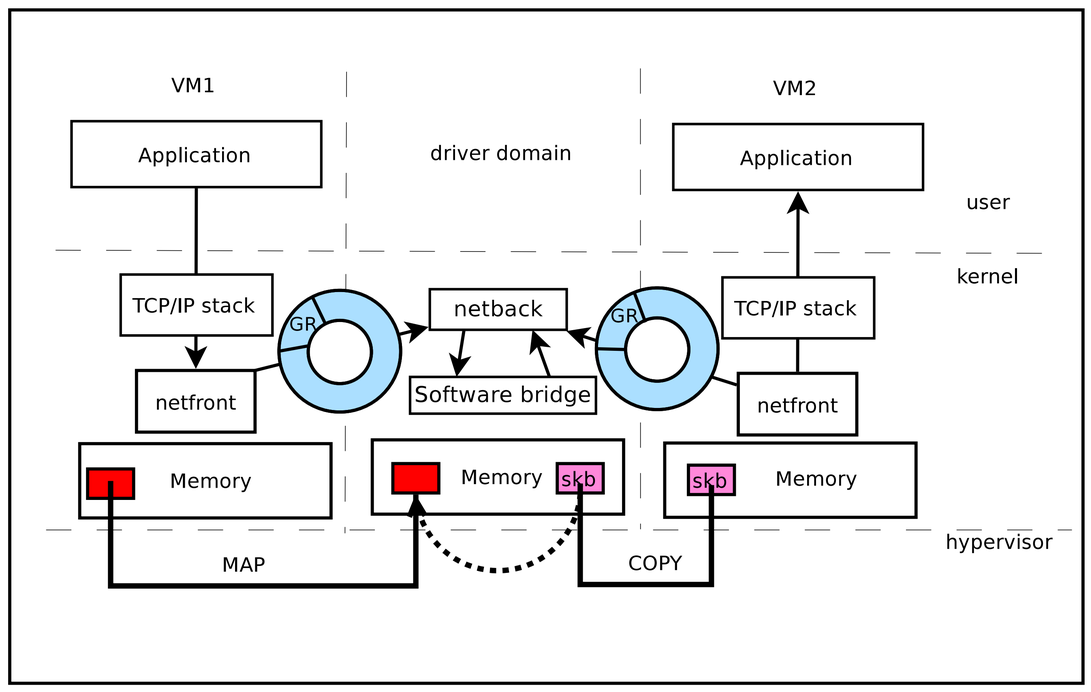
V4VSockets

Low overhead intra-node communication in Xen

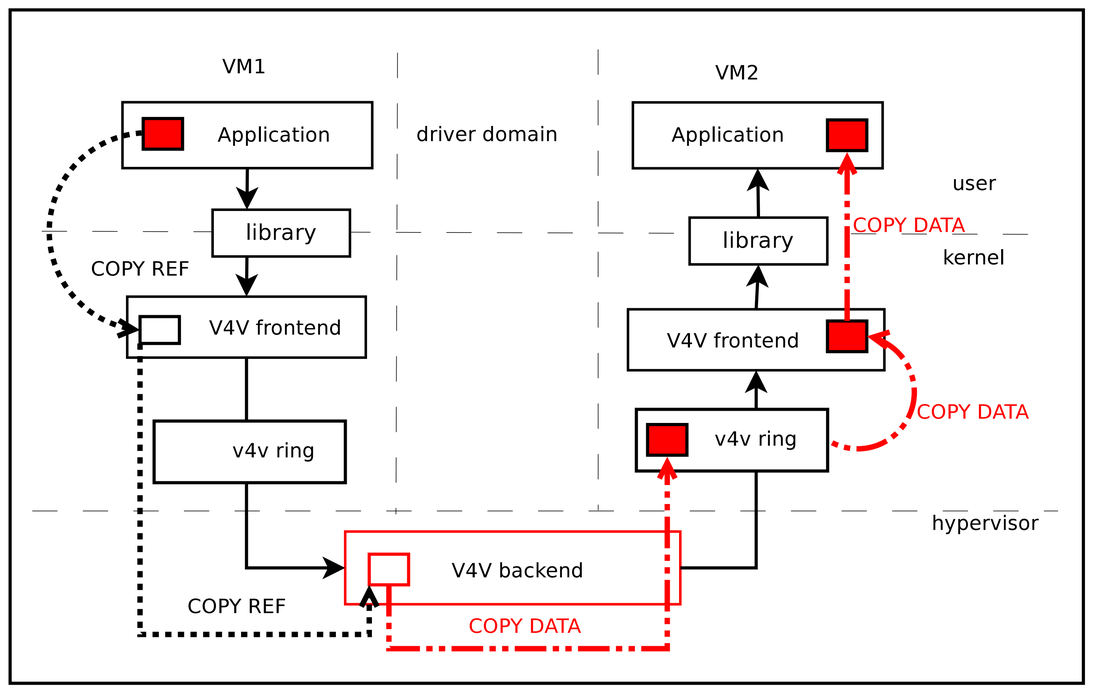
I/O Path in Xen (generic environment)



Intra-node communication suffers from severe overheads:

⇒ inefficient data paths
⇒ driver domain handles packet forwarding
⇒ unnecessary TCP/IP stack crossing and fragmentation

I/O Path in Xen with V4VSockets



V4VSockets is built as a full-stack protocol framework that supports p2p communication between VMs.

