Rekindling Network Protocol Innovation with User-Level Stacks

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https://github.com/cnplab/multistack

Motivation

- Extending layer 4 functionality could address a lot of problems
  - Increased performance
    - MPTCP, WindowScale, FastOpen, TLP, PRR
  - Ubiquitous encryption
    - TcpCrypt

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Is it really possible to deploy layer 4 extensions?

- Networks still accommodate TCP extensions
  - 86 % of the paths are usable for well-designed TCP extensions despite middleboxes

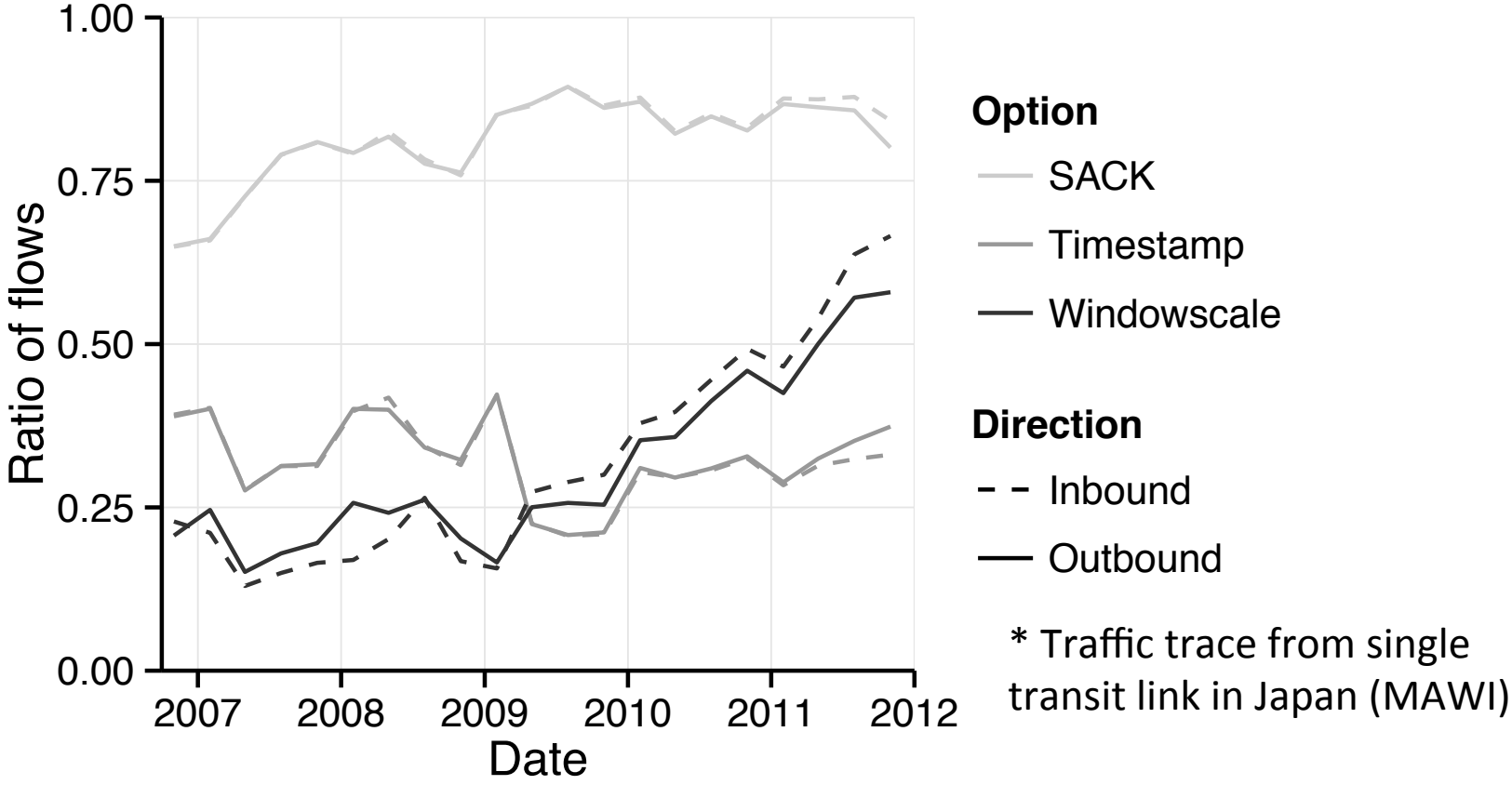
Protocol Stacks in End Systems: The Theory

- OSes implement stacks
  - High performance
  - Isolation between applications
  - Socket APIs
- New OS versions adopt new protocols/extensions

Extending Protocol Stacks: The Reality

- OSes' release cycle is slow
- Support in the newest OS version does not imply deployment
  - Stakeholders are reluctant to upgrade their OS
  - Often new features, even if available, must be explicitly enabled

How Long does Deployment Take?



- *Windows*: SACK is default since Windows 2000. WS and TS implemented in Windows 2000 but enabled as default since Windows Vista (2009)
- *Linux*: SACK/TS on by default since 1999, WS since 2004

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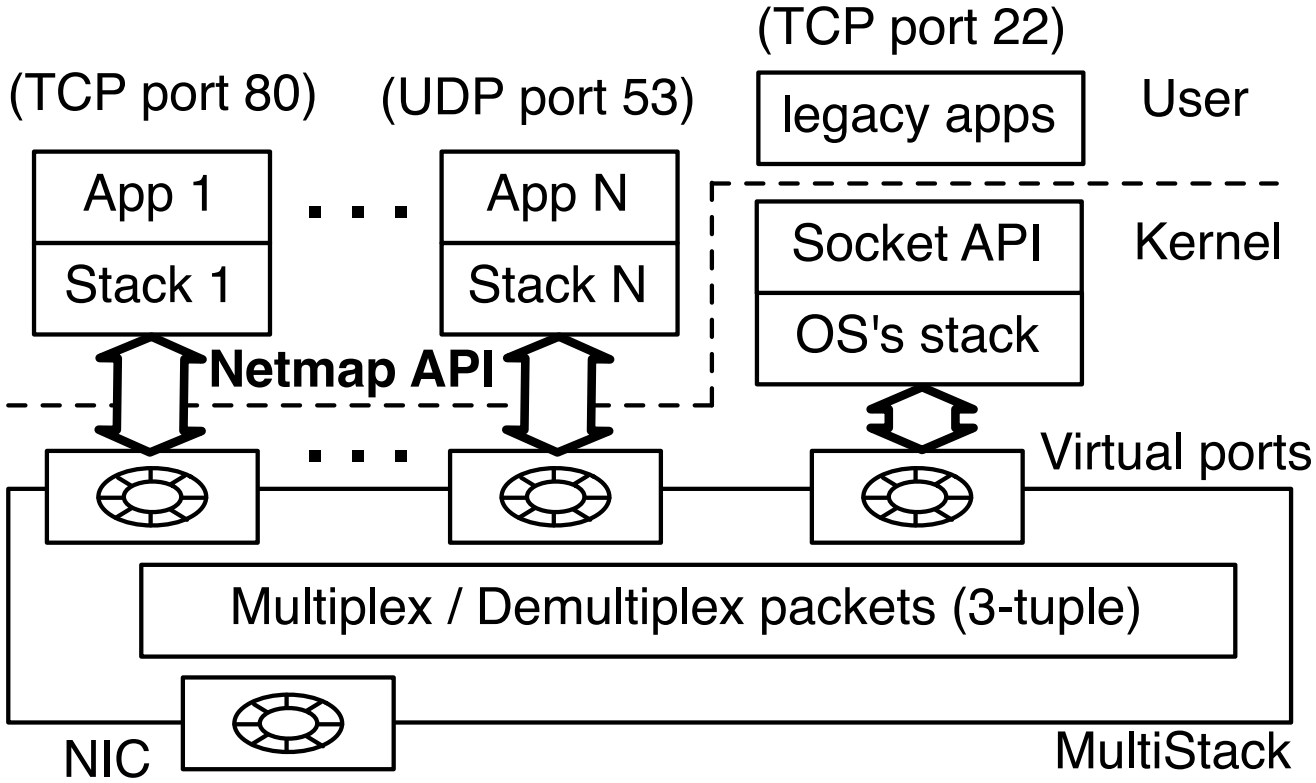
- **Problem: no practical way to do this, we need:**
  - Isolation between applications
  - Support for legacy applications and the OS's stack
  - High performance

