

# High Performance Tor Experimentation from the Magic of Dynamic ELFs

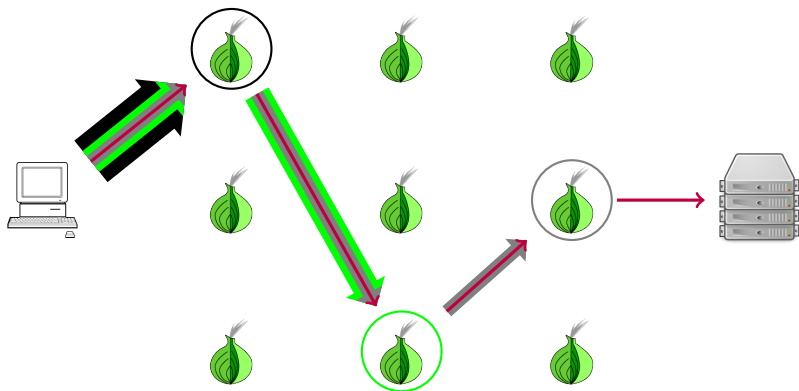
Justin Tracey<sup>1</sup>   Rob Jansen<sup>2</sup>   Ian Goldberg<sup>1</sup>

<sup>1</sup>University of Waterloo

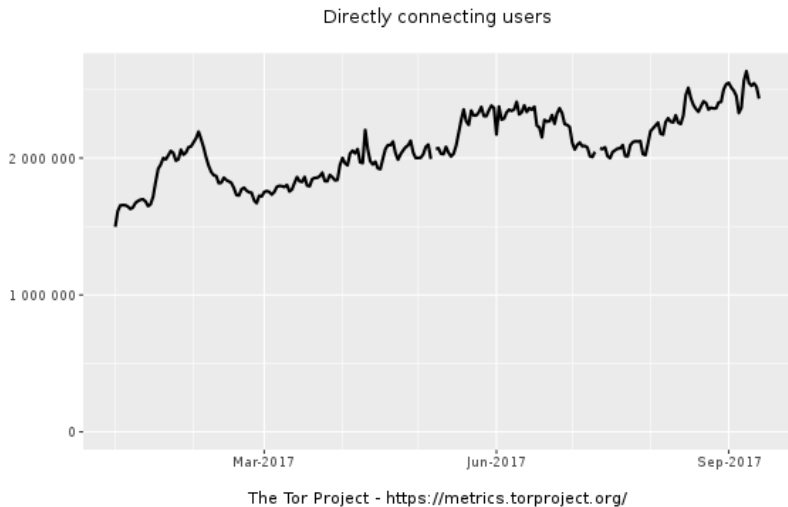
<sup>2</sup>U.S. Naval Research Laboratory

CSET 2018

# Tor



# Why does Tor matter?



# Experimenting on Tor

	Commit message (Expand)	Author	Age
*	Merge branch 'bug23499' <b>HEAD</b> <b>master</b>	Nick Mathewson	8 hours
\			
*	Rename write_http_status_line, since it does more now.	Nick Mathewson	16 hours
*	Make missing reason_phrase into a BUG().	Nick Mathewson	16 hours
*	get rid of the scary 256-byte-buf landmine	Roger Dingledine	22 hours
*	Make dir servers include a "Date:" http header more often	Roger Dingledine	22 hours
*	get rid of a case where we might log a NULL as %s	Roger Dingledine	26 hours
*	Merge branch 'maint-0.3.1'	Nick Mathewson	12 hours
\ \			
* \	Merge branch 'maint-0.3.0' into maint-0.3.1 <b>maint-0.3.1</b>	Nick Mathewson	12 hours
\ \			
* \ \	Merge branch 'maint-0.2.9' into maint-0.3.0 <b>maint-0.3.0</b>	Nick Mathewson	12 hours
\ \			
* \ \	Merge branch 'maint-0.2.8' into maint-0.2.9 <b>maint-0.2.9</b>	Nick Mathewson	12 hours
\ \			
*	version bump: 0.2.8.15 <b>maint-0.2.8</b>	Nick Mathewson	12 hours
*	version bump: 0.2.9.12	Nick Mathewson	12 hours
*	version bump: 0.3.0.11	Nick Mathewson	12 hours
*	Remove changes files for items already in release-0.3.1	Nick Mathewson	12 hours
*	Merge branch 'maint-0.3.1'	Nick Mathewson	15 hours
\ \ \ \ \ \			
/ / / / /			
*	Merge branch 'maint-0.3.0' into maint-0.3.1	Nick Mathewson	15 hours
\ \ \ \ \ \			
/ / / / /			
*	entrynodes.c: fix syntax error around BUG() statement	Martin Kepplinger	15 hours

