Using Trusted Execution Environments On High-Performance Computing Platforms

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BERKELEY LAB

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UNIVERSITY OF CALIFORNIA

Secure High-Performance Computing

How to compute with large sensitive data?

Biomedical data

Proprietary data

Secure from both external and internal threats

Integrity or confidentiality or both

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High-Performance Computing Workloads

Common characteristics

Large data sets (10s–100s GB per node)
Limited user interaction (batch)
Often highly multithreaded

Dedicated (super computers) or shared (cloud) nodes

Diverse compute, memory, and security requirements

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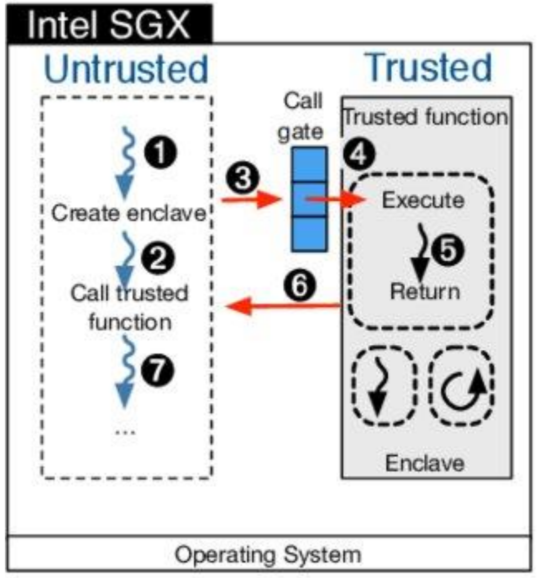
We Analyze Two TEEs



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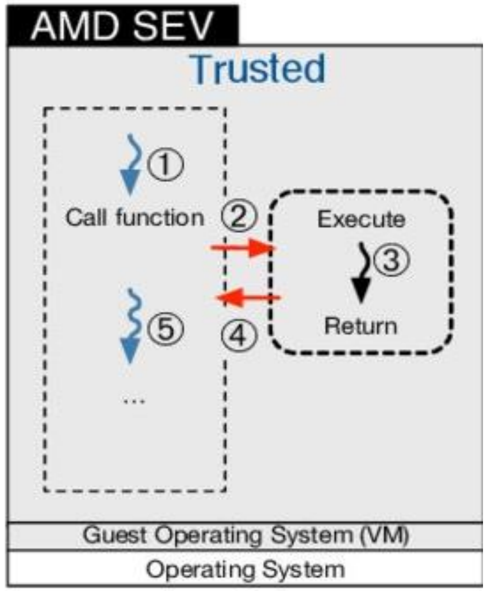


[1]

Technology	Ensures Integrity	TCB Size	Secure Memory Size	Application Changes
Intel SGX	Yes	Small	128 MB (useable: 94MB)	Required
AMD SEV	No	Large	Up to RAM size	Not Required

