



























- Deterministic, Stable, and Reliable Threads. In *Proc. ACM SOSP*, 2013.
- [23] B. Cully, G. Lefebvre, D. Meyer, M. Feeley, N. Hutchinson, and A. Warfield. Remus: High Availability via Asynchronous Virtual Machine Replication. In *Proc. USENIX NSDI*, 2008.
- [24] D. Devetsery, M. Chow, X. Dou, J. Flinn, and P. M. Chen. Eidetic Systems. In *Proc. USENIX OSDI*, 2014.
- [25] J. Devietti, B. Lucia, L. Ceze, and M. Oskin. DMP: Deterministic Shared Memory Multiprocessing. In *Proc. ACM ASPLOS*, 2009.
- [26] Digital Corpora. 2009-M57-Patents packet trace. <http://digitalcorpora.org/corp/nps/scenarios/2009-m57-patents/net/>.
- [27] M. Dobrescu, N. Egi, K. Argyraki, B.-G. Chun, K. Fall, G. Iannaccone, A. Knies, M. Manesh, and S. Ratnasamy. RouteBricks: Exploiting Parallelism To Scale Software Routers. In *Proc. ACM SOSP*, 2009.
- [28] Y. Dong, W. Ye, Y. Jiang, I. Pratt, S. Ma, J. Li, and H. Guan. COLO: COarse-grained LOck-stepping Virtual Machines for Non-stop Service. In *Proc. ACM SoCC*, 2013.
- [29] G. W. Dunlap, D. G. Lucchetti, M. A. Fetterman, and P. M. Chen. Execution Replay of Multiprocessor Virtual Machines. In *Proc. ACM SIGPLAN/SIGOPS VEE*, 2008.
- [30] E. N. Elnozahy and W. Zwaenepoel. Manetho: Transparent roll back-recovery with low overhead, limited rollback, and fast output commit. *IEEE Trans. Comput.*, 41(5):526–531, May 1992.
- [31] E. N. M. Elnozahy, L. Alvisi, Y.-M. Wang, and D. B. Johnson. A Survey of Rollback-Recovery Protocols in Message-passing Systems. *ACM Comput. Surv.*, 34(3):375–408, Sept. 2002.
- [32] European Telecommunications Standards Institute. NFV Whitepaper. [https://portal.etsi.org/NFV/NFV\\_White\\_Paper.pdf](https://portal.etsi.org/NFV/NFV_White_Paper.pdf).
- [33] S. K. Fayazbakhsh, L. Chiang, V. Sekar, M. Yu, and J. C. Mogul. Enforcing Network-wide Policies in the Presence of Dynamic Middlebox Actions Using Flowtags. In *Proc. USENIX NSDI*, 2014.
- [34] M. Flajsluk and M. Rosenblum. Network Interface Design for Low Latency Request-Response Protocols. In *Proc. USENIX ATC*, 2013.
- [35] A. Gember, R. Viswanathan, C. Prakash, R. Grandl, J. Khalid, S. Das, and A. Akella. OpenNF: Enabling Innovation in Network Function Control. In *Proc. ACM SIGCOMM*, 2014.
- [36] Z. Guo, X. Wang, J. Tang, X. Liu, Z. Xu, M. Wu, M. F. Kaashoek, and Z. Zhang. R2: An Application-Level Kernel for Record and Replay. In *Proc. USENIX OSDI*, 2008.
- [37] S. Han, K. Jang, K. Park, and S. Moon. PacketShader: a GPU-accelerated Software Router. In *Proc. ACM SIGCOMM*, 2010.
- [38] Intel. Data Plane Development Kit. <http://dpdk.org/>.
- [39] Intel. PCI-SIG SR-IOV Primer: An Introduction to SR-IOV Technology. <http://www.intel.com/content/www/us/en/pci-express/pci-sig-sr-iov-primer-sr-iov-technology-paper.html>.
- [40] R. Kohavi and R. Longbotham. Online experiments: Lessons learned. *Computer*, 40(9):103–105, 2007.
- [41] O. Laadan, N. Viennot, and J. Nieh. Transparent, Lightweight Application Execution Replay on Commodity Multiprocessor Operating Systems. In *Proc. ACM SIGMETRICS*, 2010.