MultiStack: Operating System Support for User-space Stacks



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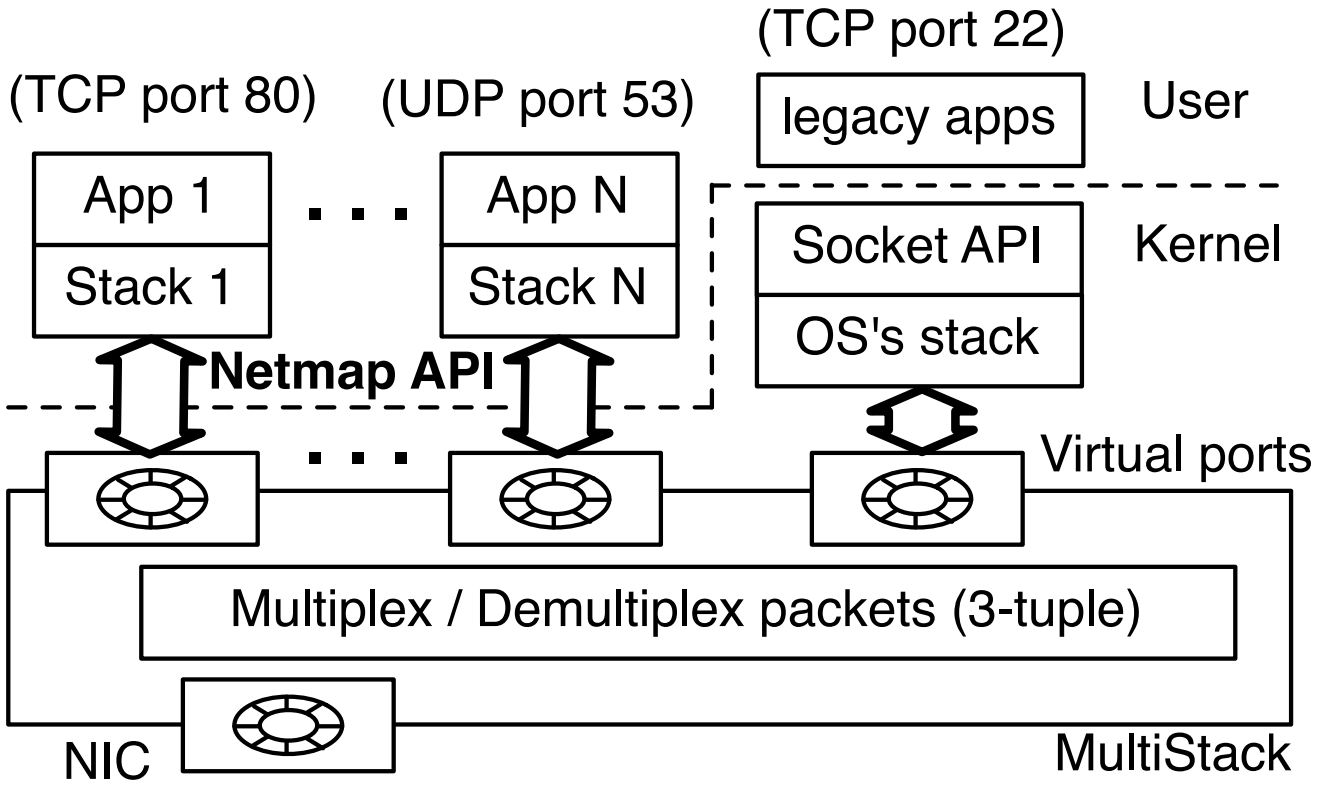
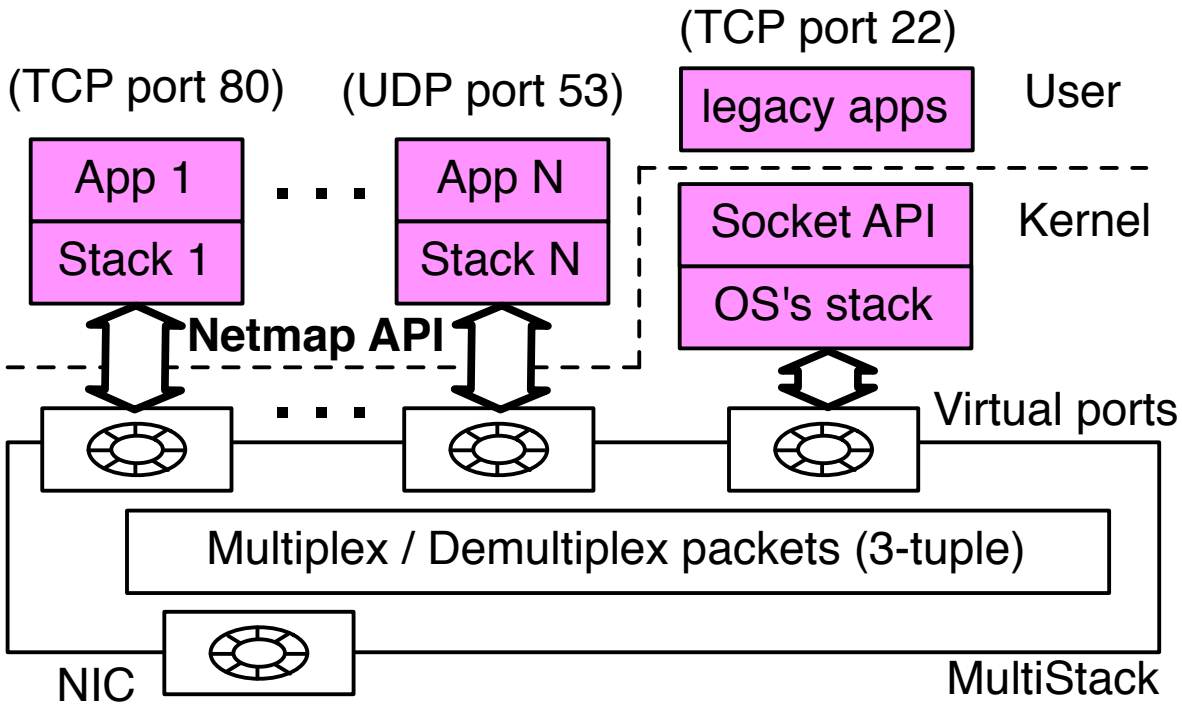


Apps/stacks **register** desired 3-tuple with the MultiStack kernel module

MultiStack: operating system support for user-space stacks



- Support for multiple stacks (including OS's stack)
- Namespace isolation based on traditional 3-tuple
- Very high performance
- Runs on FreeBSD and Linux (and it's open source!)