# Experimenting on Tor Safely

*“1. Use a test Tor network whenever possible.”*

—Tor Research Safety Board guidelines

# Available Options

- ▶ Deployed Networks (e.g., PlanetLab)
- ▶ Emulators (e.g., NetMirage)
- ▶ Simulators (e.g., ns-3)
- ▶ Hybrids (e.g., DCE, Shadow)

# Shadow

real applications, simulated networks

[Download Latest](#)

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[Launch on EC2](#)

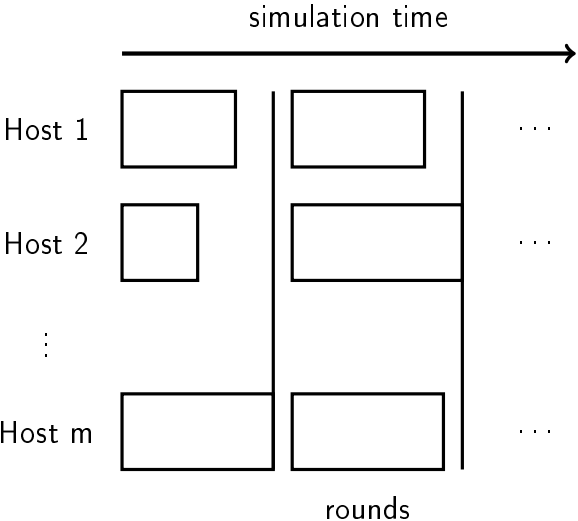


an open-source network simulator/emulator hybrid

**runs real applications like Tor  
and Bitcoin over a simulated  
Internet topology**

light-weight, efficient, scalable, parallelized, controllable, deterministic, accurate,  
modular, and more!

# Discrete-Event Network Simulation





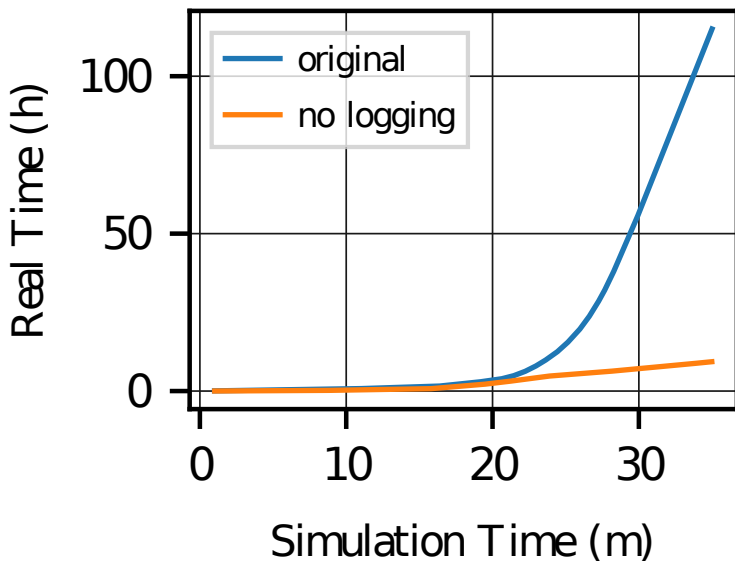
# Performance Constraints in Shadow

- ▶ Logging
- ▶ Loading and running plugins
- ▶ No compiler optimizations
- ▶ Load Balancing

