# 6.033 Spring 2021

## Lecture #6: Virtual Machines and Performance

wrapping up operating systems

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# **operating systems** enforce modularity on a single machine using **virtualization**

in order to enforce modularity + have an effective operating system, a few things need to happen

1. programs shouldn't be able to refer to (and corrupt) each others' **memory** → **virtual memory**

2. programs should be able to **communicate** with each other → **bounded buffers** (virtualize communication links)

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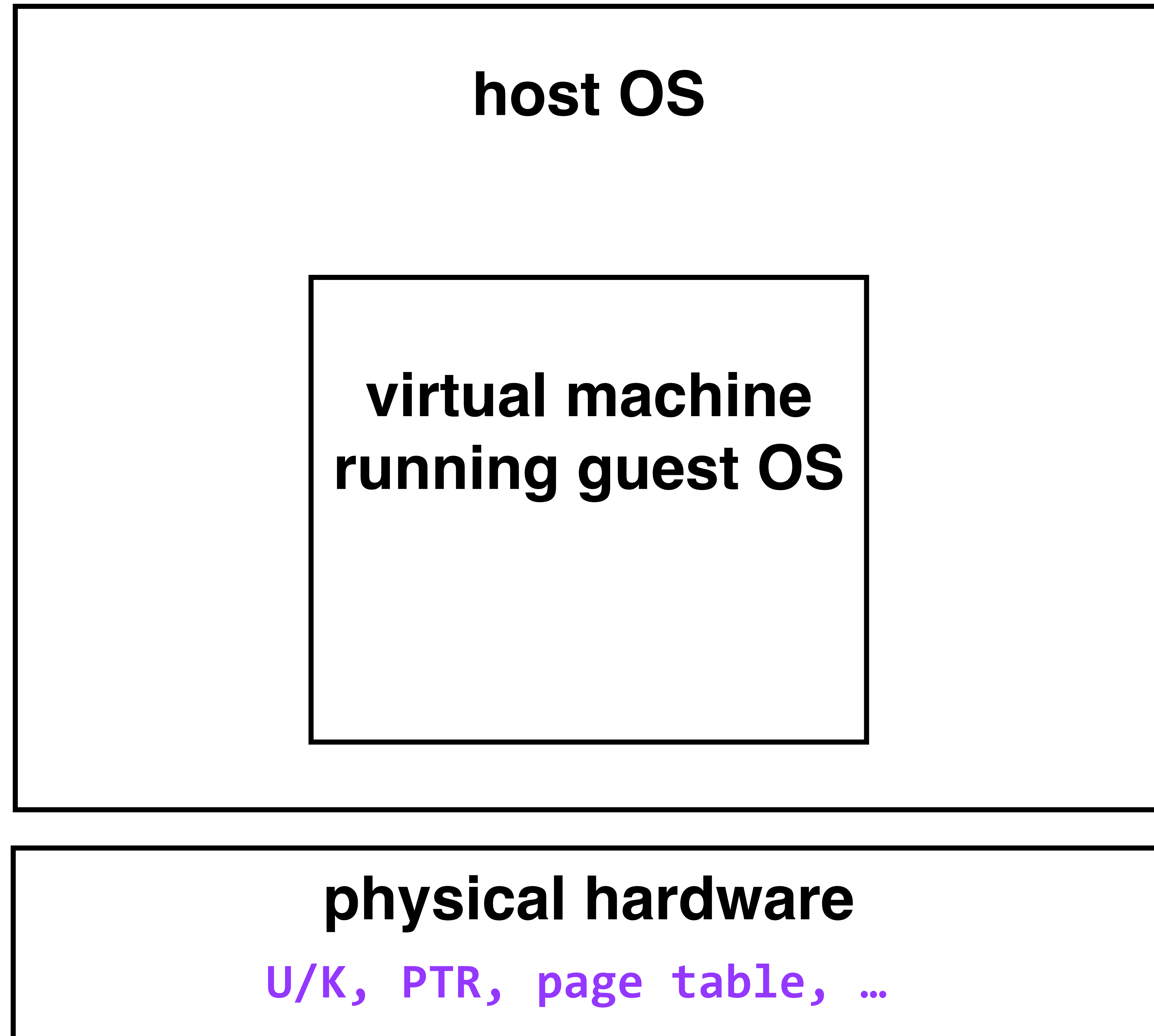
**today's goal:** run multiple operating systems at once