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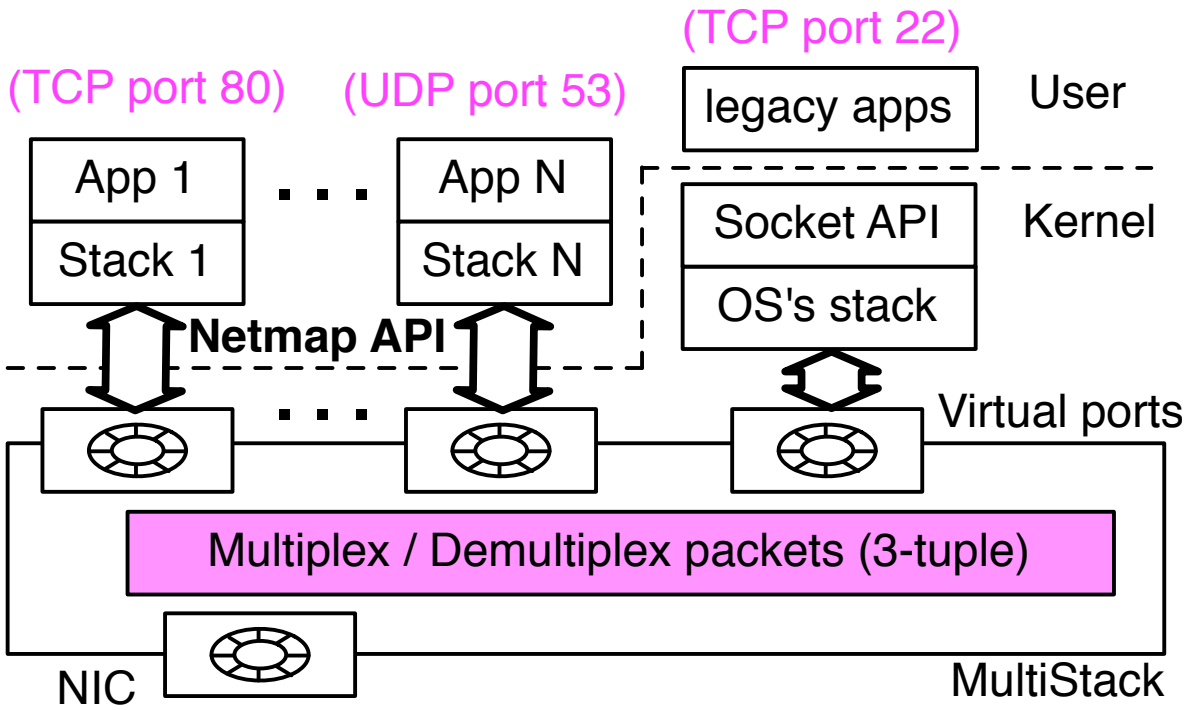

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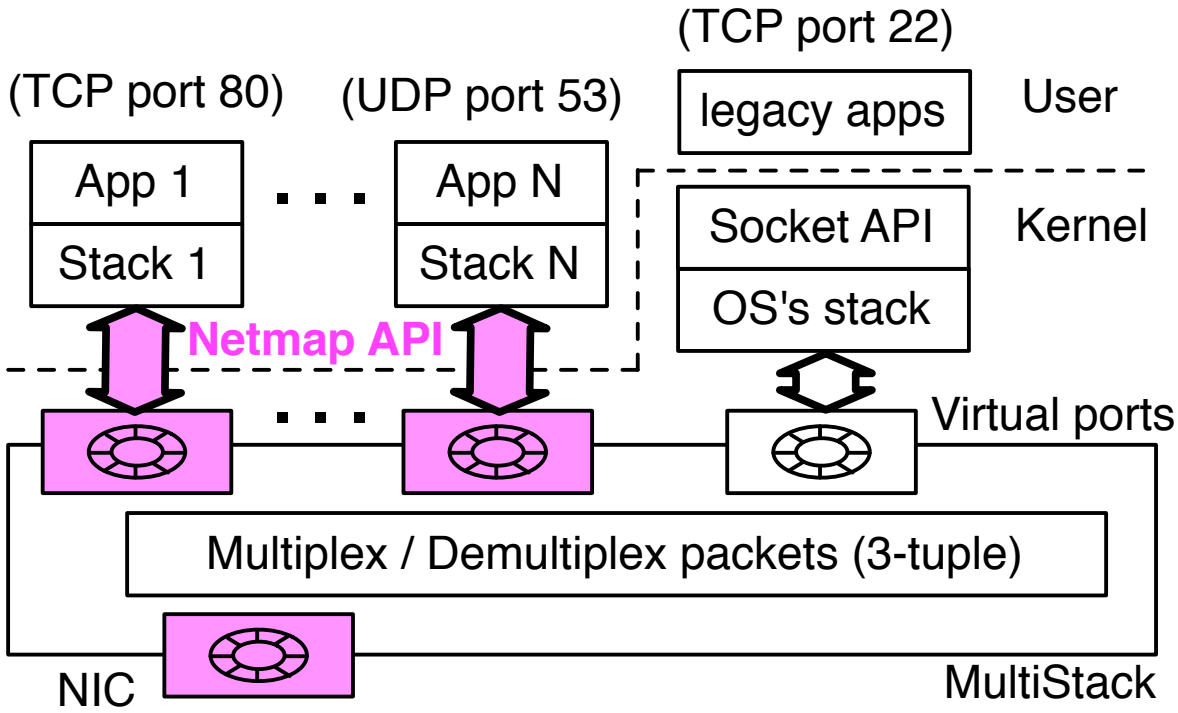