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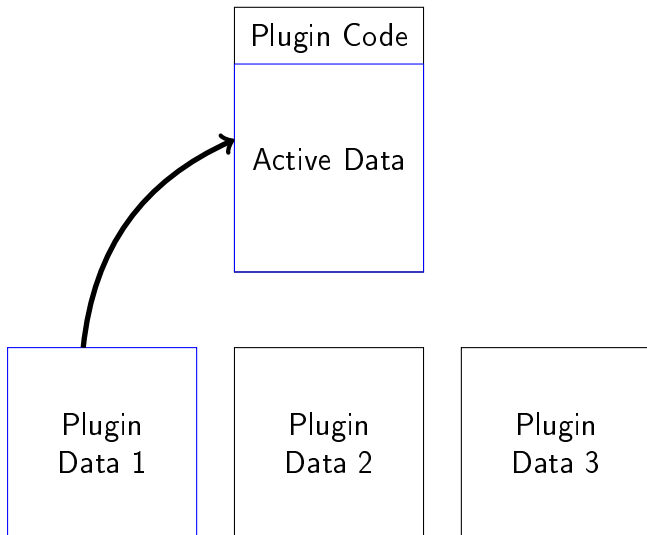
# Logging Performance



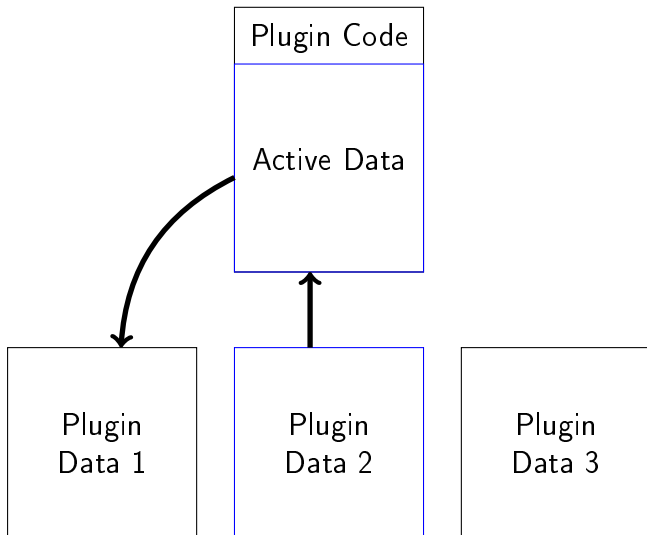
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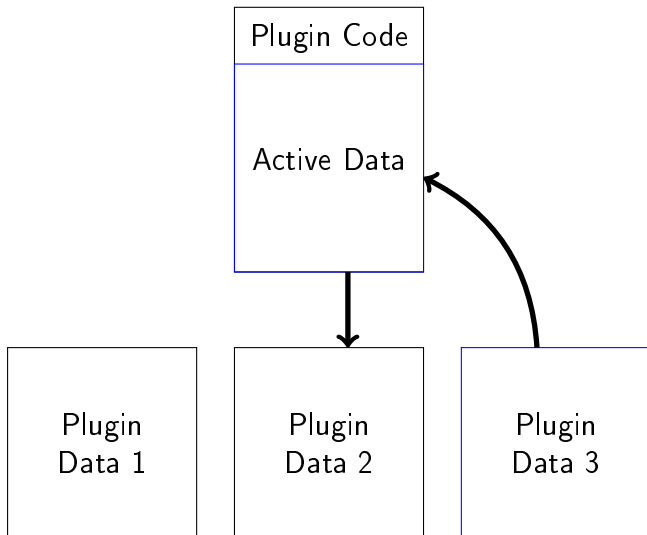
# Changing Hosts