**common computing environment:** running multiple OSes on a single physical machine



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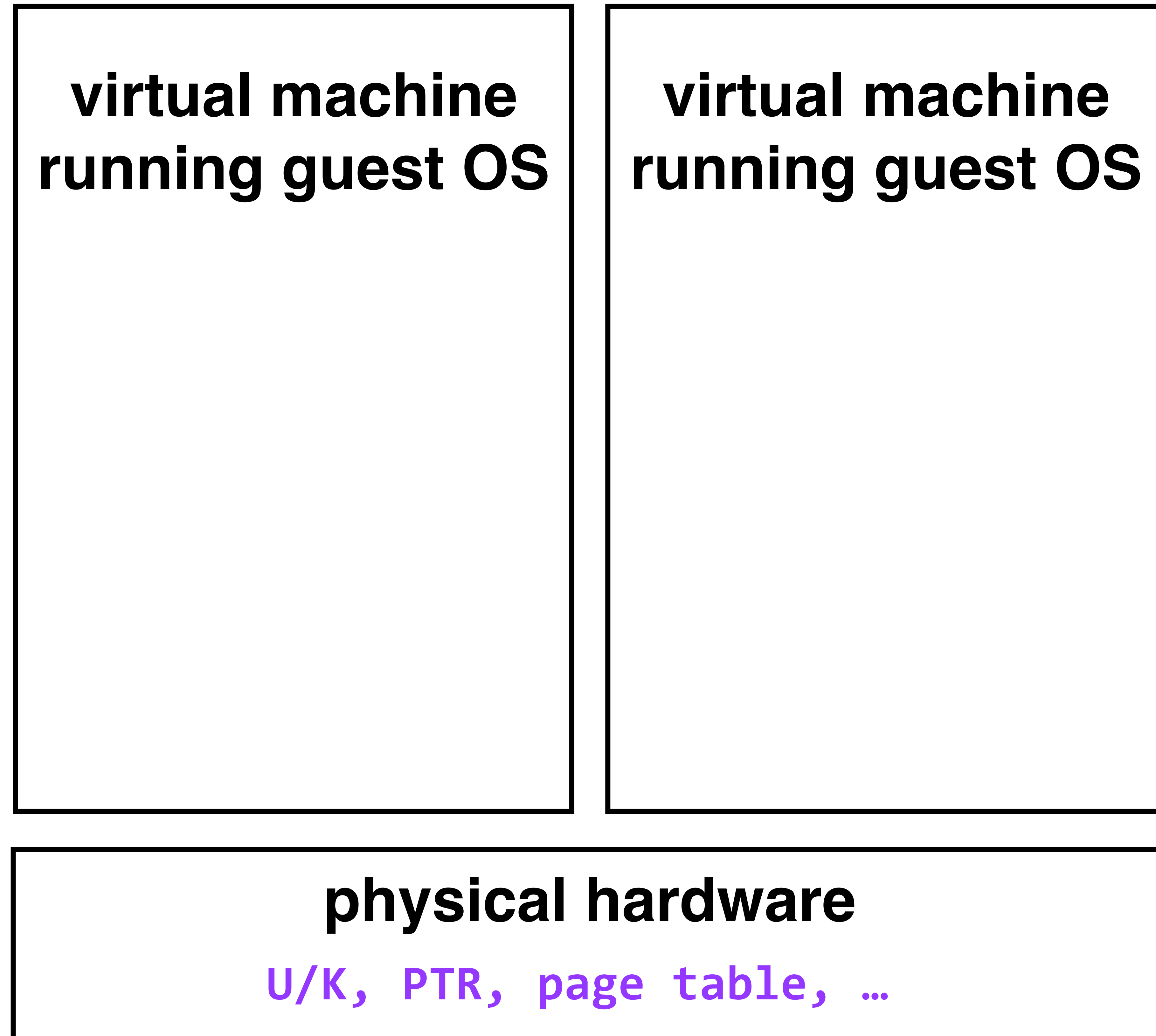

