networks

  Virtual Ethernet Device(veth): Ethernet-like device operating at layer 2 with its own MAC address

- Physical/virtual device mapping

  Linux software bridge, IP forwarding, Virtual switch etc.

Building a Virtual Router: 3 step process



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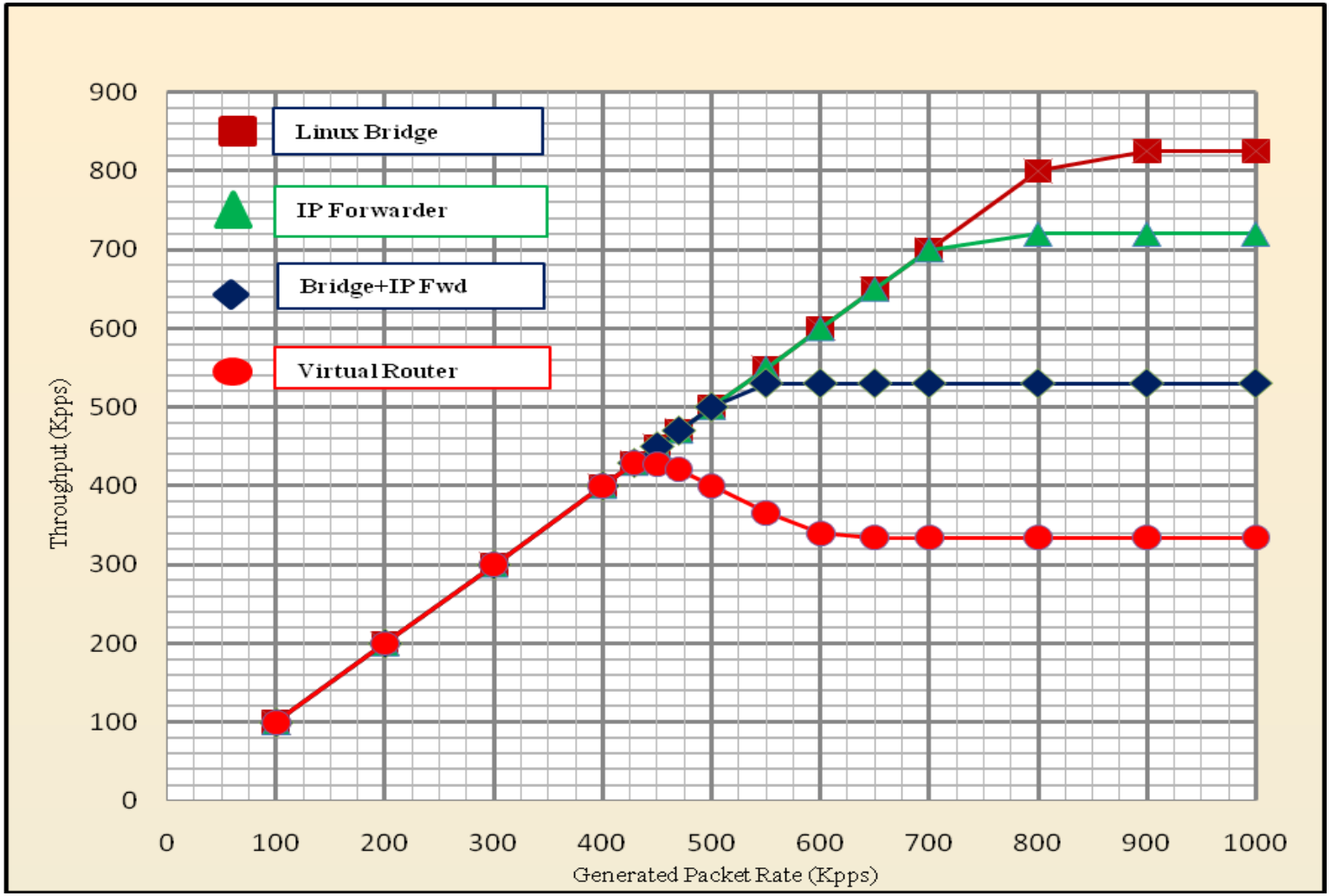
Impact of adding virtual components



IP Forwarder vs. Virtual Router

- IP Forwarder

  Throughput: 720kpps

  Packet drop: Ingress physical interface, CPU saturation observed at the offered load of 720kpps

