

MRemu: An Emulation-based Framework for Datacenter Network Experimentation using Realistic MapReduce Traffic

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Context

- Big Data & Big Data analytics frameworks
 - Scale out to hundred or even thousands of commodity servers
 - Increased network traffic volumes and multiplicity of traffic patterns
- Data center networks
 - Scale-out topologies (e.g., fat-tree, leaf-spine)
 - Network control software (e.g, SDN)

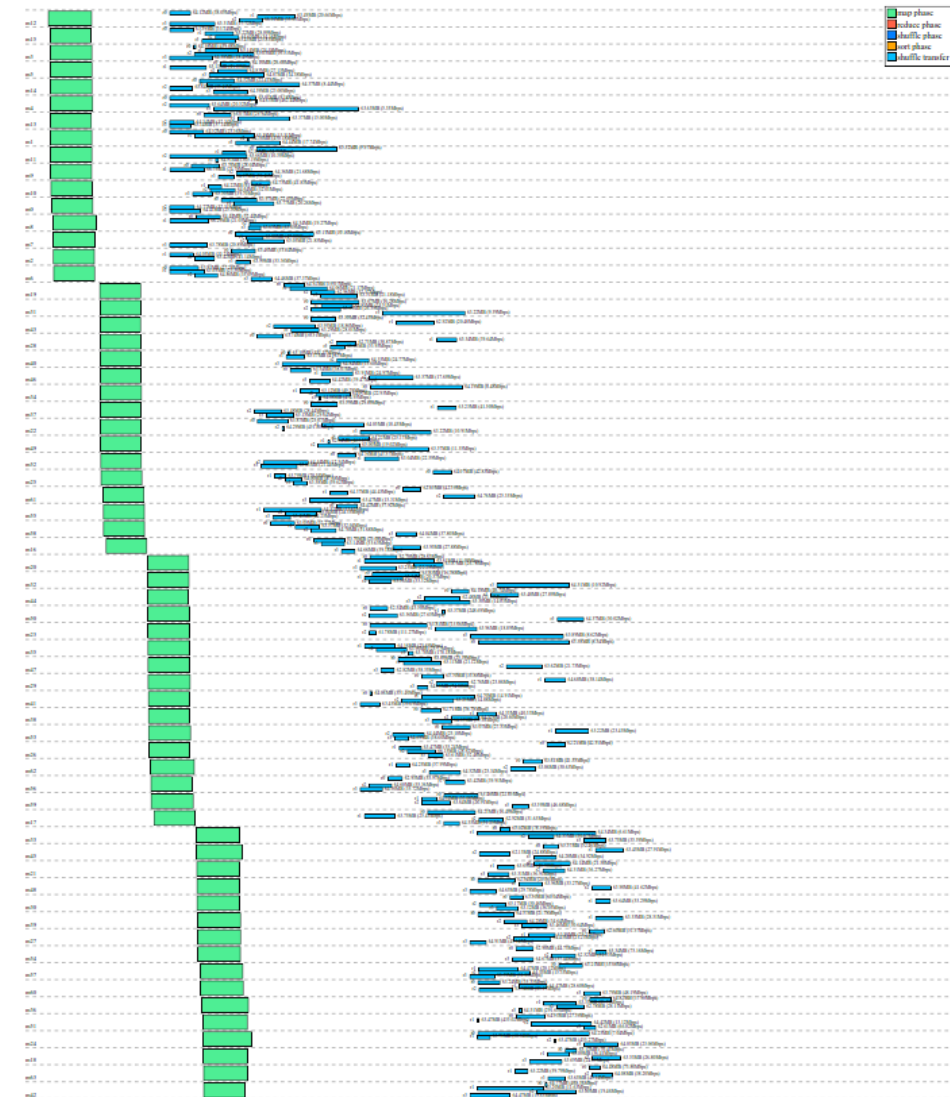
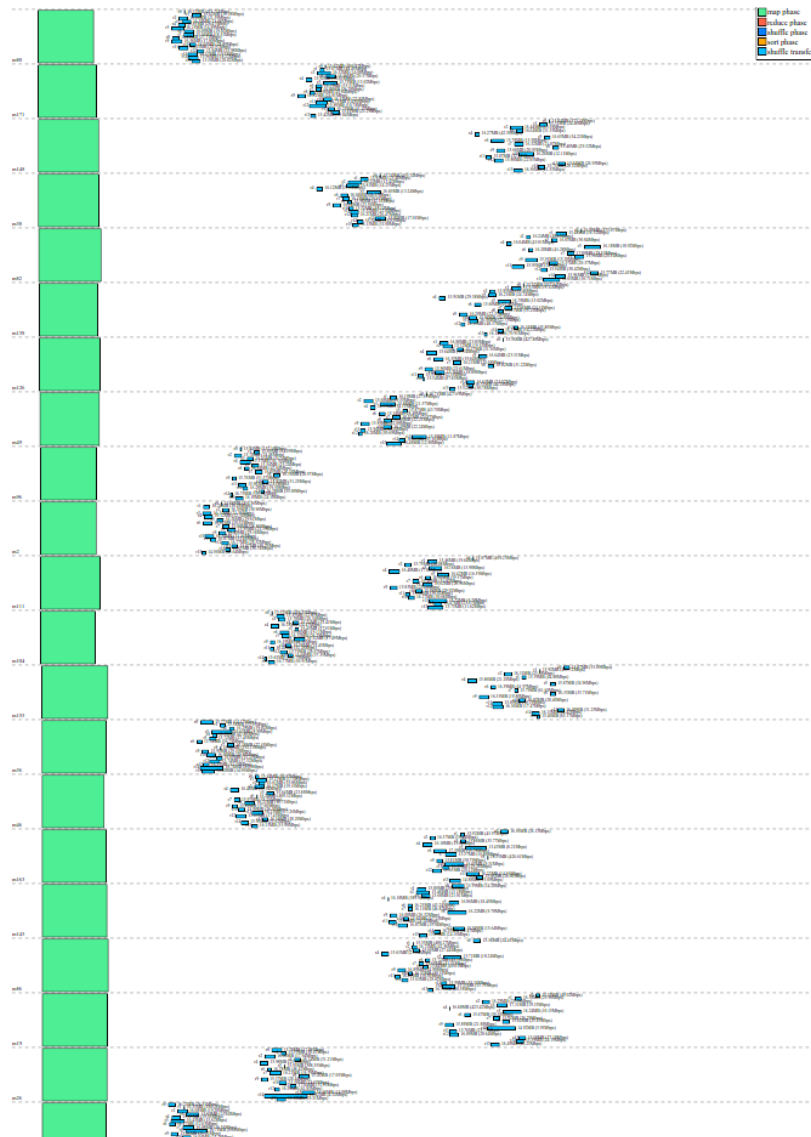
Problem