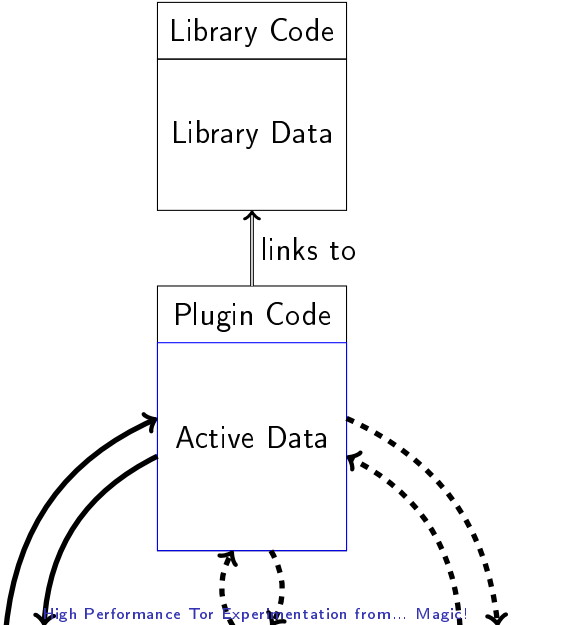
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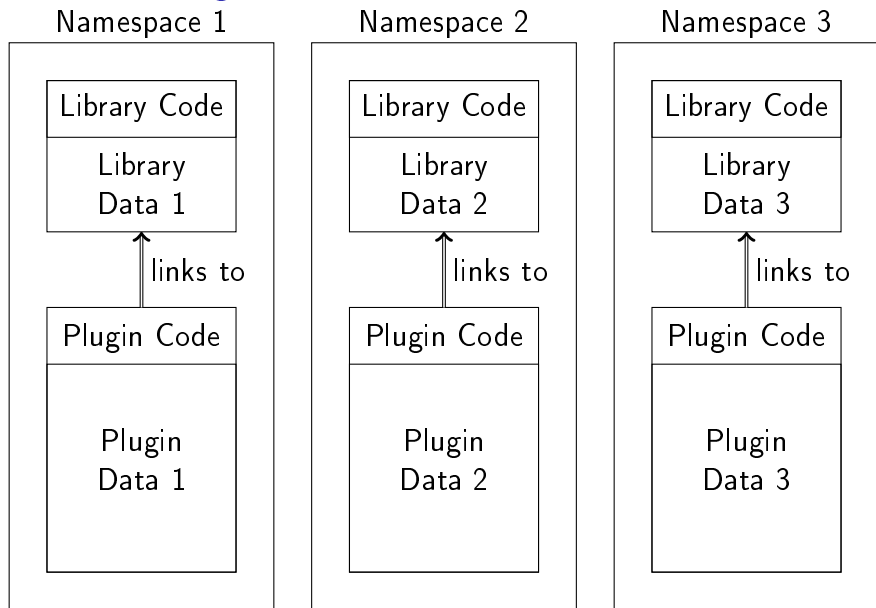