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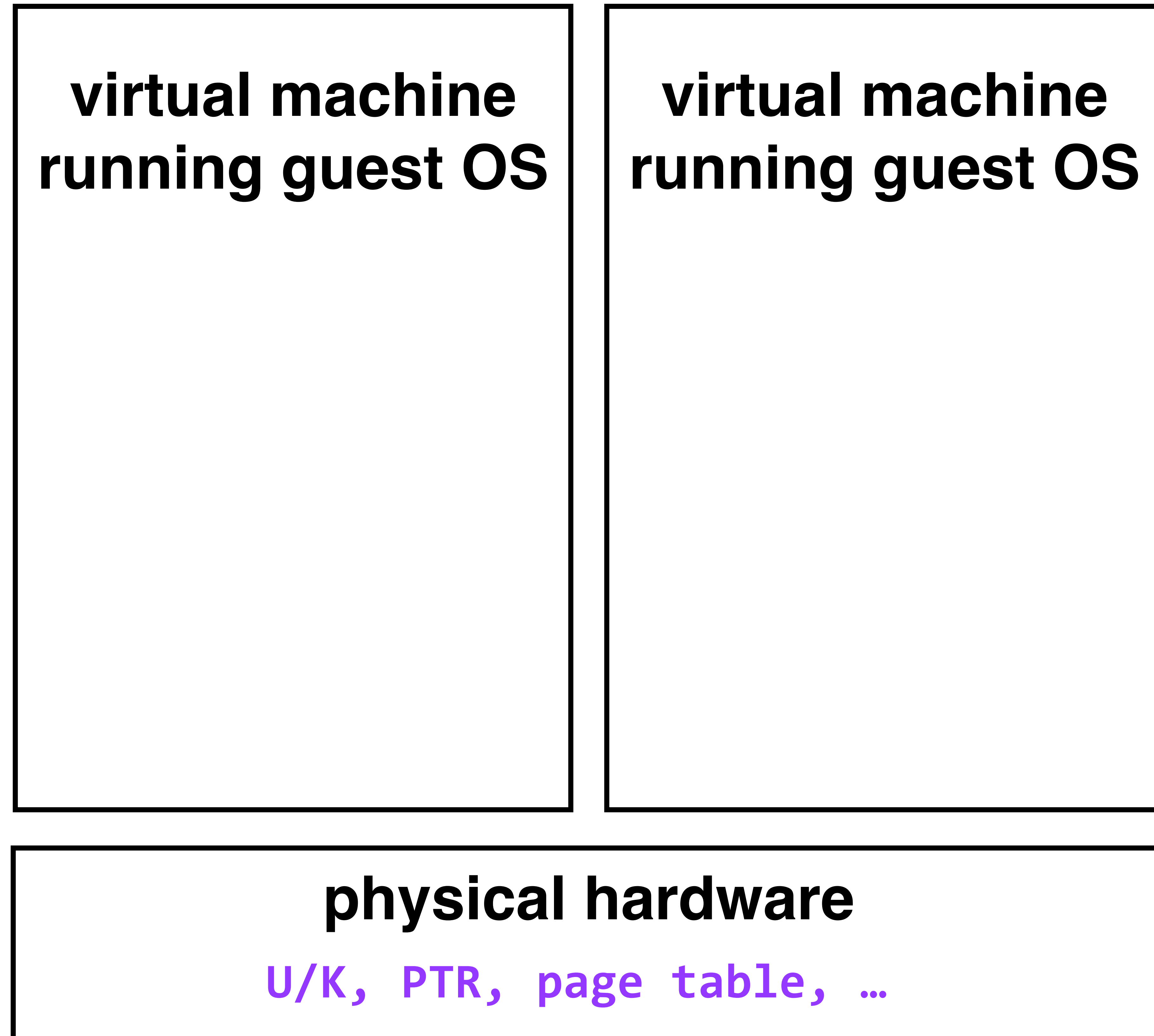
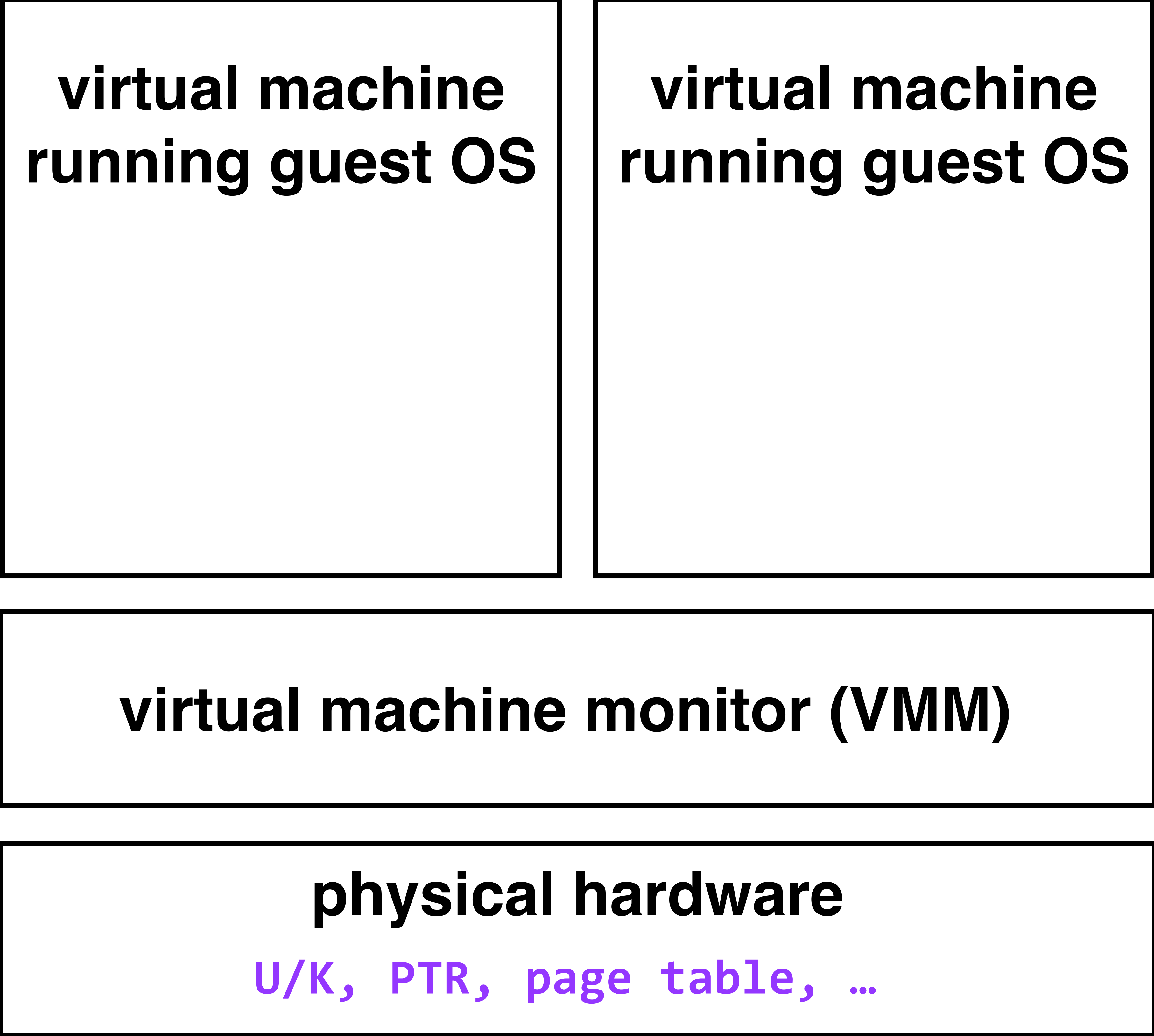