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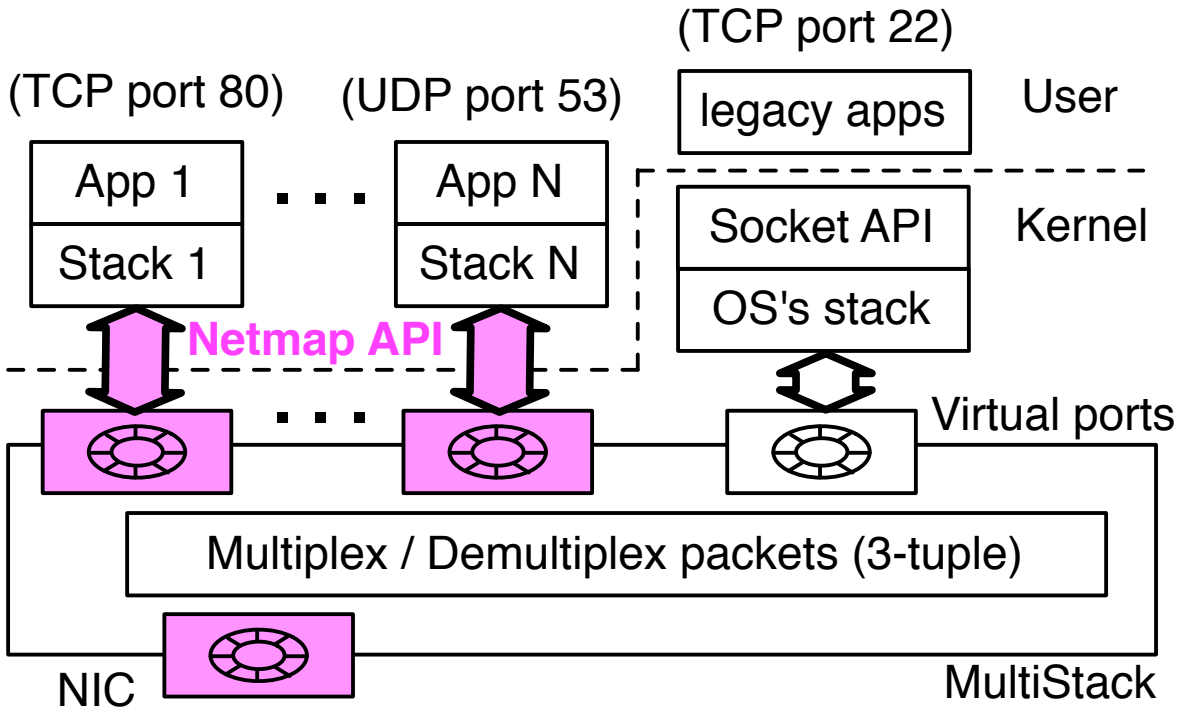

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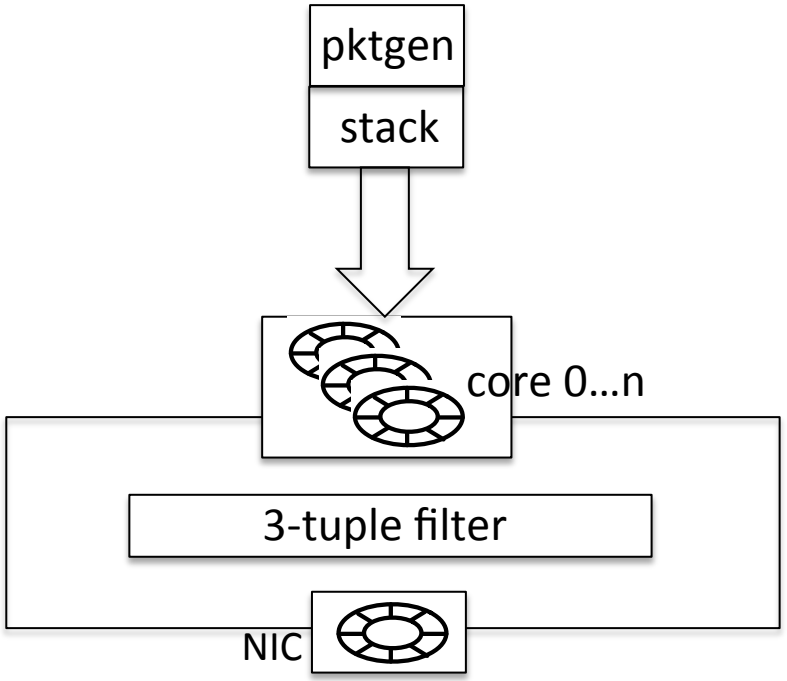

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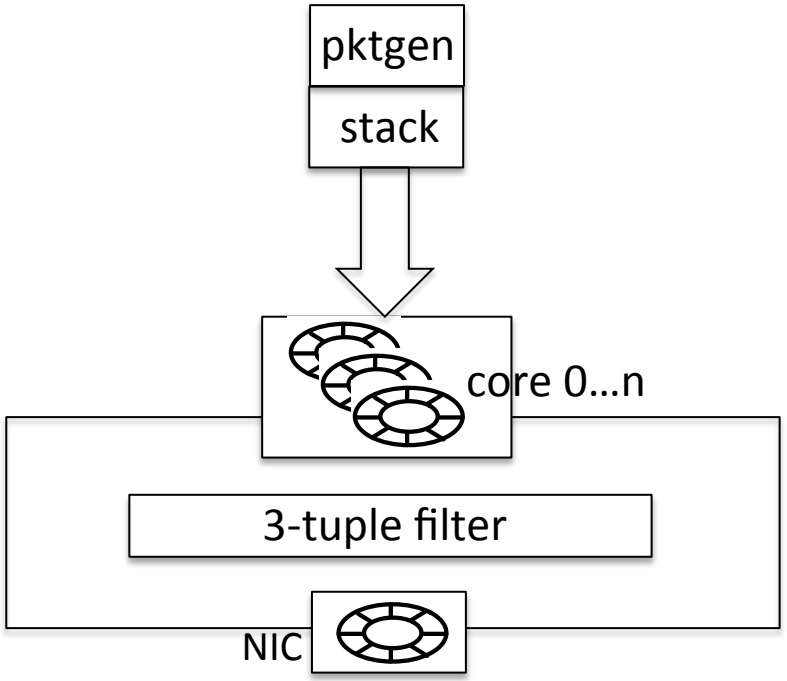

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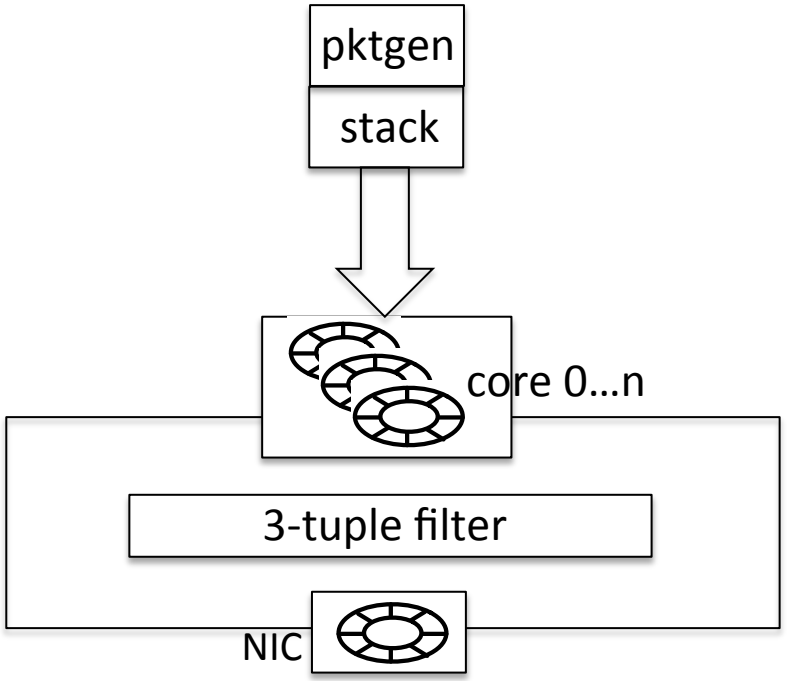