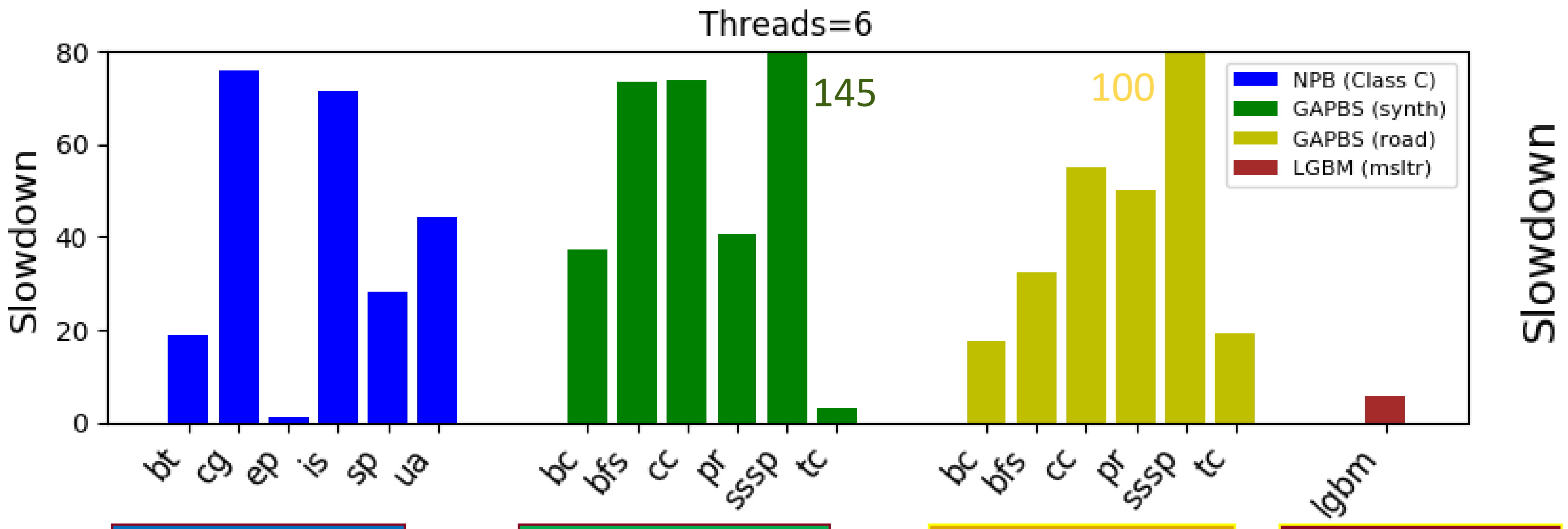
[1] Christian Göttel et al. "Security, performance and energy trade-offs of hardware-assisted memory protection mechanisms." IEEE Symposium on Reliable Distributed Systems (SRDS), 2018.

Methodology

- Benchmarks used: NAS parallel benchmarks, LightGBM and GAPBS
- Platforms used: Intel Core i7-8700 (12 threads/socket) for SGX and AMD EPYC 7451 (dual socket with 48 threads/socket) for SEV study
- Use of SCONE (SGX) and Kata (SEV) containers
- Measured slowdown of the used workloads under secure execution on both platforms
- Relate the slowdown to other collected metrics

Performance Impact of SGX

High slowdown, especially for graph workloads

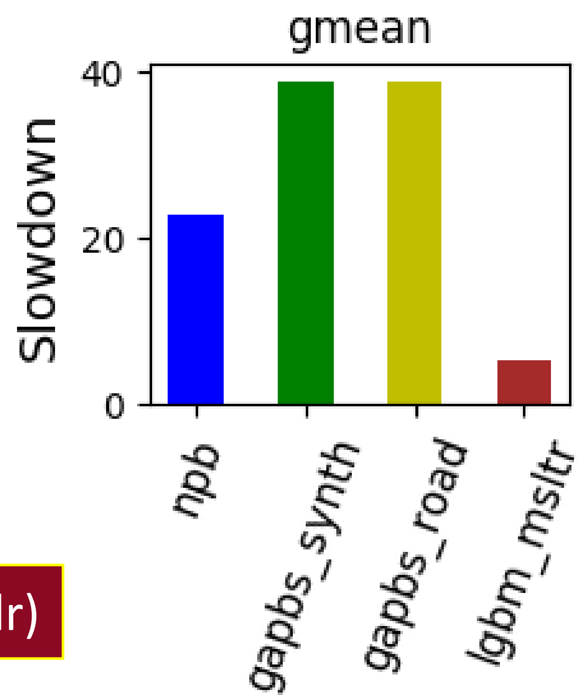


NPB (Class C)

