The Virtual Block Interface:
A Flexible Alternative to the Conventional Virtual Memory Framework

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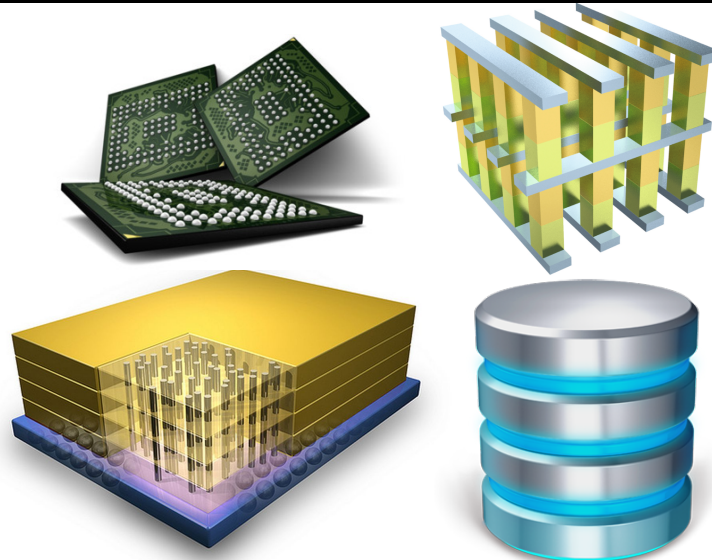
Computing Systems Are Diversifying

Application

Cannot adapt efficiently

Virtual Memory
**managed by the operating system**

Hardware

Motivation, Goal, and Key Idea

- Continually adapting the conventional virtual memory framework is **challenging**

- Prior work for optimizing virtual memory
    - Applicable to only limited problems or applications
    - Not compatible and can not be implemented in a single system

- **Goal:** Design an alternative virtual memory framework that
    - Efficiently and flexibly supports increasingly diverse system configurations
    - Provides the key features of conventional virtual memory framework while eliminating its key inefficiencies

- **Virtual Block Interface (VBI):** A new virtual memory framework
    - **Key Idea:** Delegate physical memory management to dedicated hardware in the memory controller

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VBI: Overview
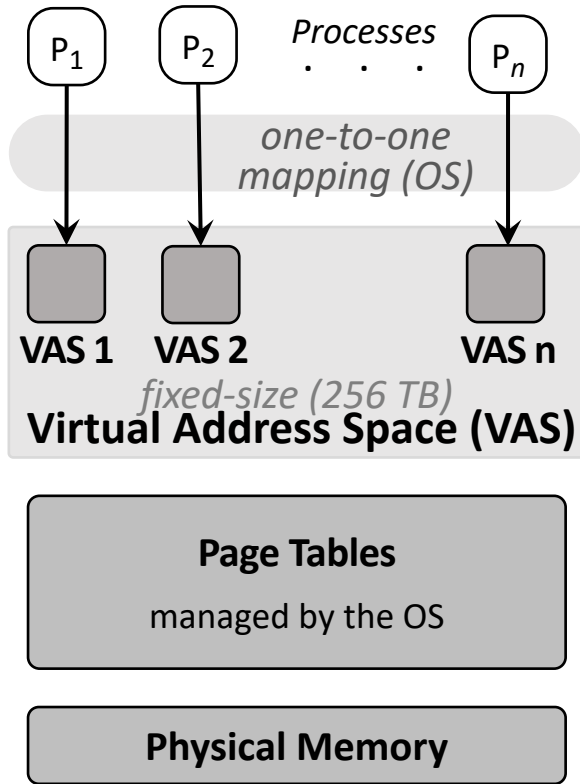
Conventional Virtual Memory
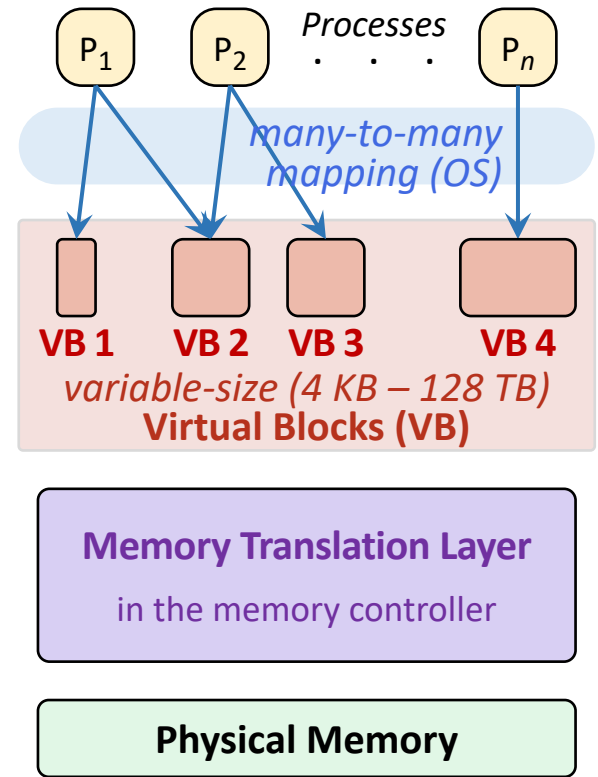
VBI

Key Optimizations and Results

- **Benefits:** Many optimizations not easily attainable before. Examples:
    - Appropriately sized process address space
    - Flexible address translation structures
    - Communicating data semantics to the hardware   *Inherent to VBI design*
    - Inherently virtual caches
    - Eliminating 2D page walks in virtual machines
    - Delayed physical memory allocation   *Covered in the paper*
    - Early memory reservation mechanism

- **Evaluation:** Two example use cases
    - VBI significantly improves performance in both native execution and virtual machines (by 2.4x and 4.3x on average, respectively)
    - Increases the effectiveness of managing heterogeneous memory architectures

> **VBI is a promising new virtual memory framework**
> - Can enable several important optimizations
> - Increases design flexibility for virtual memory
> - A new direction for future work in novel virtual memory frameworks

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