# Lock on Libraries

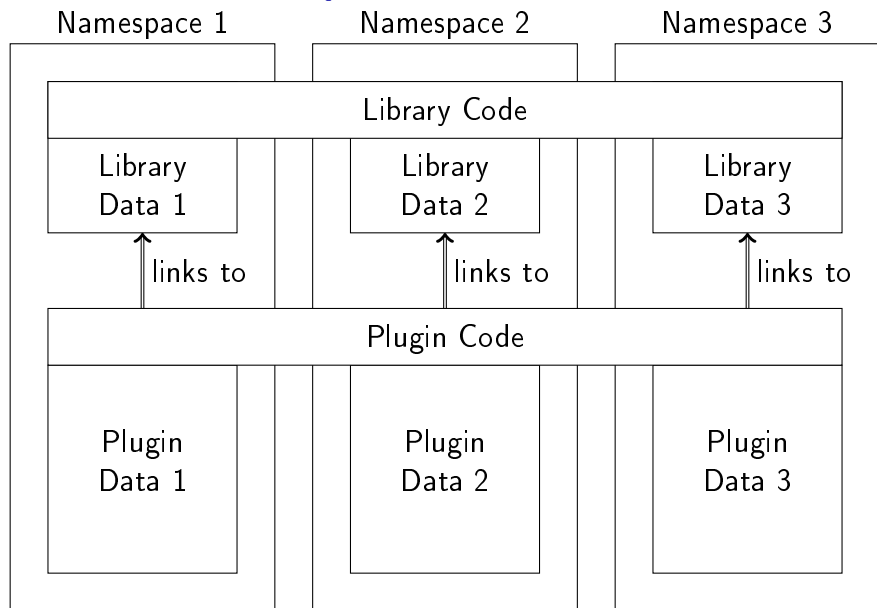




# The New Design: drow-loader



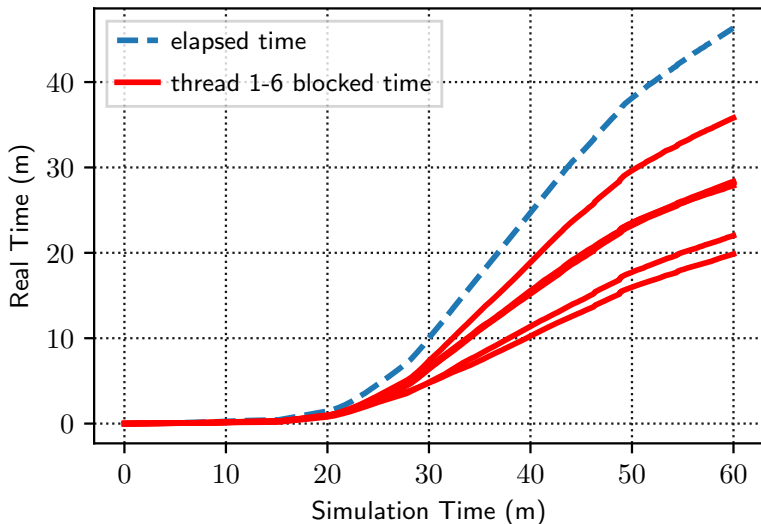
# draw-loader: Memory Overhead



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- ▶ Loading and running plugins
- ▶ No compiler optimizations
- ▶ **Load Balancing**