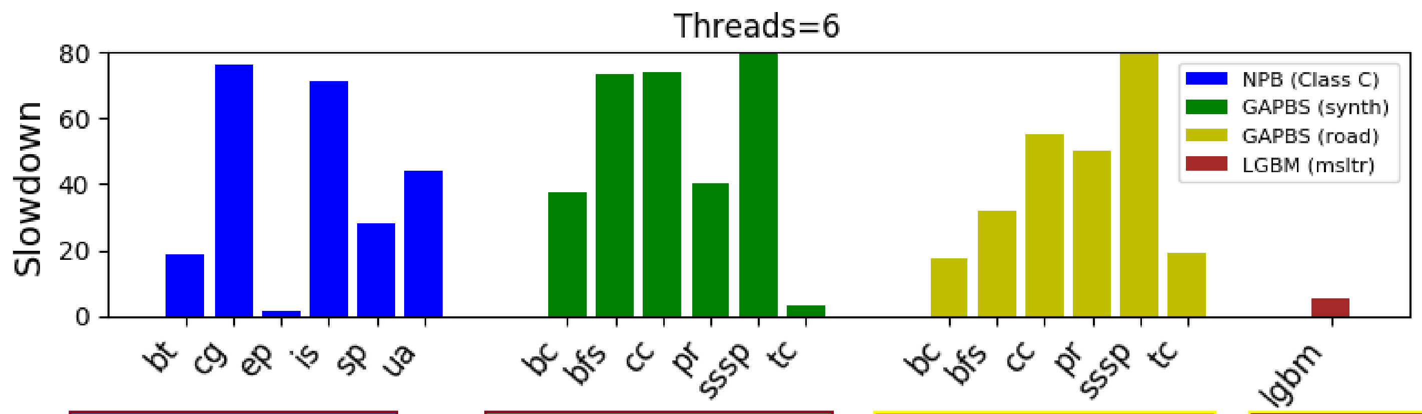
GAPBS (synth)

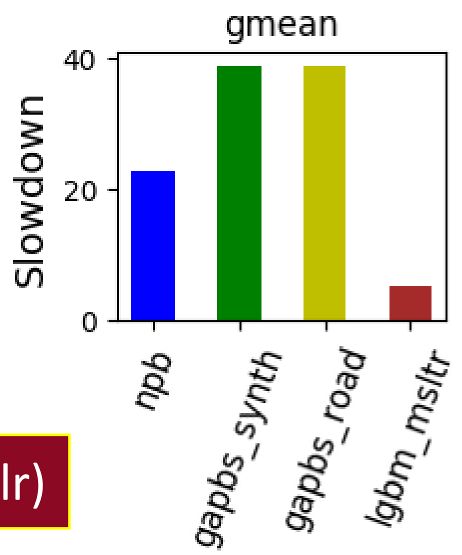
GAPBS (road)

LGBM (mslr)