**problem:** how to (safely) share physical hardware?

**virtual machine monitor:** virtualizes the physical hardware for the guest OSes



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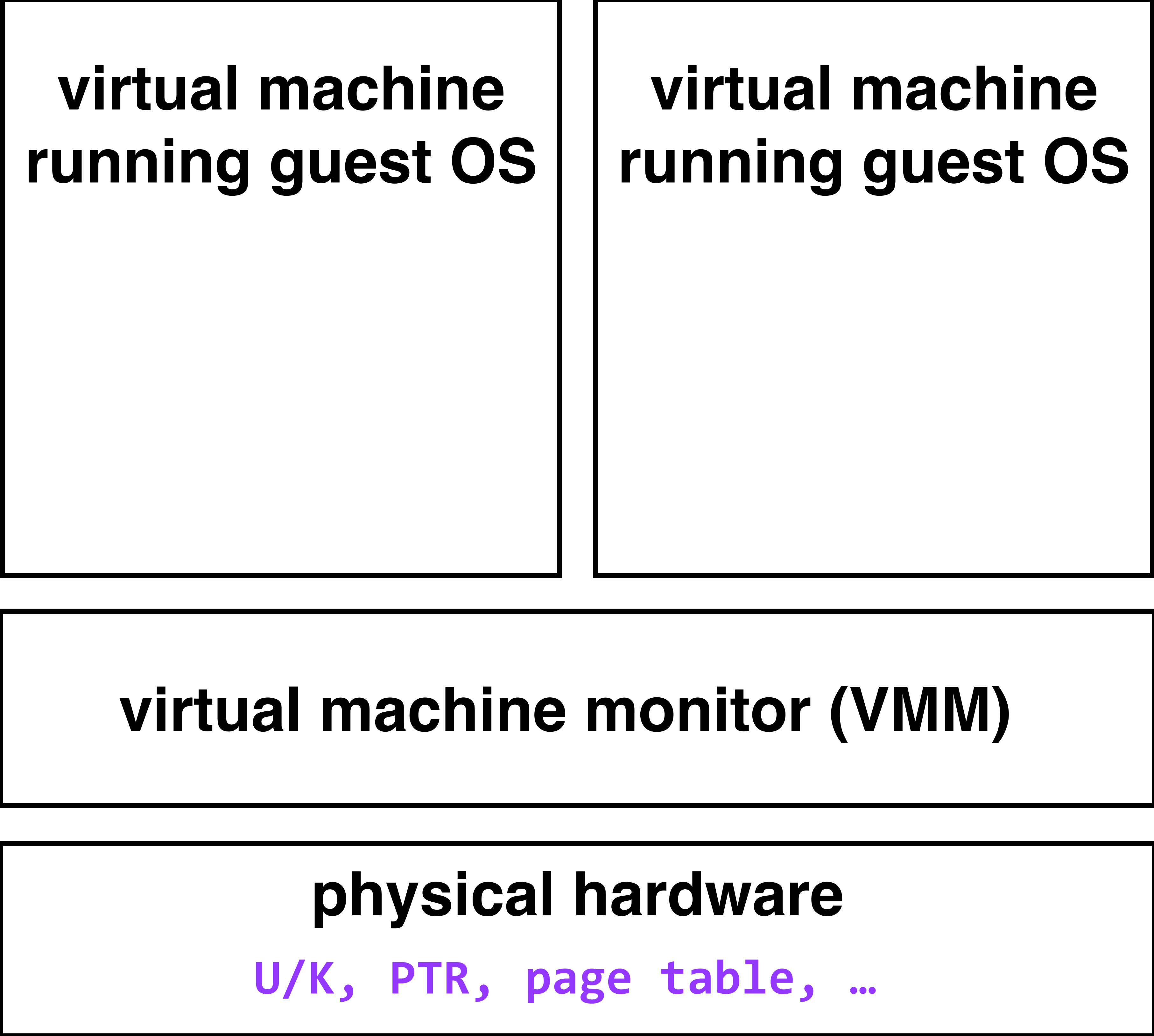


guest OSes run in user mode

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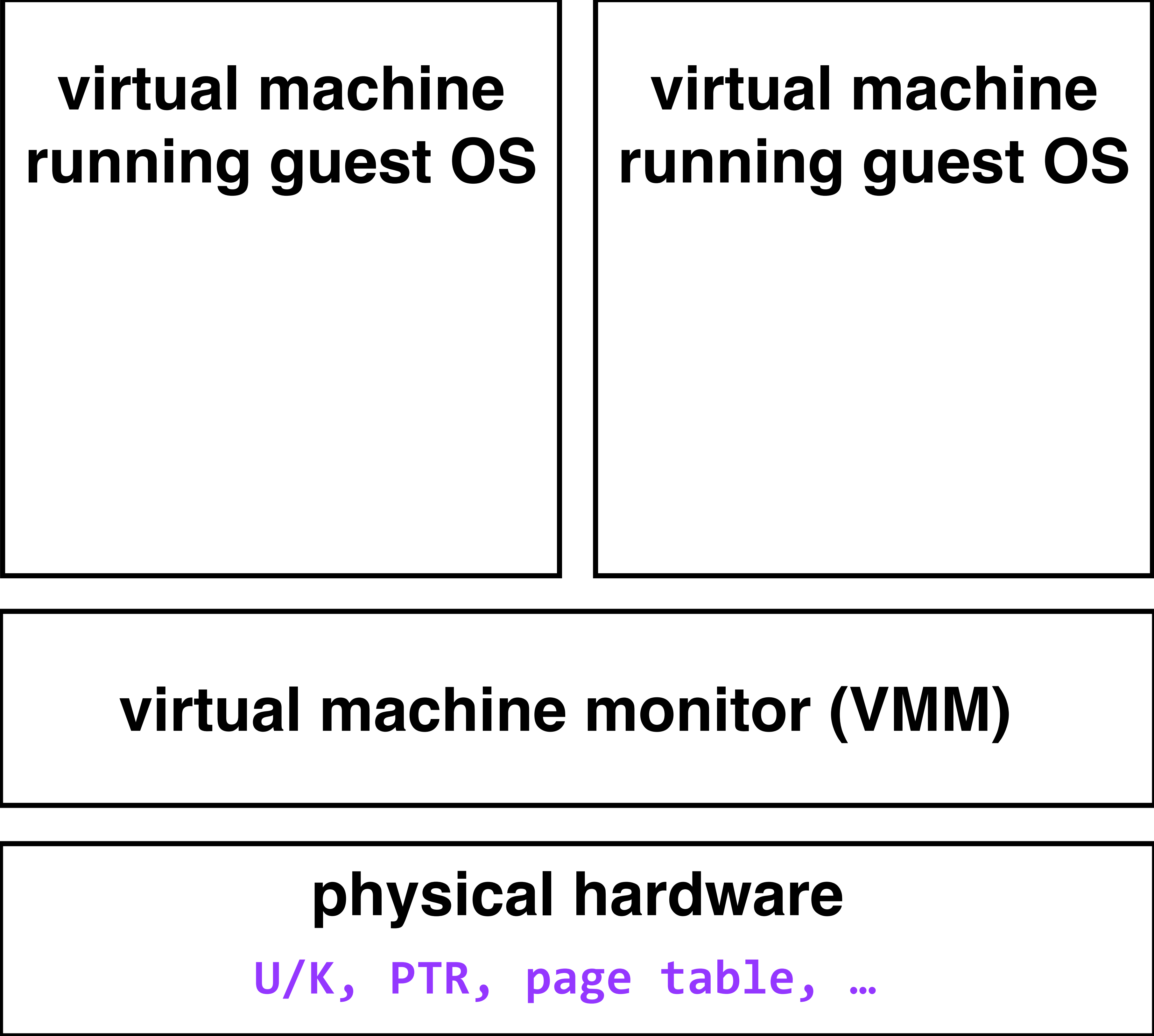