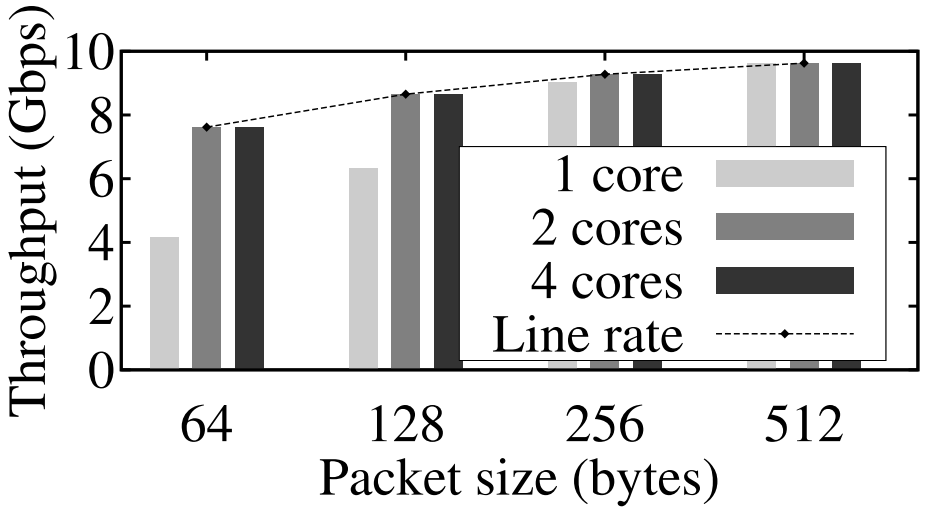

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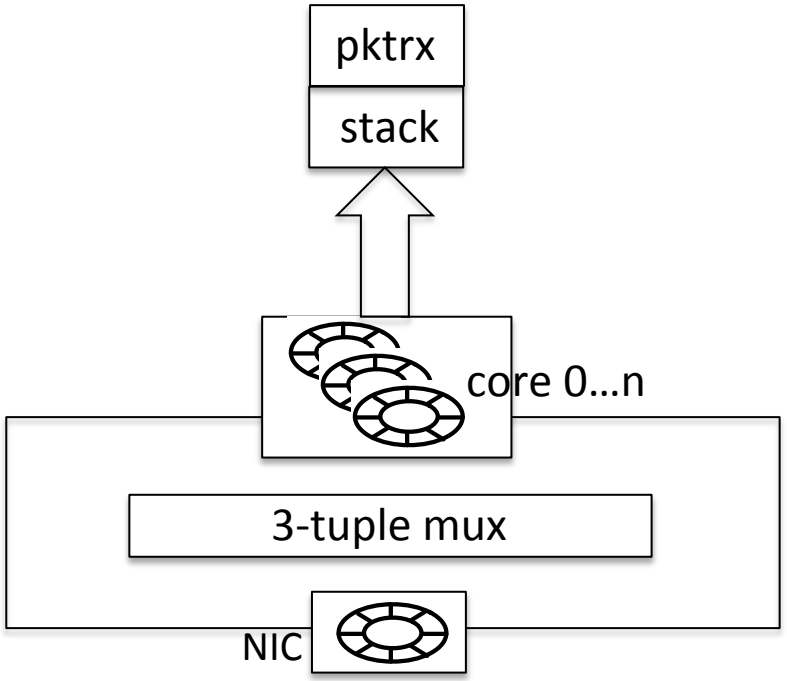

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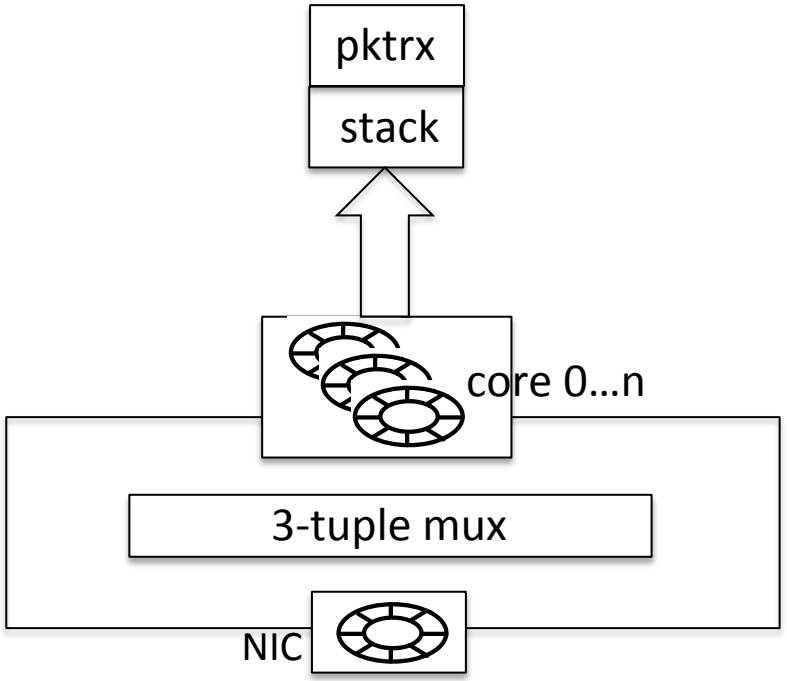

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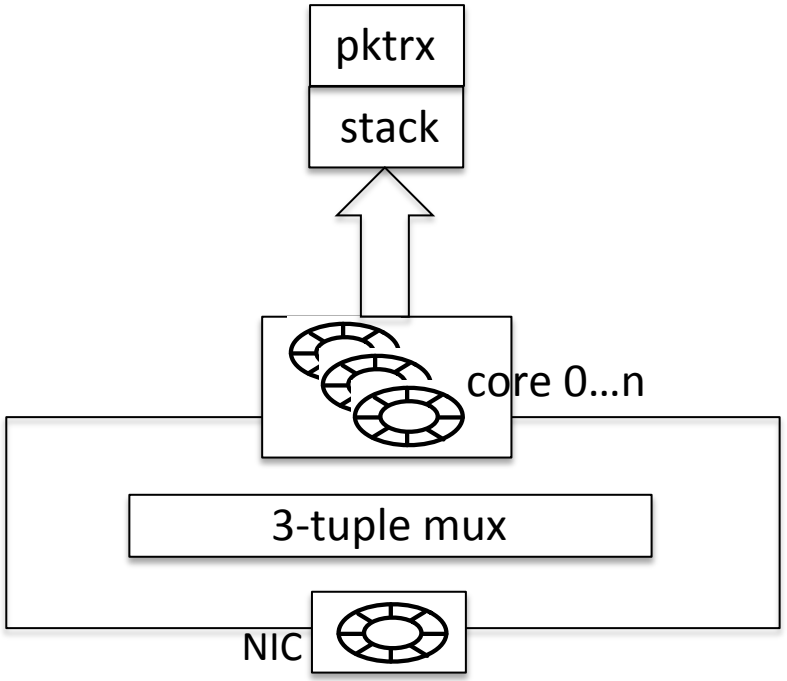