Enclave Page Cache (EPC) Faults





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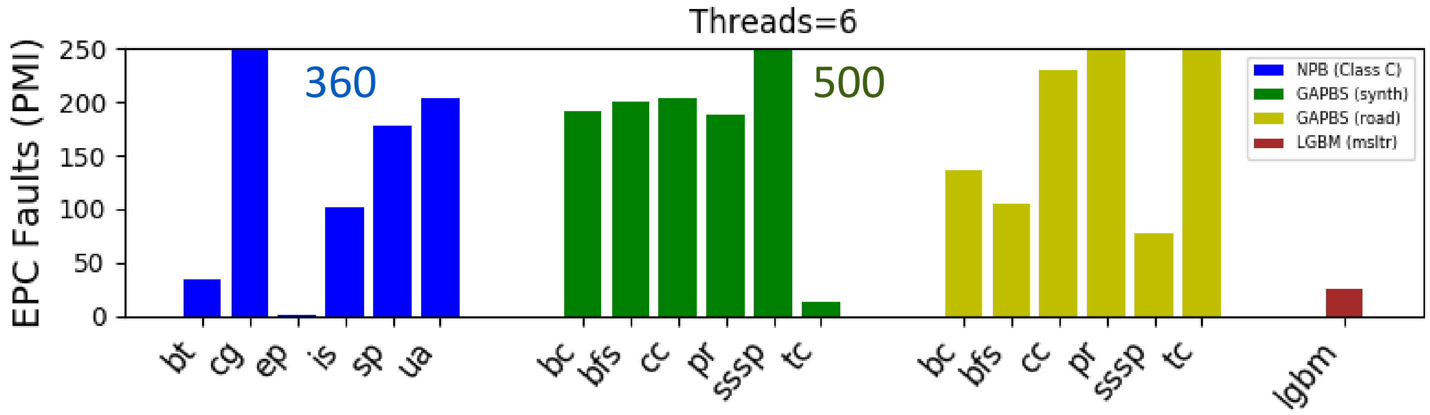
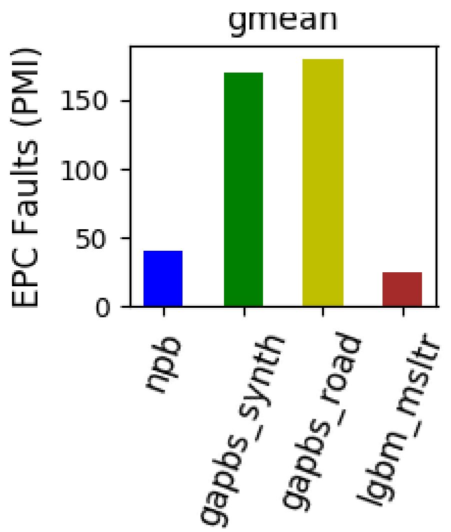