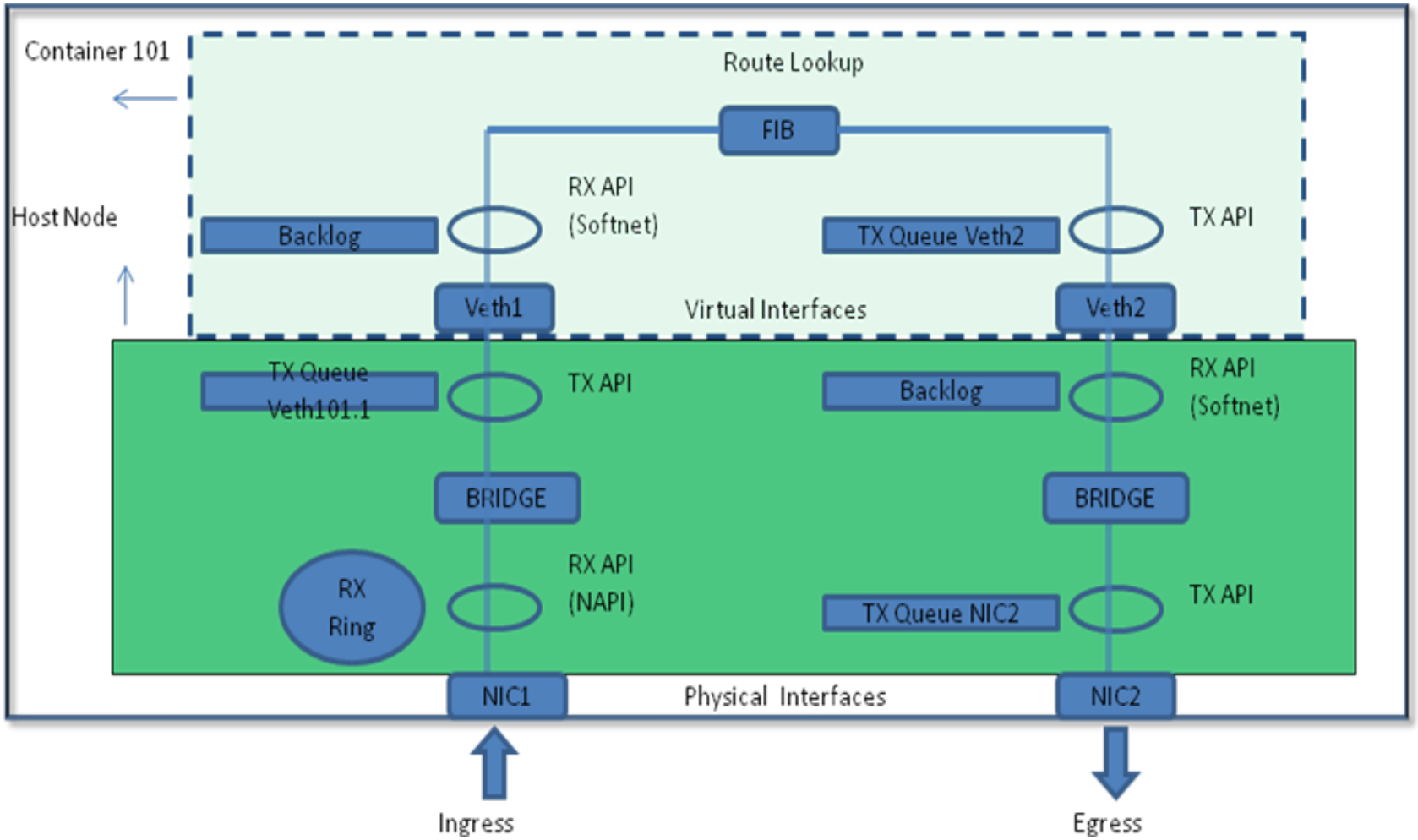
- Virtual Router

  Throughput: 334kpps

  Packet drop: Backlog queue congestion occurred at the offered load of 429kpps

  Ingress physical interface, CPU saturation observed at the offered load of 650kkp