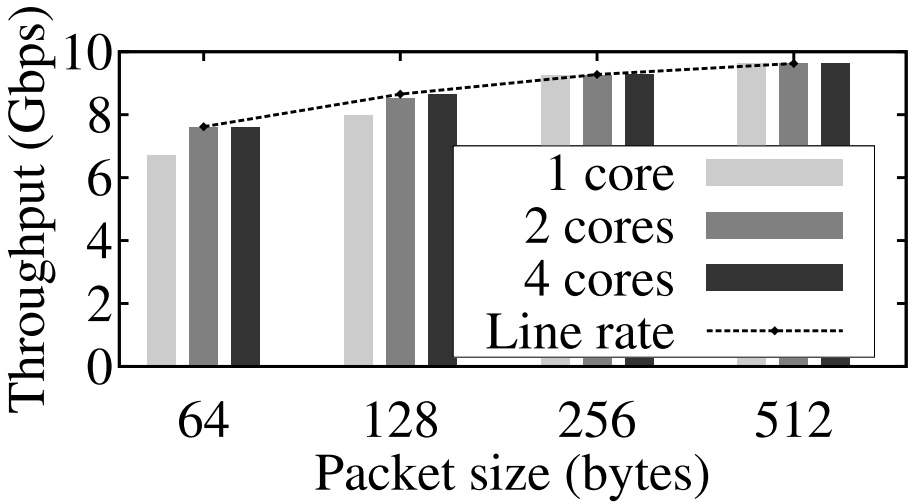

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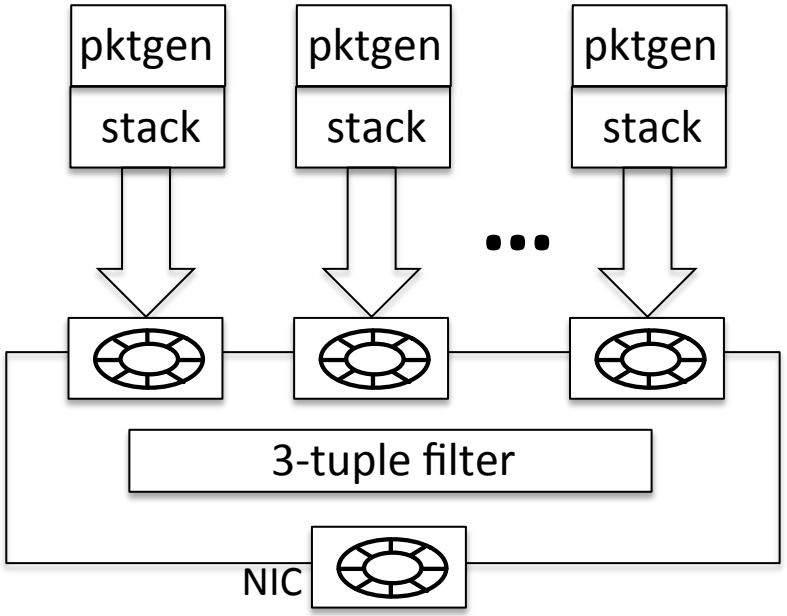

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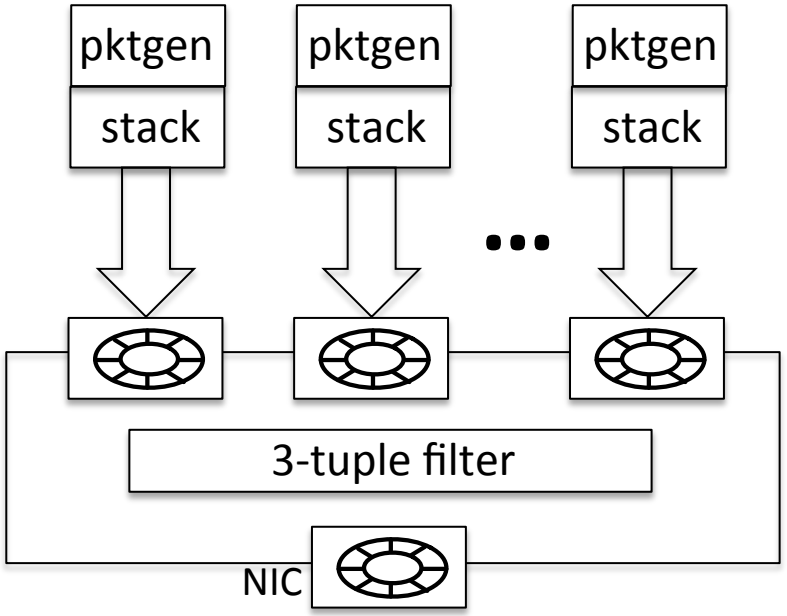

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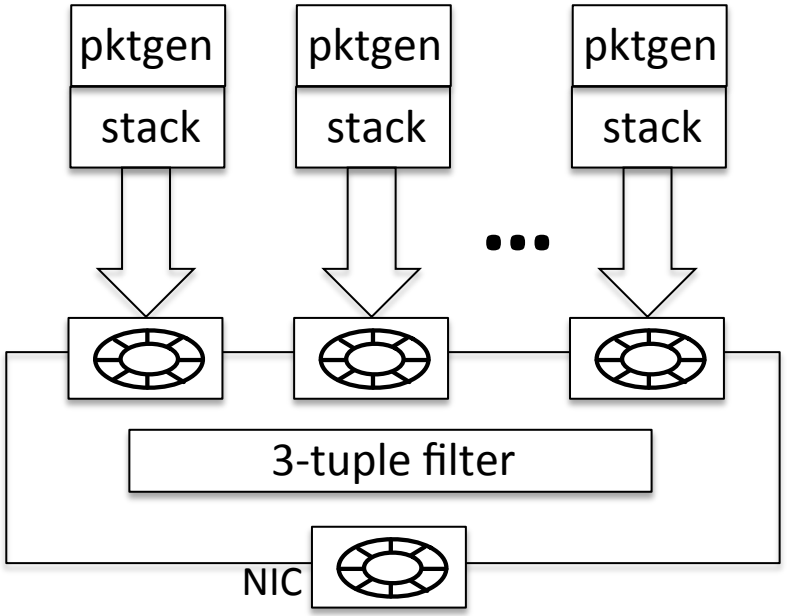