360

500



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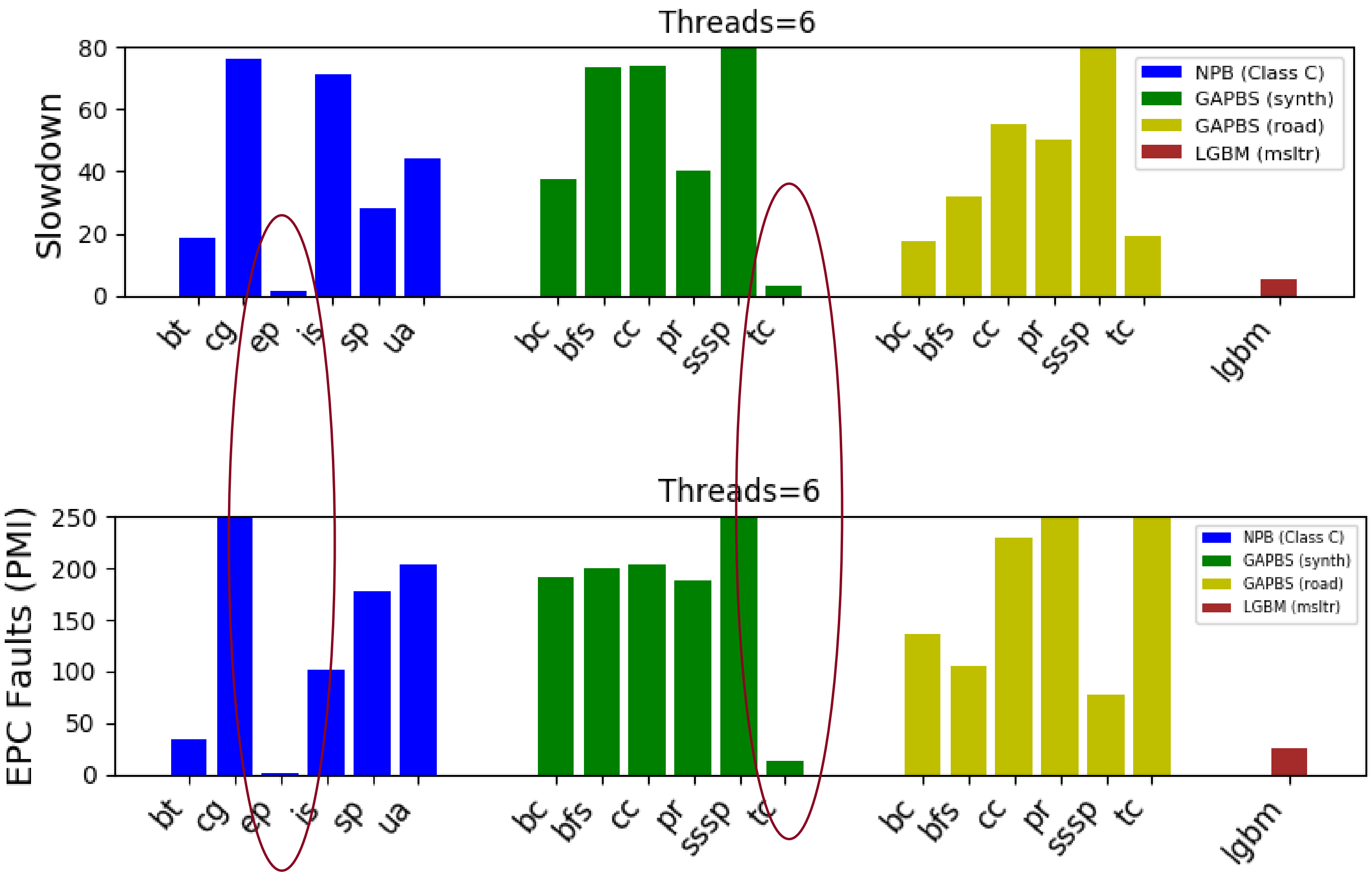