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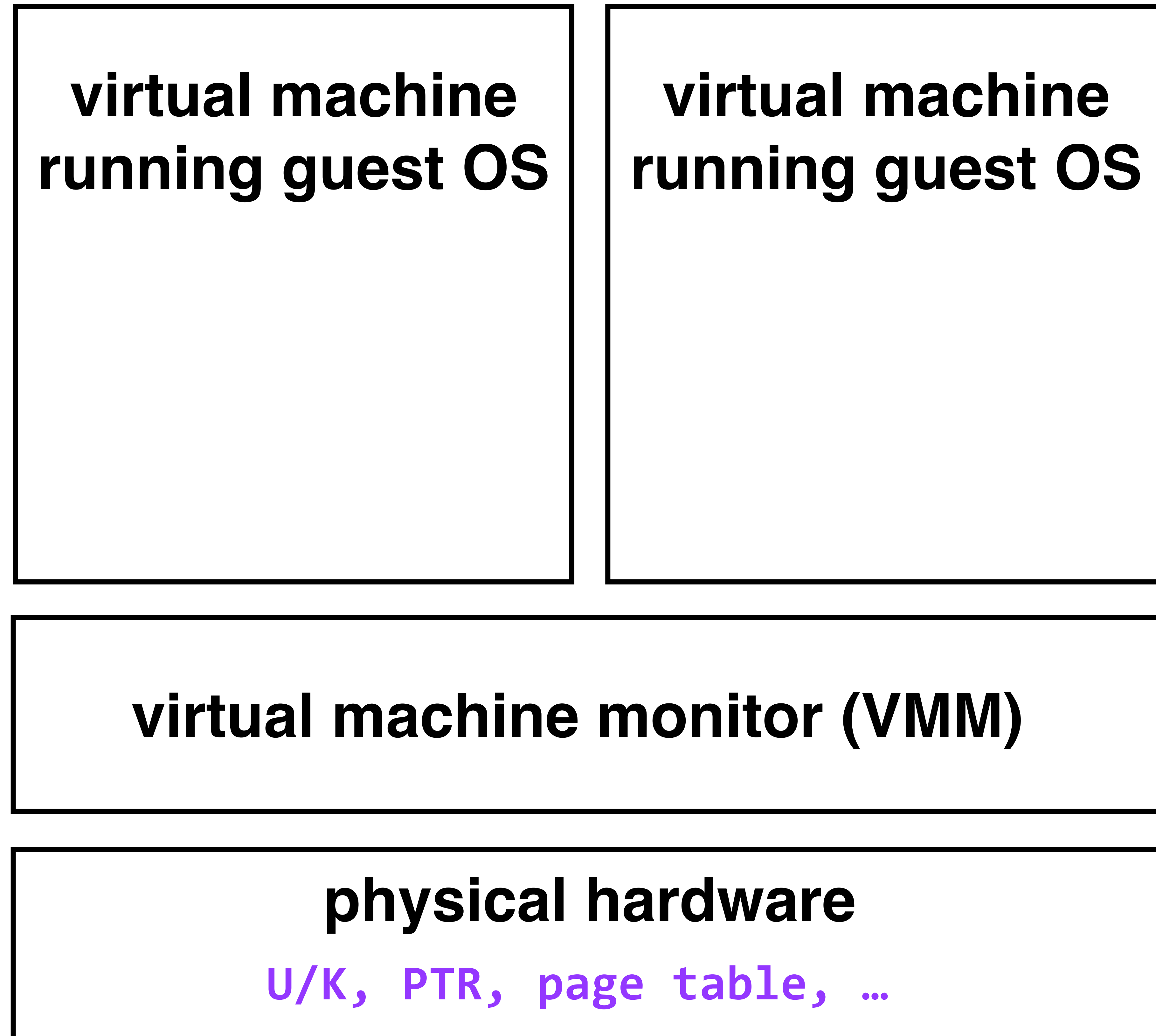