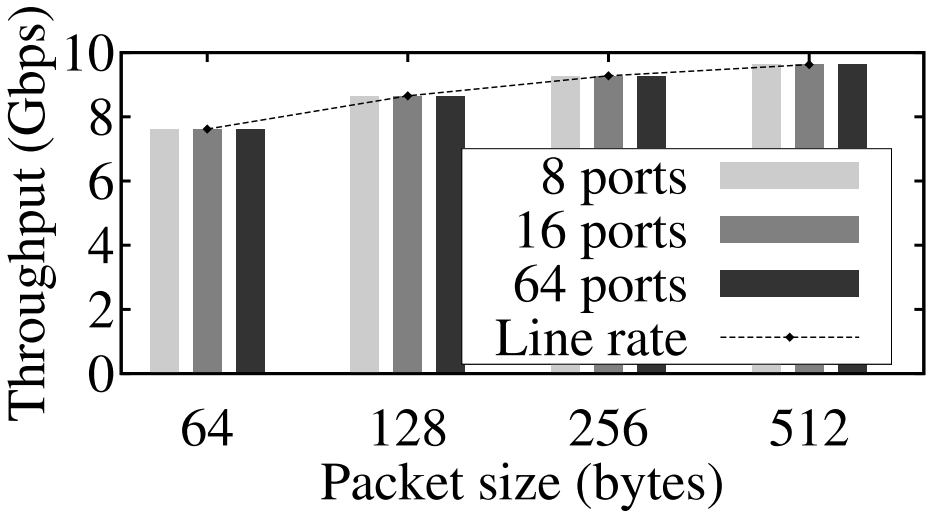

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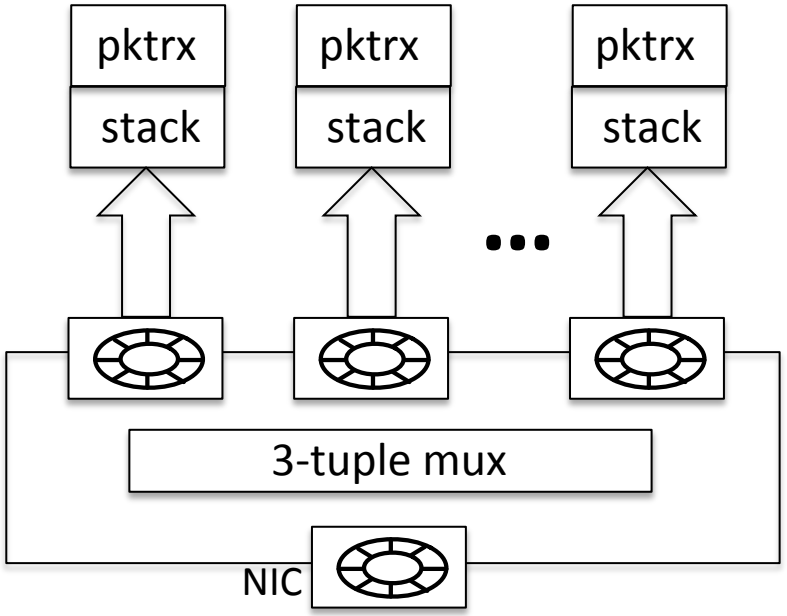

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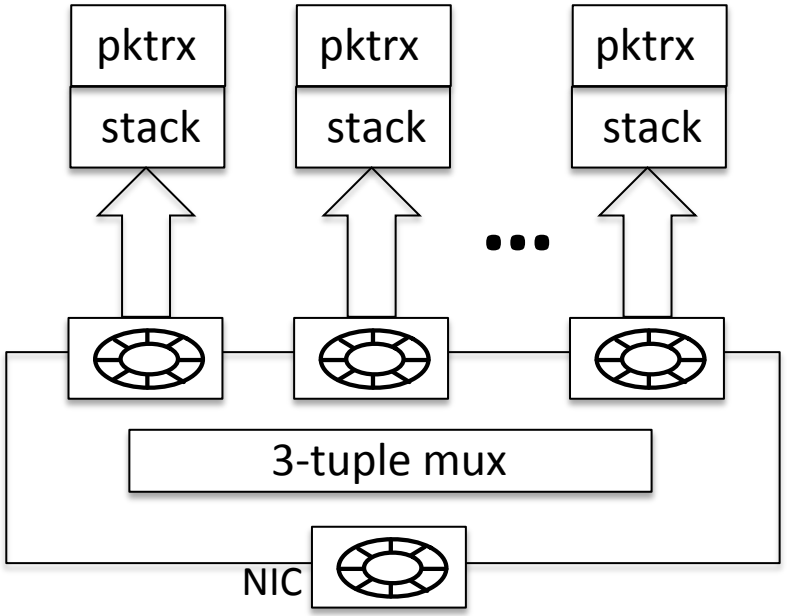

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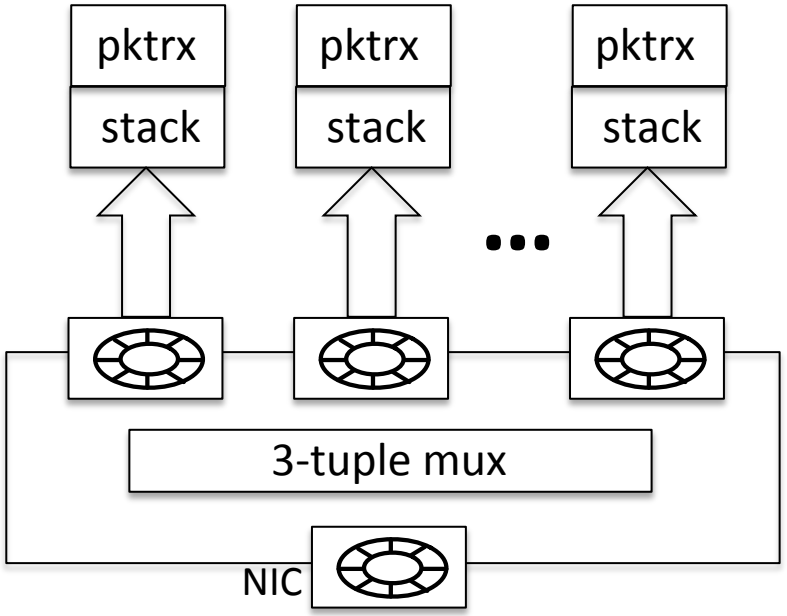