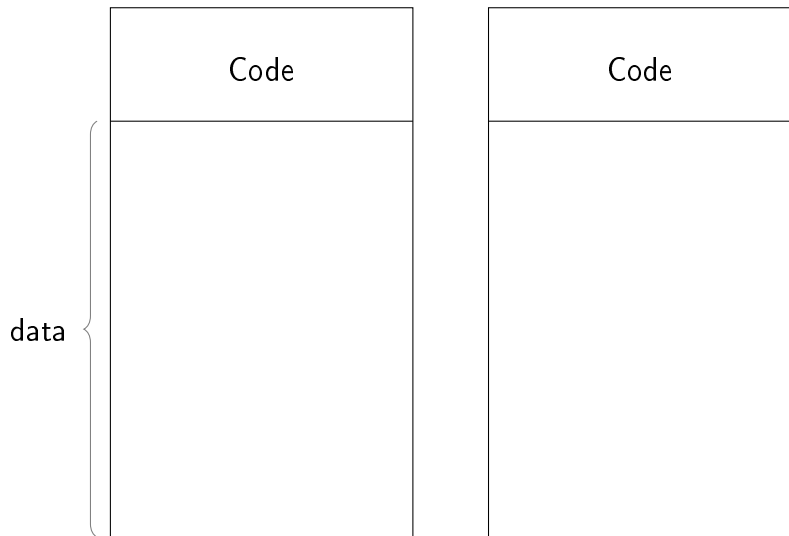
# Time Spent Blocked Per Thread



# Problems in Shadow: No Host Migration

thread1:plugin1

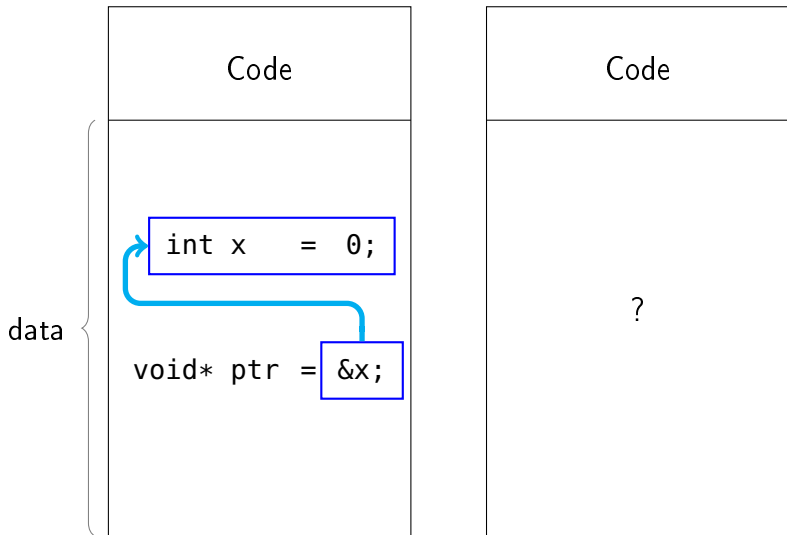
thread2:plugin1



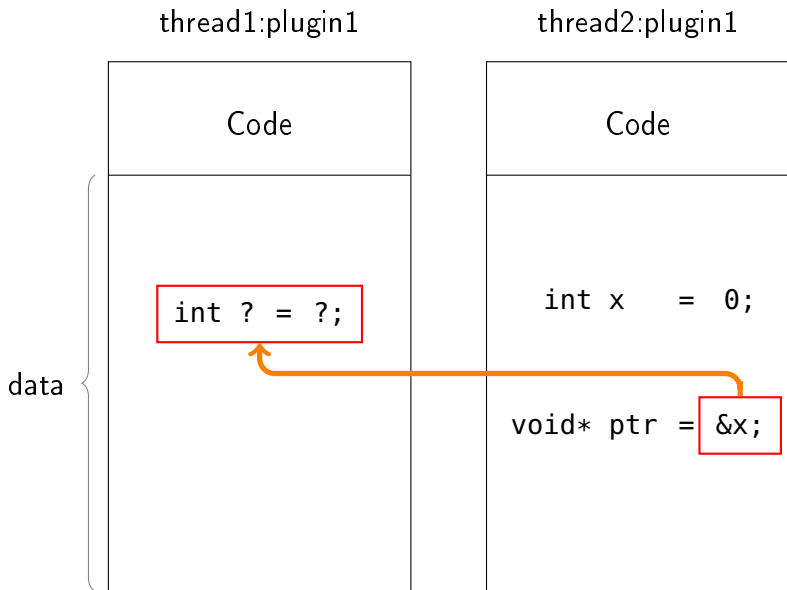
# Problems in Shadow: No Host Migration

thread1:plugin1