- The need for a real hardware infrastructure
 - is often not a valid option
 - even when datacenter resources are available
 - Not practical to to reconfigure them in order to evaluate different network topologies and characteristics (e.g., bandwidth and latency)
- Alternatives:
 - Simulation & Emulation

Problem

- Most research on data center networks do not use realistic Big Data traffic
 - synthetic traffic patterns
- Simplified Shuffle-like traffic patterns
 - e.g., all-to-all
 - not consider transfer scheduling decisions, number of parallel transfers, etc.
 - overlap communication with computation
- How the reported results translate to performance improvement for actual analytics runtimes?

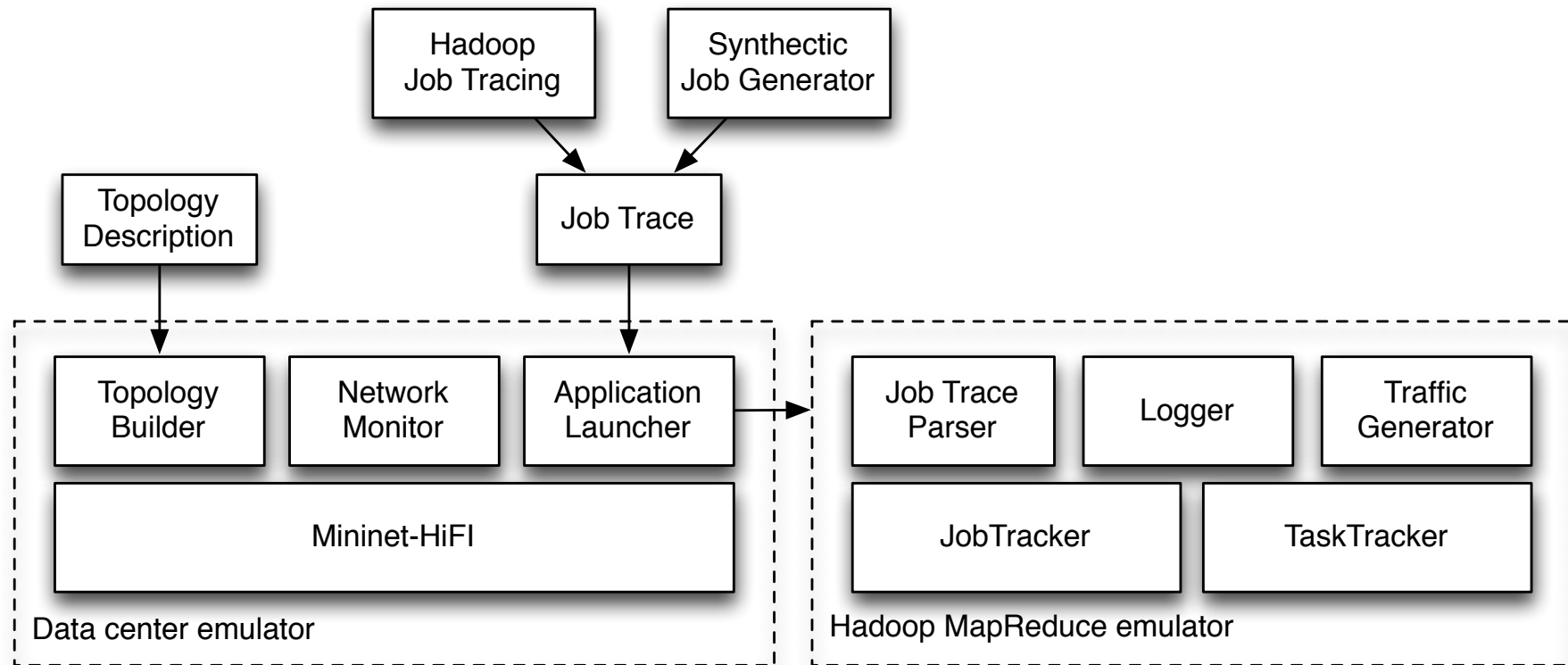
Network Traffic in real Hadoop Applications



Proposed solution: MRemu

- Emulation-based framework for data center network experimentation
- Highlights:
 - Ability to run a complete data center in a single server
 - Use of realistic network traffic
 - replay or extrapolate from executions of real applications in production datacenters patterns
 - Mimics framework internals (e.g, transfer scheduling, phases overlaps, etc.)