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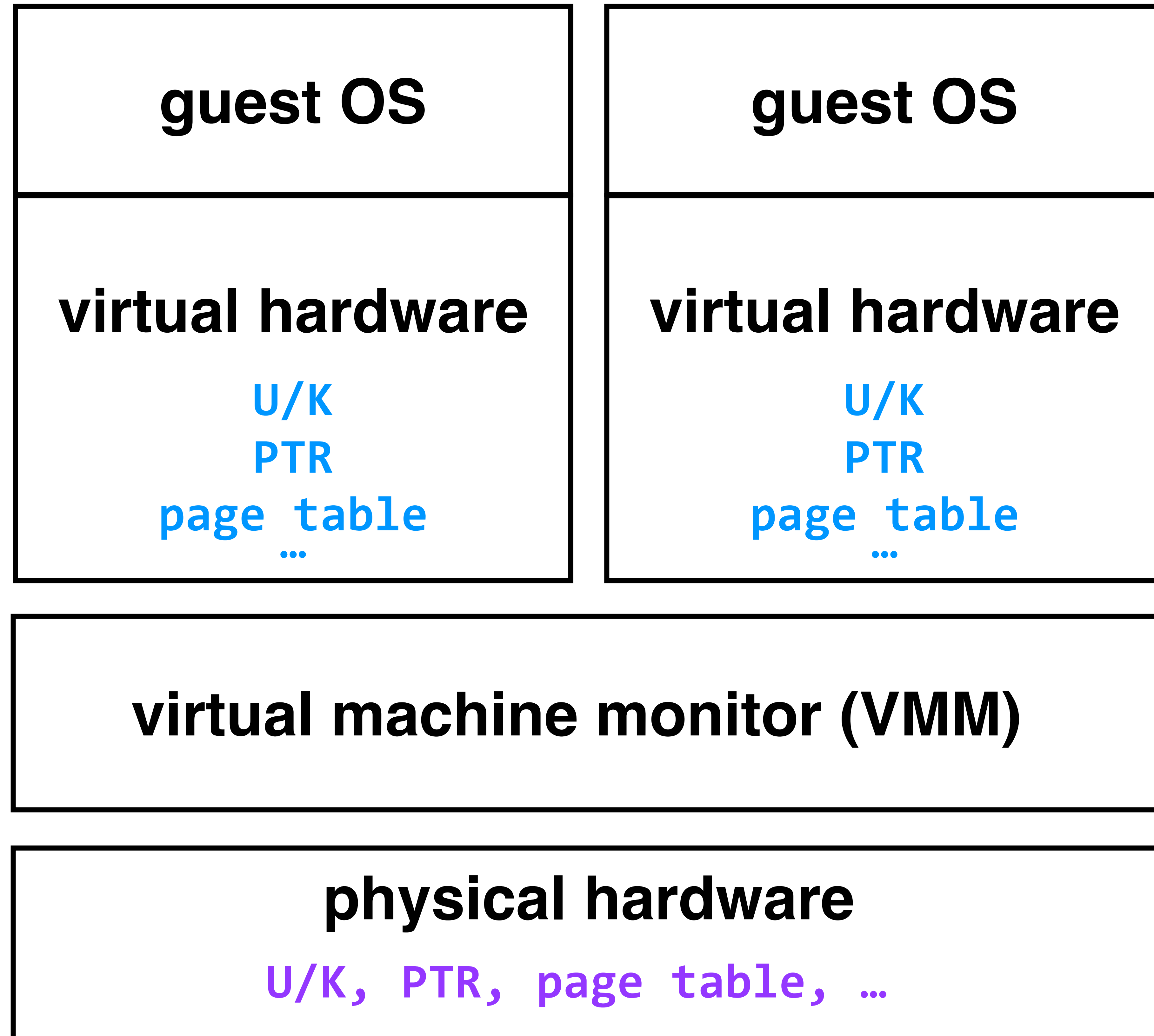