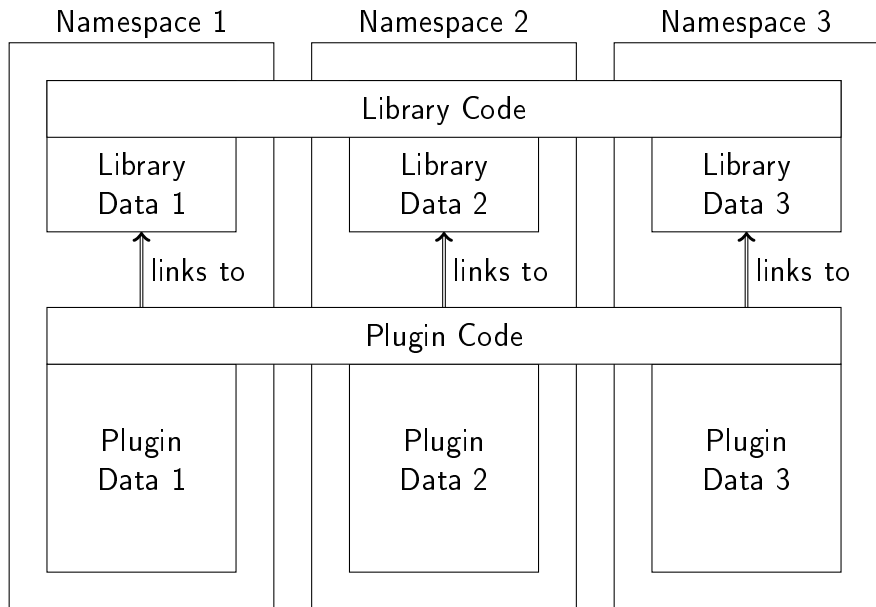
thread2:plugin1



# Problems in Shadow: No Host Migration

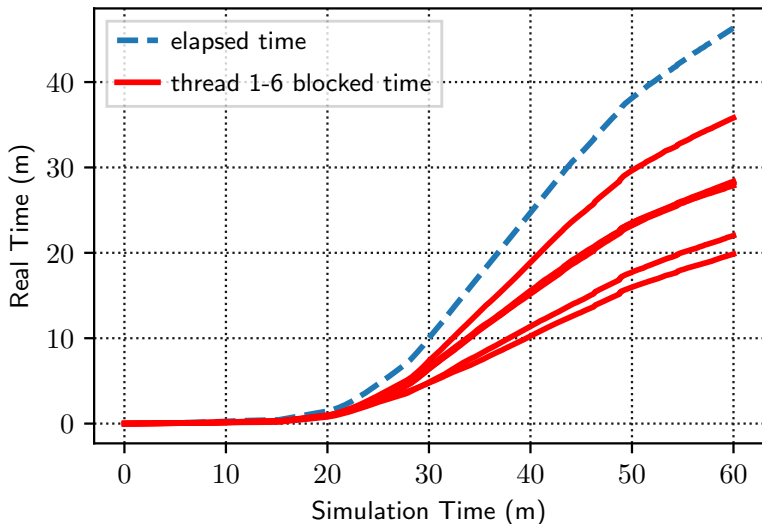


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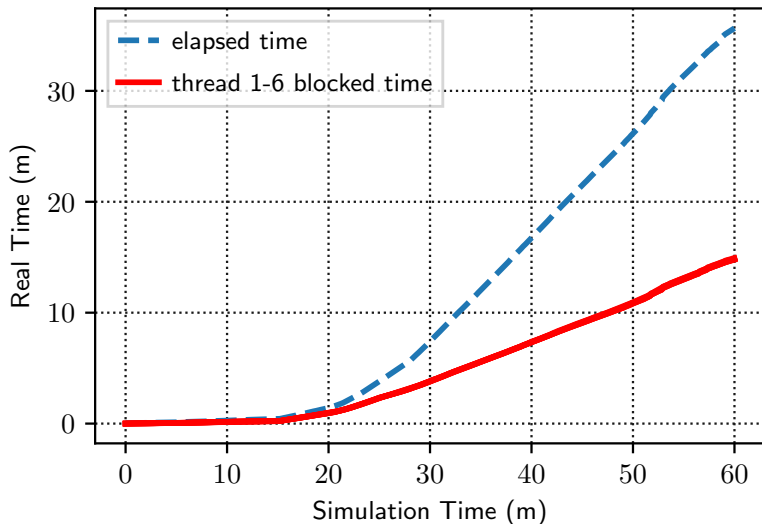