⇒ *Application layer*: the socket interface.
⇒ *Transport layer*: a VM kernel driver.
⇒ *Network/Link layer*: the hypervisor, providing encapsulation of upper-layer messages to V4V messages, and packet delivery.

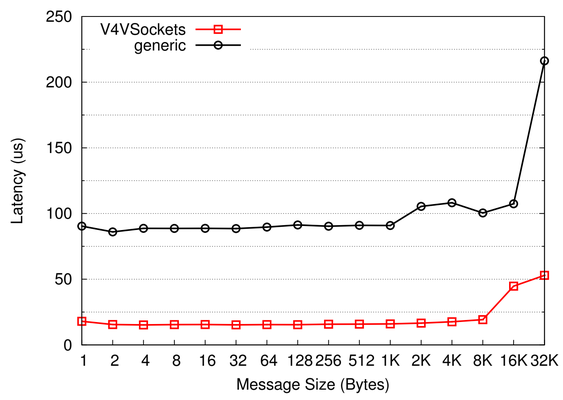
Key features

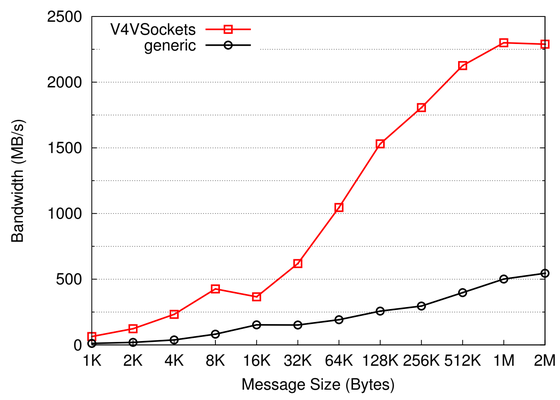
V4VSockets is an efficient, socket-compliant, high performance intra node communication framework for VMs.

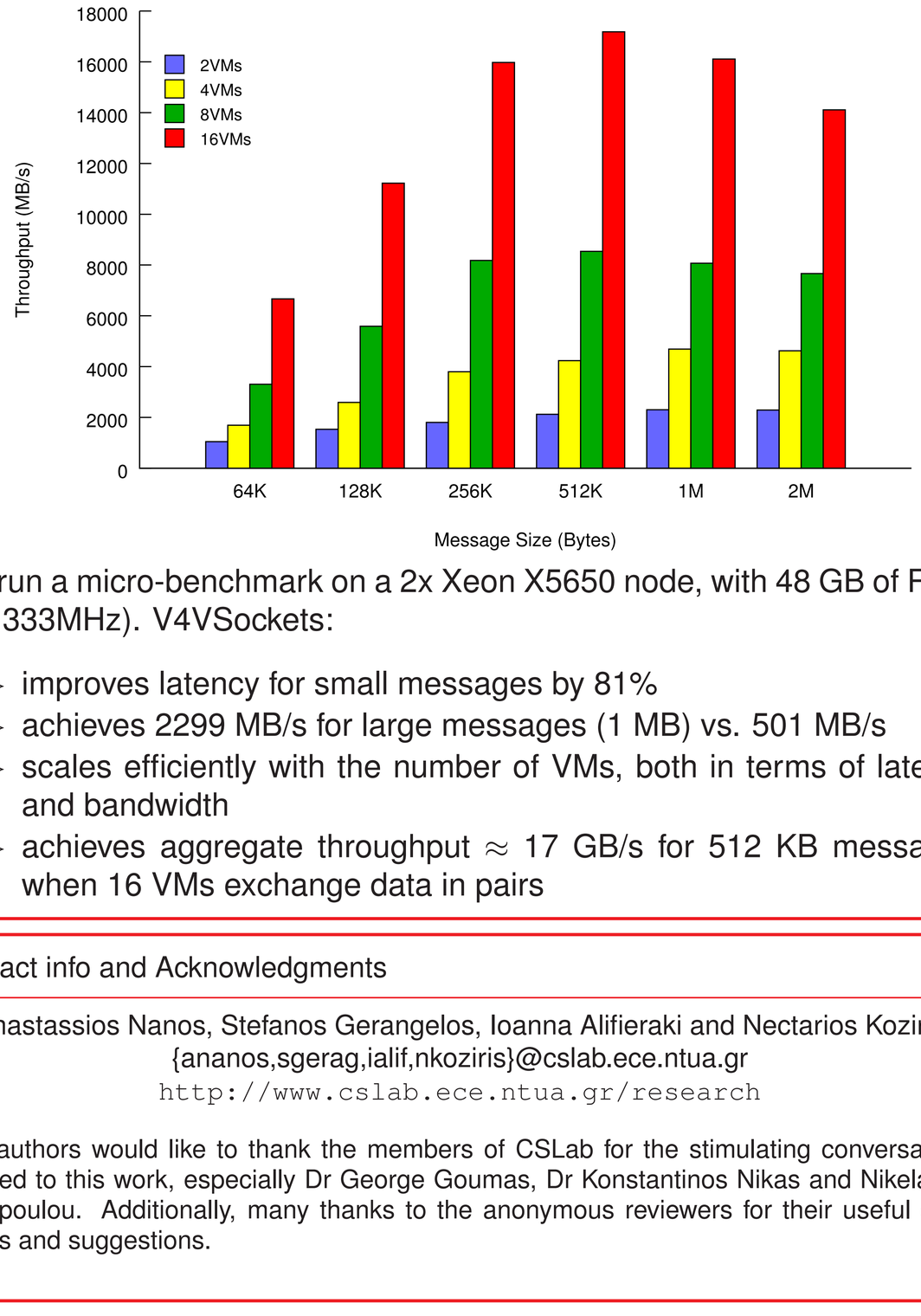
V4VSockets features:

⇒ *optimized data path* (data are copied from / to the VM kernel memory without the need to share pages between VMs)
⇒ *low-overhead* framework (no intermediary VM – driver domain – no scheduling implications are involved)
⇒ *secure* (no security implications – data cross the hypervisor and either get dropped or pushed forward using V4V semantics)
⇒ *ultra low latency* and *high bandwidth*
⇒ open-source, available @ `https://github.com/HPSI/v4v`

Ping-pong benchmark



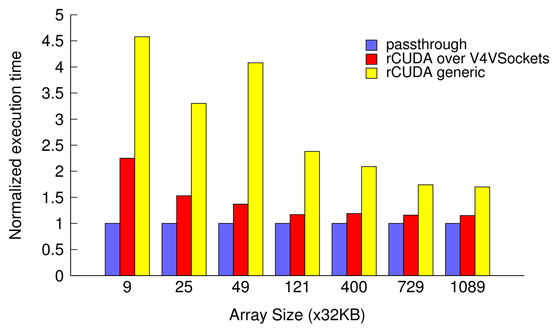


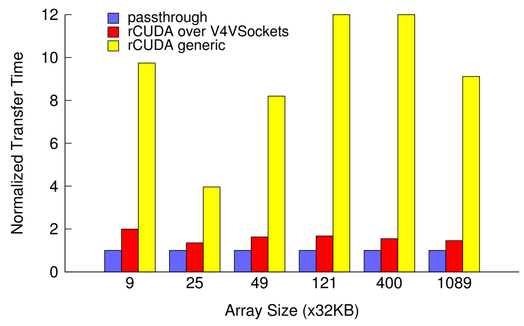


We run a micro-benchmark on a 2x Xeon X5650 node, with 48 GB of RAM (@1333MHz). V4VSockets:

⇒ improves latency for small messages by 81%
⇒ achieves 2299 MB/s for large messages (1 MB) vs. 501 MB/s
⇒ scales efficiently with the number of VMs, both in terms of latency and bandwidth
⇒ achieves aggregate throughput ≈ 17 GB/s for 512 KB messages when 16 VMs exchange data in pairs

GPU stencil performance through rCUDA





We run the matrix-matrix product benchmark: (a) natively via GPU passthrough, (b) via rCUDA over TCP sockets and (c) via rCUDA over V4VSockets. Steps include: (i) 2x input matrix copies, (ii) GPU product compute, (iii) 1x output matrix copy back. V4VSockets:

⇒ adds a minimum overhead of 15% (compared to native execution)
⇒ boosts transfer throughput by 7x (at best) compared to TCP/IP

Work in Progress

⇒ Strengthen our implementation towards a more user-friendly approach.
⇒ Thoroughly examine the CPU utilization overheads imposed by V4VSockets.
⇒ Polish the peer discovery framework to adaptively use V4VSockets over generic TCP sockets.
⇒ Perform an elaborate performance evaluation of the GPU sharing framework we have developed.

Contact info and Acknowledgments

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