- [42] L. Lamport. Time, clocks, and the ordering of events in a distributed system. *Commun. ACM*, 21(7):558–565, July 1978.
- [43] C. Lattner and V. Adve. LLVM: A Compilation Framework for Lifelong Program Analysis & Transformation. In *Proc. IEEE CGO*, 2004.
- [44] J. R. Lorch, A. Baumann, L. Glendenning, D. Meyer, and A. Warfield. Tardigrade: Leveraging Lightweight Virtual Machines to Easily and Efficiently Construct Fault-Tolerant Services. In *Proc. USENIX NSDI*.
- [45] J. Martins, M. Ahmed, C. Raiciu, V. Olteanu, M. Honda, R. Bifulco, and F. Huici. ClickOS and the Art of Network Function Virtualization. In *Proc. USENIX NSDI*, 2014.
- [46] R. Mittal, J. Sherry, S. Ratnasamy, and S. Shenker. Recursively Cautious Congestion Control. In *Proc. USENIX NSDI*, 2014.
- [47] A. Pesterev, J. Strauss, N. Zeldovich, and R. T. Morris. Improving Network Connection Locality on Multicore Systems. In *Proc. ACM EuroSys*, 2012.
- [48] R. Potharaju and N. Jain. Demystifying the Dark Side of the Middle: A Field Study of Middlebox Failures in Datacenters. In *Proc. ACM IMC*, 2013.
- [49] Z. A. Qazi, C.-C. Tu, L. Chiang, R. Miao, V. Sekar, and M. Yu. SIMPLE-fying Middlebox Policy Enforcement Using SDN. In *Proc. ACM SIGCOMM*, 2013.
- [50] S. Rajagopalan, D. Williams, and H. Jamjoom. Pico Replication: A High Availability Framework for Middleboxes. In *Proc. ACM SoCC*, 2013.
- [51] S. Rajagopalan, D. Williams, H. Jamjoom, and A. Warfield. Split/Merge: System Support for Elastic Execution in Virtual Middleboxes. In *Proc. USENIX NSDI*, 2013.
- [52] L. Rizzo. netmap: a Novel Framework for Fast Packet I/O. In *Proc. USENIX ATC*, 2012.
- [53] L. Rizzo and G. Lettieri. Vale: a Switched Ethernet for Virtual Machines. In *Proc. ACM CoNEXT*, 2012.
- [54] L. Rizzo, G. Lettieri, and V. Maffione. Speeding Up Packet I/O in Virtual Machines. In *ACM/IEEE ANCS*, pages 47–58, 2013.
- [55] R. Russell. virtio: Towards a De-facto Standard for Virtual I/O Devices. *ACM OSR*, 42(5):95–103, 2008.
- [56] S. Savage, M. Burrows, G. Nelson, P. Sobalvarro, and T. Anderson. Eraser: A Dynamic Data Race Detector for Multi-threaded Programs. In *Proc. ACM SOSP*, 1997.
- [57] F. B. Schneider. Implementing Fault-tolerant Services Using the State Machine Approach: A Tutorial. *ACM Comput. Surv.*, 22(4):299–319, Dec. 1990.
- [58] V. Sekar, N. Egi, S. Ratnasamy, M. K. Reiter, and G. Shi. Design and Implementation of a Consolidated Middlebox Architecture. In *Proc. USENIX NSDI*, 2012.
- [59] J. Sherry, S. Hasan, C. Scott, A. Krishnamurthy, S. Ratnasamy, and V. Sekar. Making Middleboxes Someone Else’s Problem: Network Processing as a Cloud Service. In *Proc. ACM SIGCOMM*, 2012.
- [60] R. Strom and S. Yemini. Optimistic Recovery in Distributed Systems. *ACM Trans. Comput. Syst.*, 3(3):204–226, Aug. 1985.
- [61] K. Veeraraghavan, D. Lee, B. Wester, J. Ouyang, P. M. Chen, J. Flinn, and S. Narayanasamy. DoublePlay: Parallelizing Sequential Logging and Replay. In *Proc. ACM ASPLOS*, 2012.
- [62] Z. Wang, Z. Qian, Q. Xu, Z. Mao, and M. Zhang. An Untold Story of Middleboxes in Cellular Networks. In *Proc. ACM SIGCOMM*, 2011.