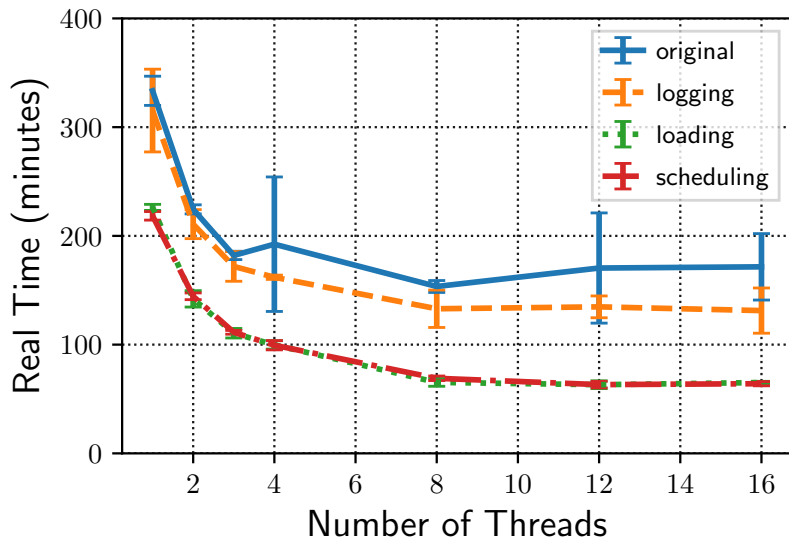
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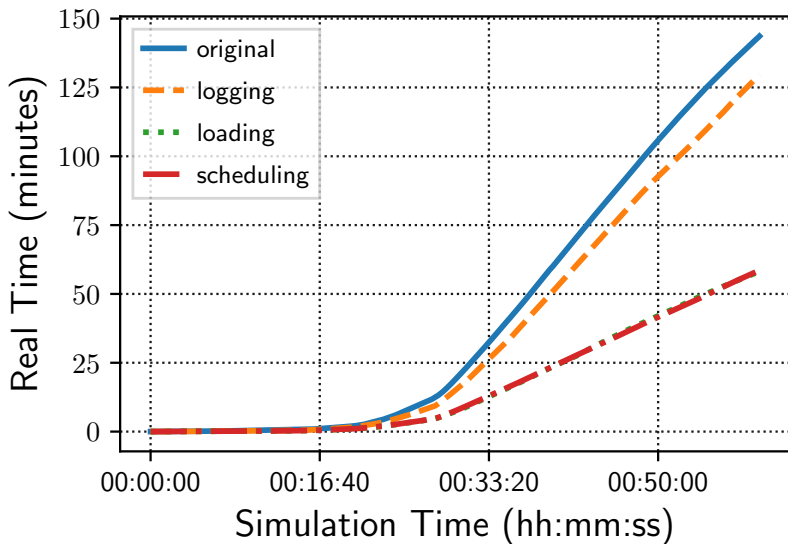
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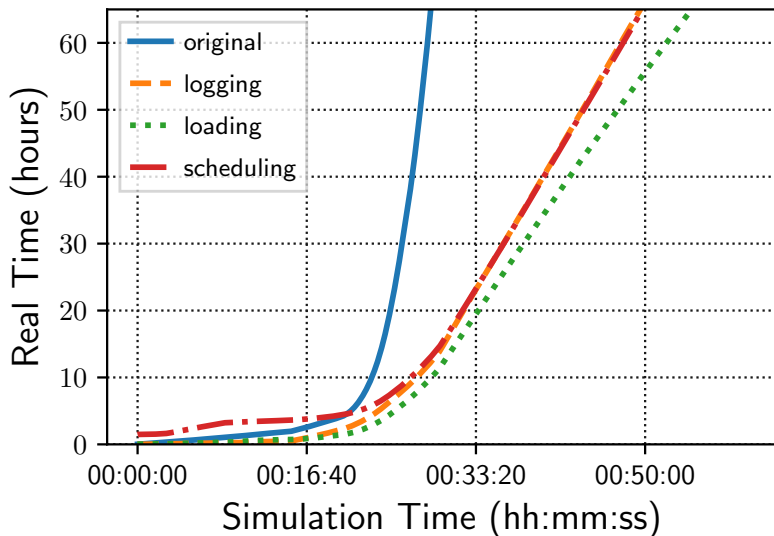
# Small Tor Experiment: 268 Hosts



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# Large Tor Experiment: 22,499 Hosts



# Takeaways

- ▶ Tor requires realistic constructed networks for testing
- ▶ Shadow provides this, but suffered from performance constraints
- ▶ We were able to analyze and address these constraints
  - ▶ up to 31% improvement in synthetic benchmarks
  - ▶ up to 73% improvement in Tor experiments
- ▶ Our changes were merged upstream and are available in Shadow now

[shadow.github.io](https://shadow.github.io)