Virtual Router Design Internals



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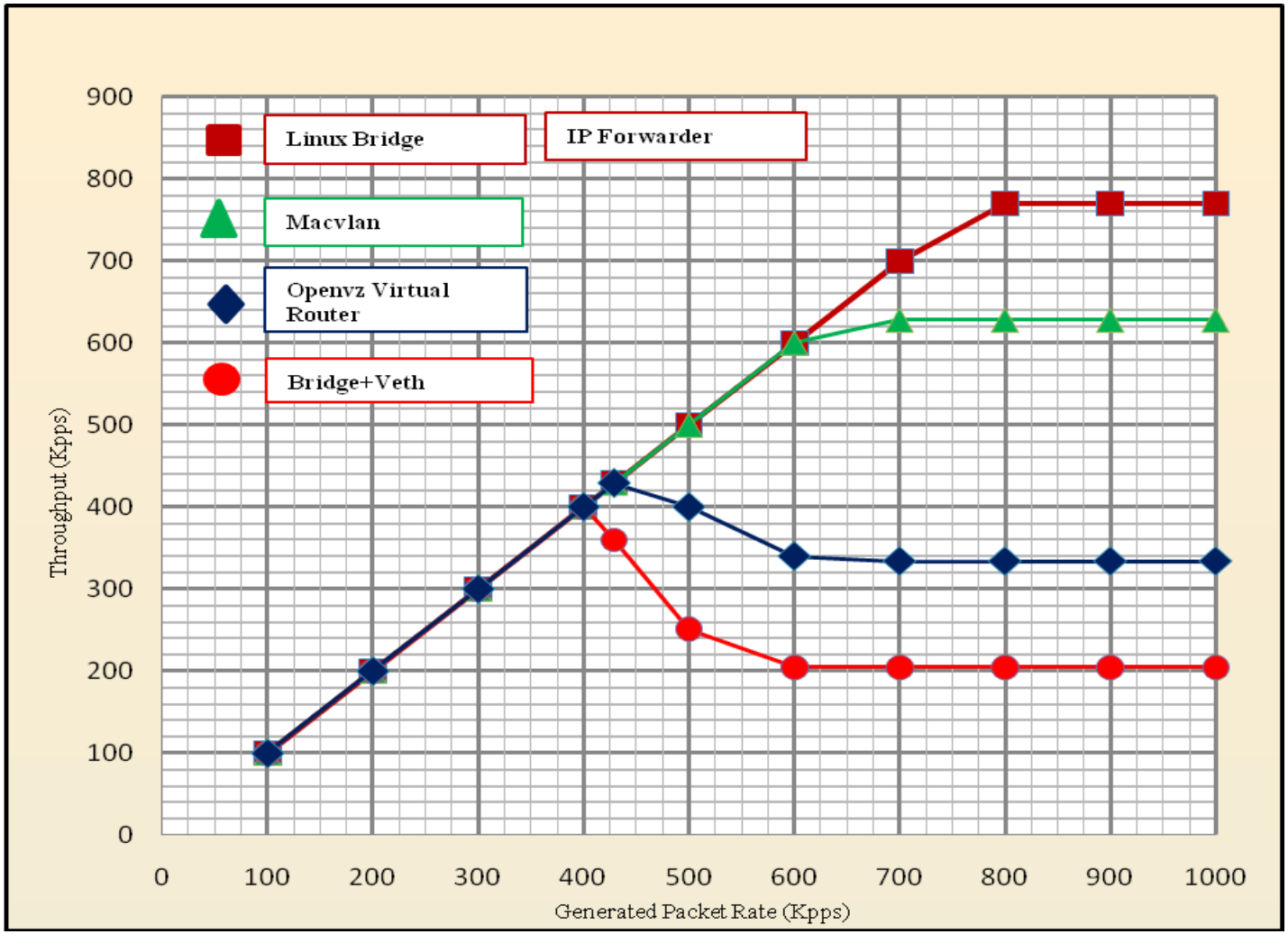
Virtual Router Design: An alternative approach

- Linux Namespaces, an emerging container based virtualization
- Macvlan, a virtual device provides a built in mechanism of physical/virtual device mapping
- Both bridge and veth are replaced with macvlan device

OpenVZ vs. Namespace Virtual Router



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Virtual devices CPU usage

Packet Rate (kpps)	CPU %age Usage			
	Kernel 2.6.27-openvz chistyakov			*Kernel 2.6.34 Net-Next*
	Linux Bridge	*Veth*	*Total*	*Macvlan*
200	9	1.5	10.5	2.3
429	11	1.9	12.9	3.5
450	16	1.9	17.9	3.6
600	17	2.2	19.2	4.6
650	18	2.3	20.3	5
800	18	2.3	20.3	5

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Conclusion and future work

- Apart form any virtualization technology, the way in which devices are mapped is important
- Linux bridge is a CPU intensive device (MAC learning, forwarding database updates etc)
- Macvlan is an attractive alternate
- It is important to know how virtual devices communicate with kernel
- Backlog is still there which may become performance bottleneck

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- Thanks for listening
- Questions ?