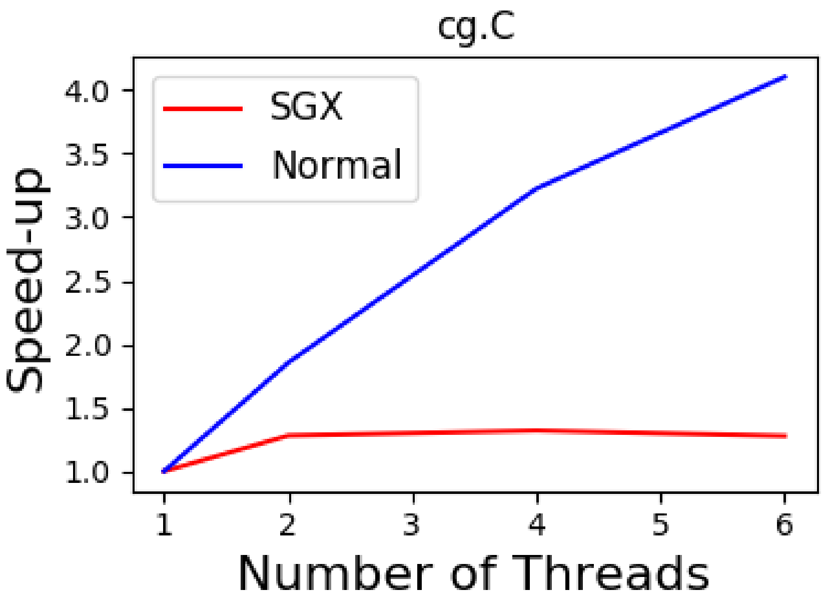
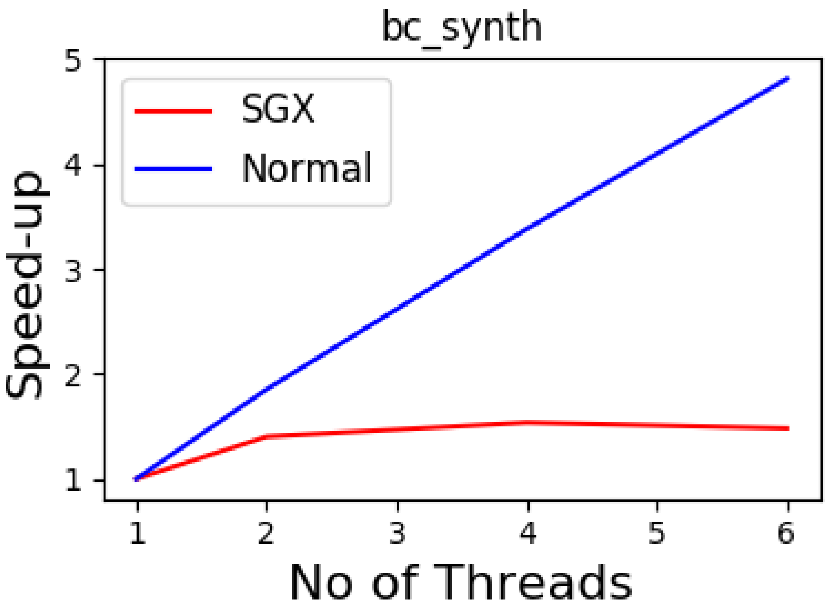


