Agile Paging:
Exceeding the Best of Nested and Shadow Paging

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Virtualizing memory

1. Nested Paging

- gVA
  - Guest Page Table
  - gPA
  - Nested Page Table
  - hPA

   Longer page walk

   Fast in-place updates

2. Shadow Paging

- gVA
  - Guest Page Table (Read Only)
  - Nested Page Table
  - Shadow Page Table
  - hPA

   Shorter page walk

   Slow mediated updates
Performance Overheads

- **Nested**: At most 31% slower
- **Shadow**: At most 70% slower

EXECUTION TIME OVERHEADS

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Solid bottom bar: Page walk overhead
Hashed top bar: VMM overheads

B: Unvirtualized
N: Nested Paging
S: Shadow Paging
A: Agile Paging
Performance Overheads

Agile Paging: At most 4% slower

Solid bottom bar: Page walk overhead
Hashed top bar: VMM overheads

B: Unvirtualized
N: Nested Paging
S: Shadow Paging
A: Agile Paging

EXECUTION TIME OVERHEADS

Agile Paging: At most 4% slower
Agile Paging

Best of both within same address space and same page walk

- Start page walk in shadow mode → Achieving fast TLB misses
- Optionally switch to nested mode → Allowing fast in-place updates
- Modest hardware change & straightforward VMM support

Session 10B – Wednesday @ 11:50am
In Crystal Ballroom (B-side)