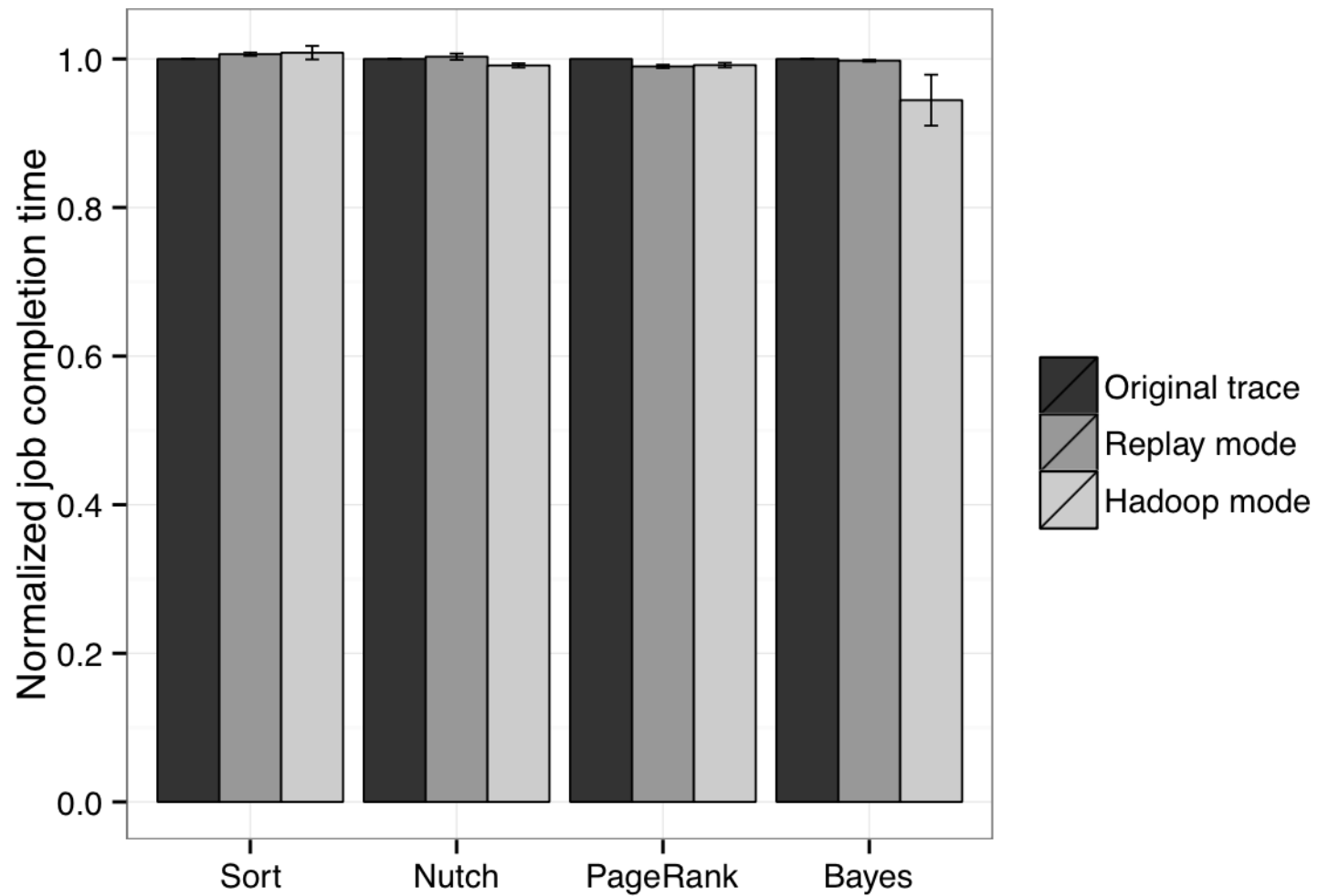
MRemu Architecture



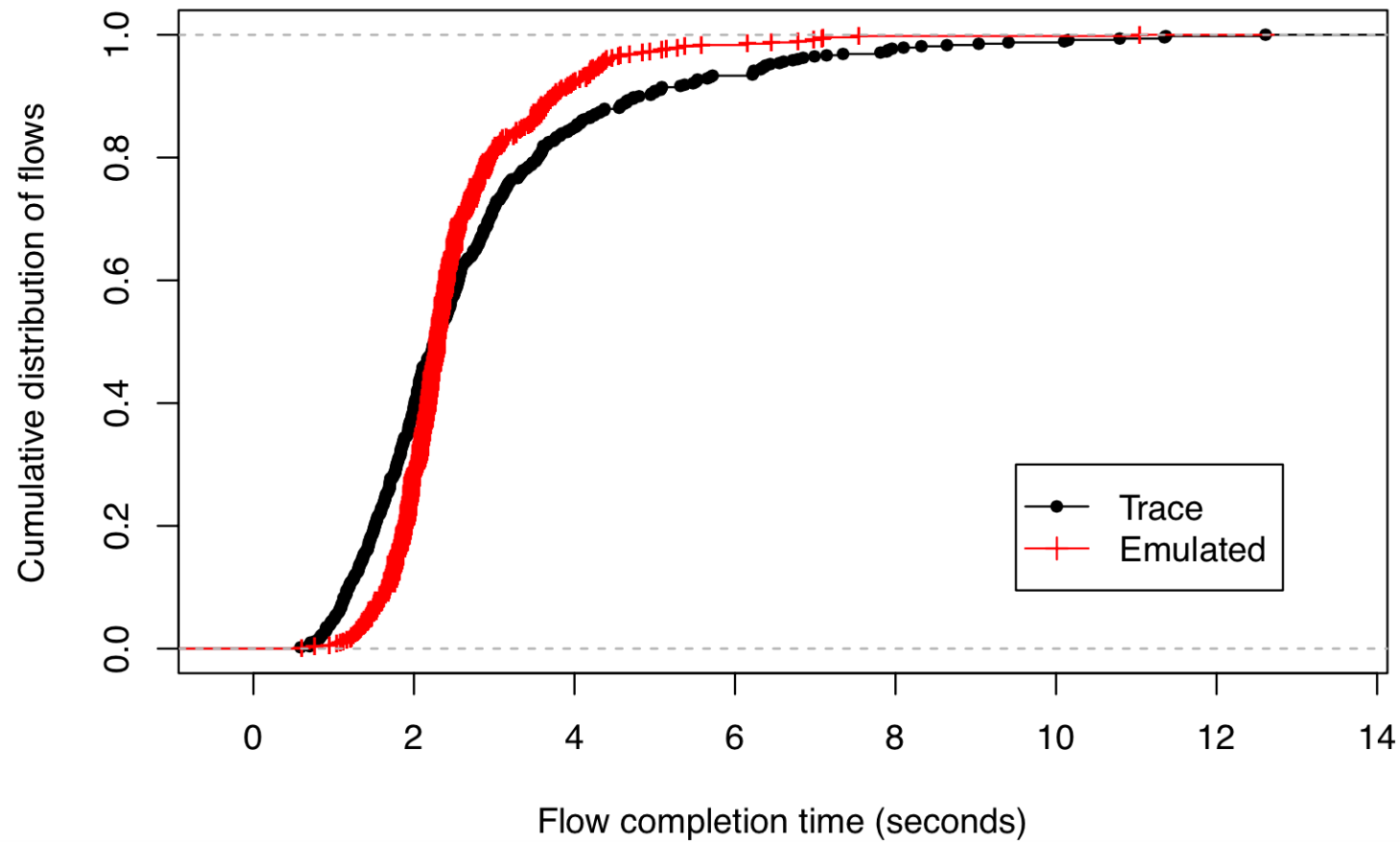
Evaluation

- Mininet-HiFi has already been validated and is widely used to reproduce networking research experiments
- Accuracy when reproducing MapReduce workloads.
 - Comparison with traces extracted from real job executions
- Execution environment (Shamrock cluster, IBM Research):
 - 16 servers with 12 x86_64 cores and 128GB of RAM
 - Non-blocking 1Gbps Ethernet network
 - Red Hat Enterprise Linux 6.2
 - Hadoop 1.1.2
 - HiBench Benchmark Suite: Sort, Nutch, PageRank and Bayes

Job Completion Time Accuracy



Individual Flow Completion Time Accuracy



Conclusion and Future Work

- MRemu, an emulation-based framework that enables conducting datacenter network research
 - without requiring expensive and continuous access to large-scale datacenter hardware resources
- Available as open source:
 - <https://github.com/mvneves/mremu>
- Future work:
 - Extend it to other frameworks and traffic patterns
 - Integrate it with Mininet-HiFi cluster edition

References

- NEVES, M. V.,: Application-aware networking to Accelerate MapReduce Applications (Ph.D. Dissertation), 2015
- NEVES, M. V., DE ROSE, C. A. F., KATRINIS, K. MRemu: An Emulation-based Framework for Datacenter Network Experimentation using Realistic MapReduce Traffic, MASCOTS 2015 (submitted)