All the benchmarks have large resident memory except ep & tc_synth

Impact of Increasing Execution Threads (under SGX)

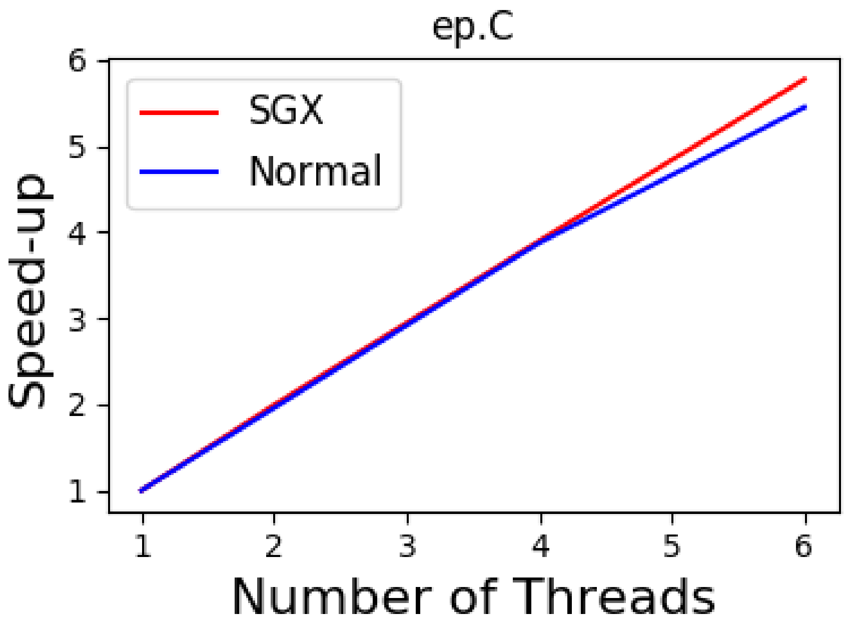




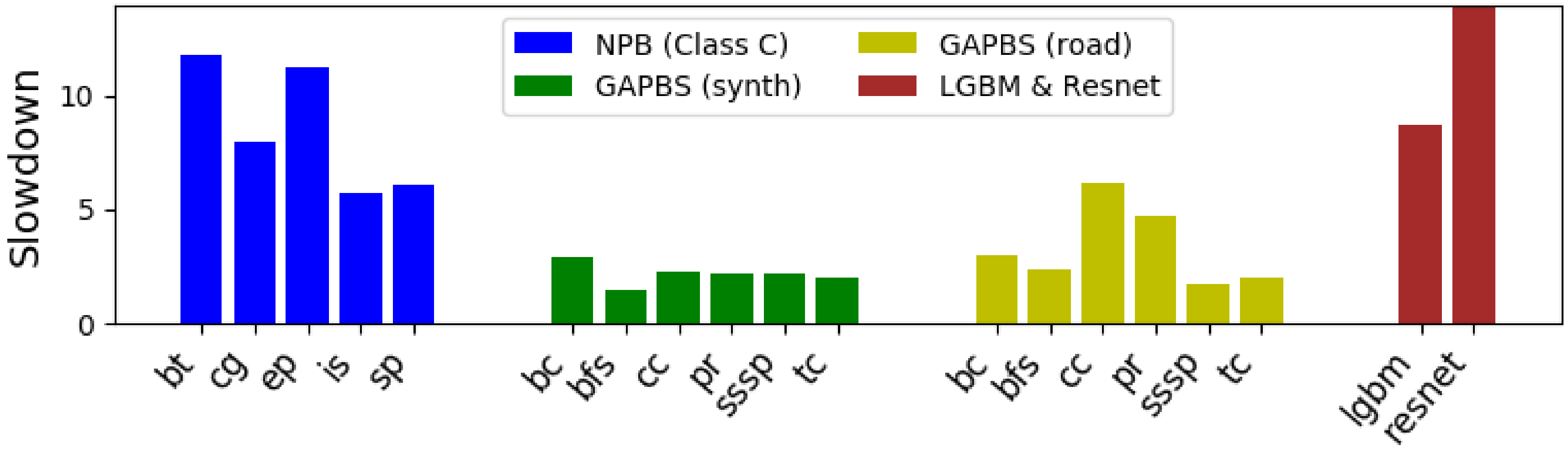
Don't scale well, as they have large resident memory

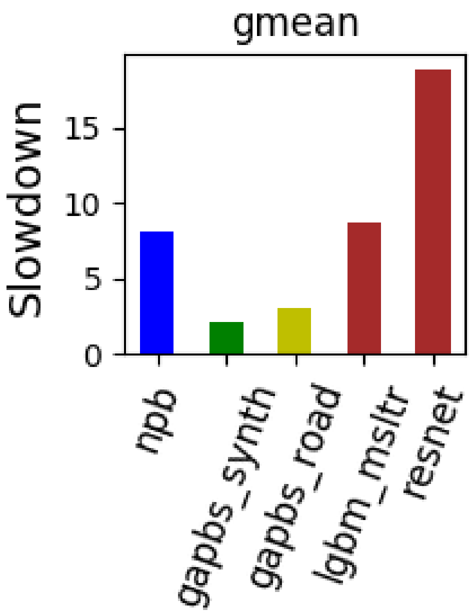
Impact of Increasing Execution Threads (under SGX)