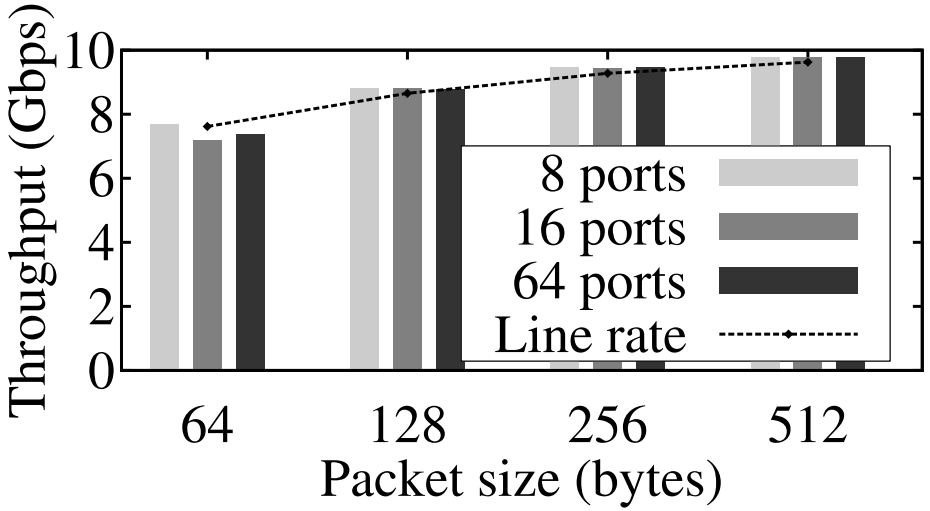

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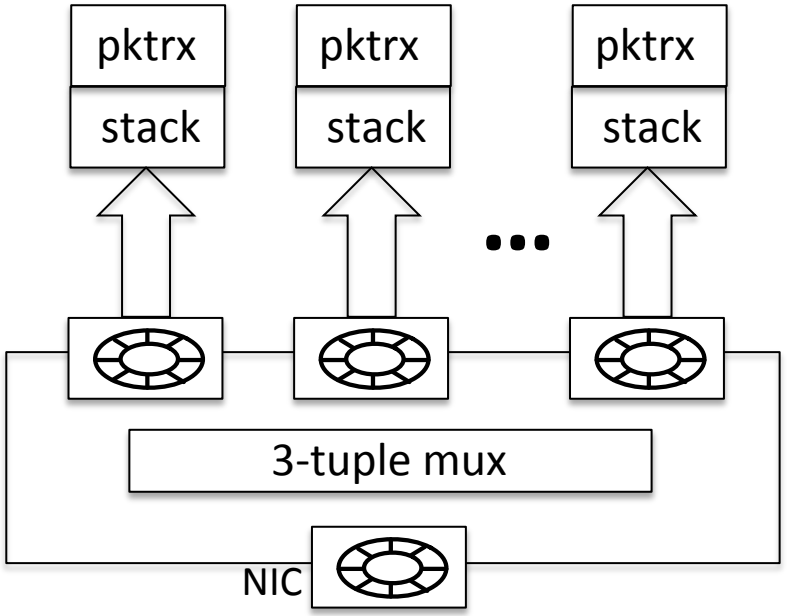

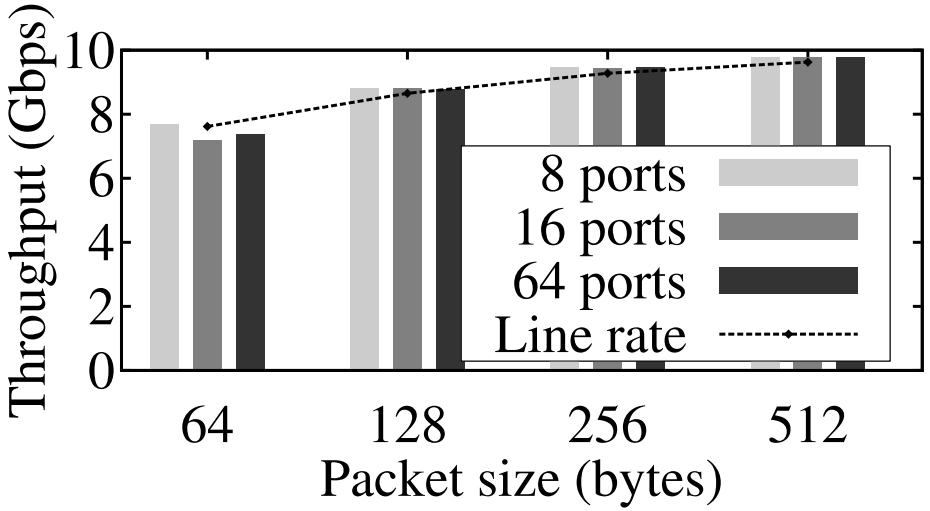

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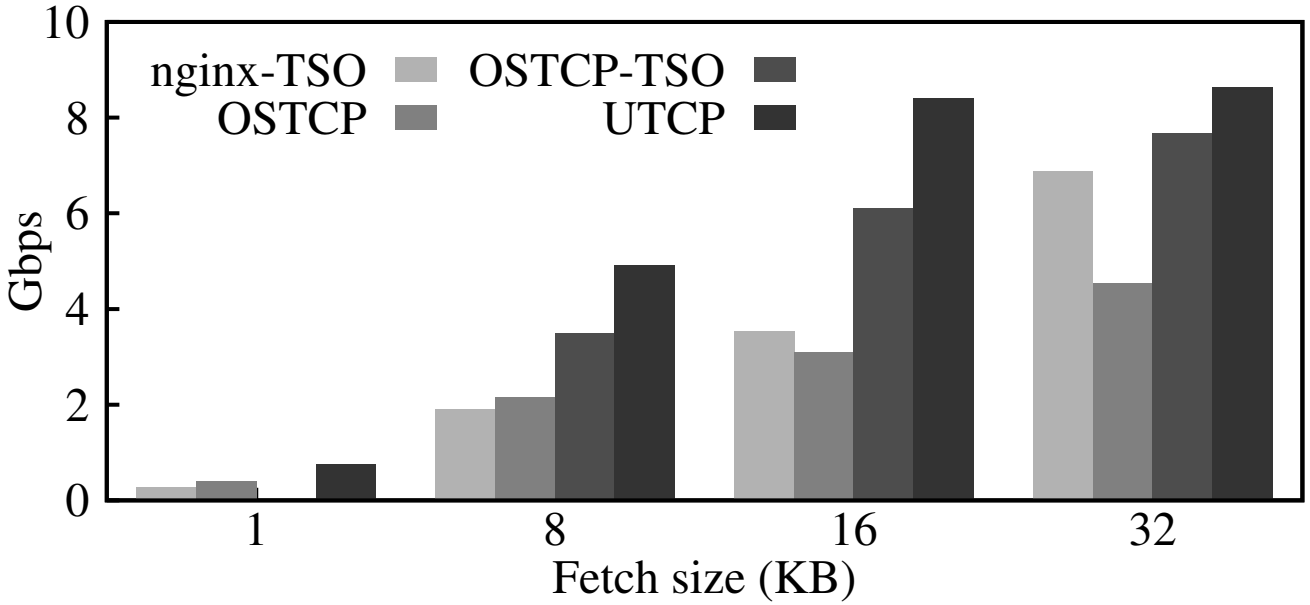
- A bit lower performance on many ports is due to the reduced number of packets taken in a single systemcall

Multistack Performance Summary

- 4 Gbps for 64 byte packets with a single CPU core
- 10 Gbps for 64 byte packets with two CPU cores
- 10 Gbps for 256 byte packets with a single CPU core

Performance with User-Level Stacks

- A simple HTTP server on top of our work-in-progress user-space TCP (UTCP)
- The same app running on top of OS's TCP



Client establishes a TCP connection, and sends HTTP GET

Server replies with HTTP OK (1- 32KB)

Single TCP connection is used for a single HTTP transaction

Conclusion

- Multi-stack: OS support for user-space stacks to rekindle widespread, timely deployment of new protocols/extensions

Try it out! https://github.com/cnplab/multistack

Rekindling Network Protocol Innovation with User-Level Stacks. SIGCOMM CCR