Scales normally under SGX and has a small memory footprint



Performance Impact of SEV





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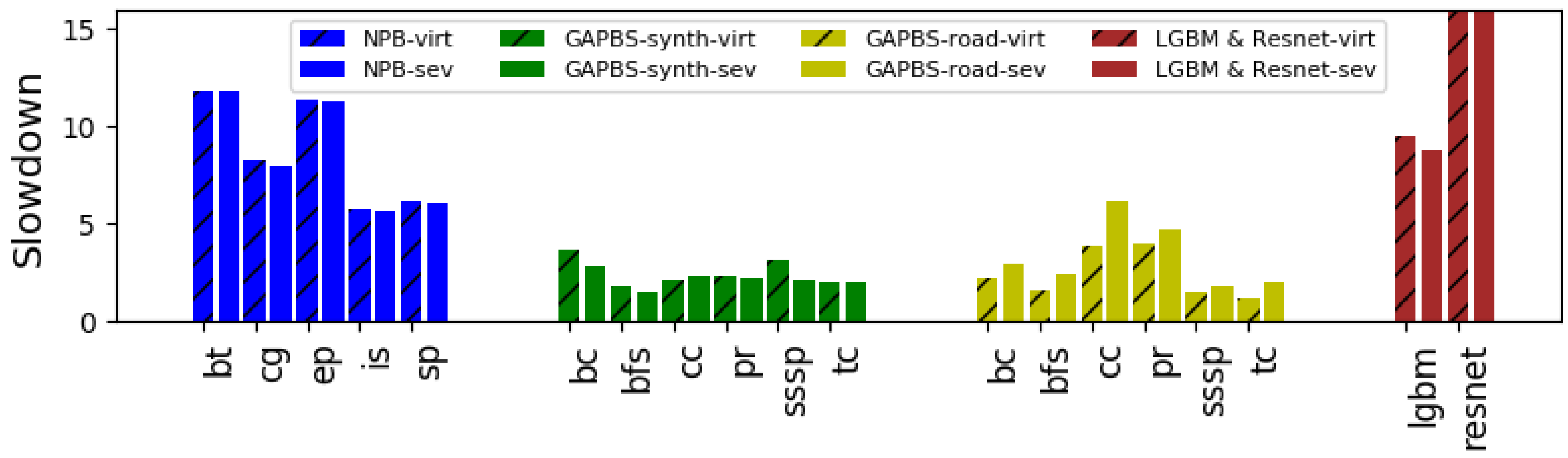
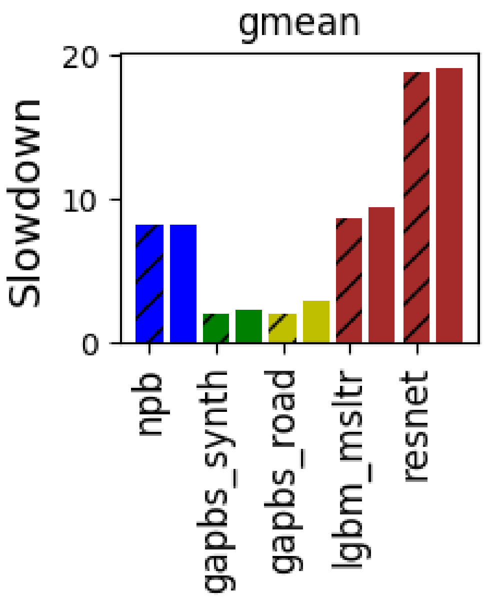




Virtualization appears to be the biggest reason of slowdown

Preliminary Takeaways

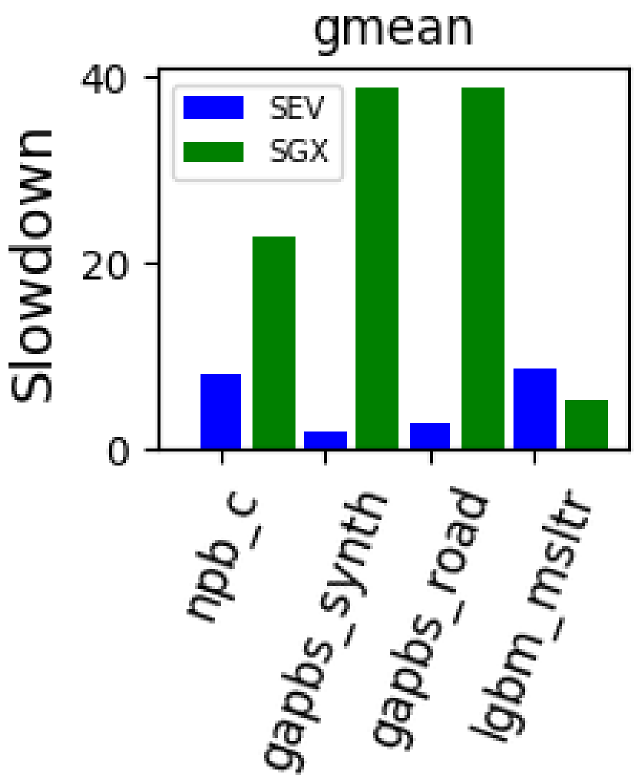
Future TEEs should support HPC apps

Smaller slowdowns for SEV

Performance issues for SGX

- EPC faults
- Multiple execution threads

Dynamic choice of threat model



SEV and SGX slowdowns