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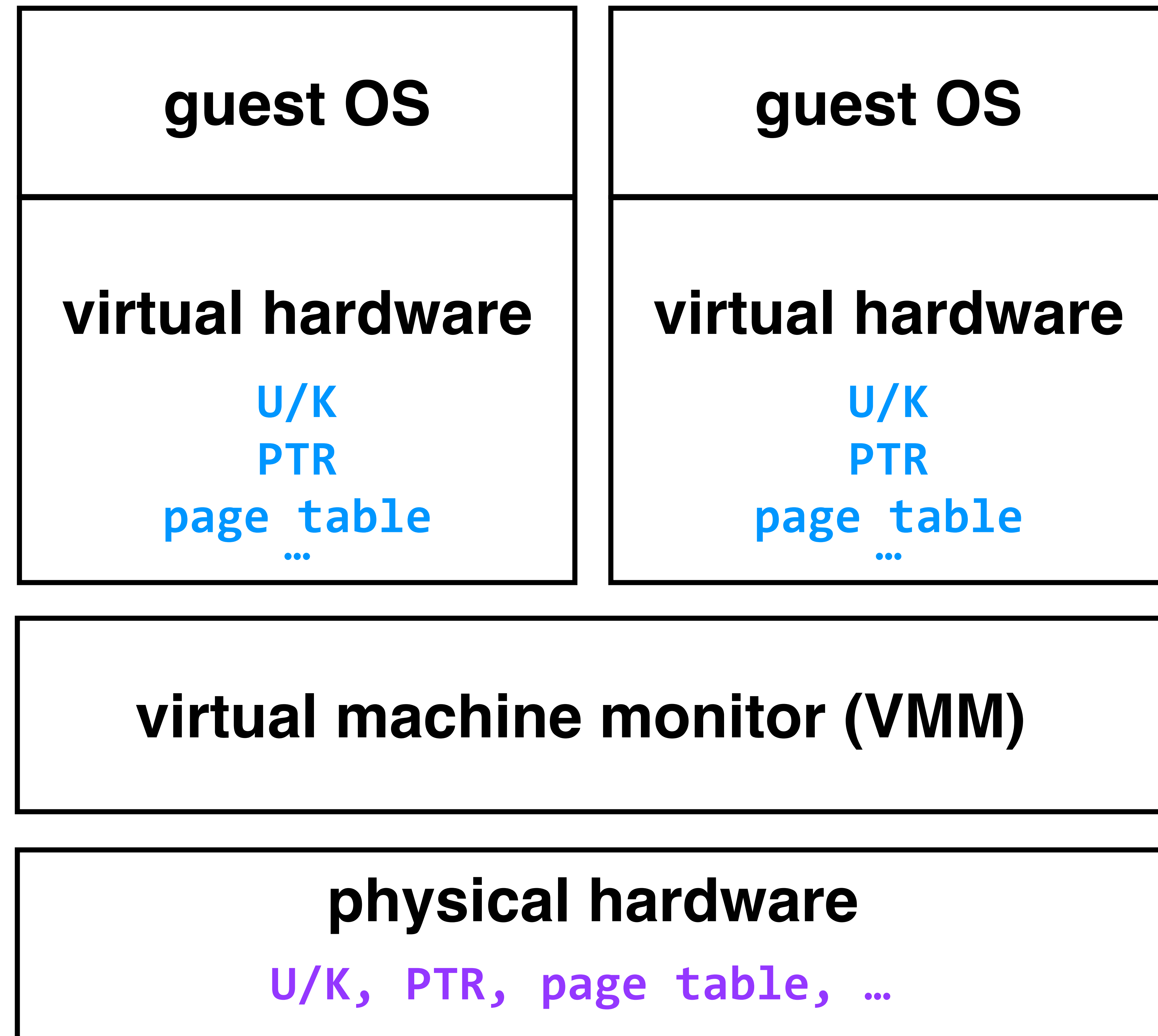


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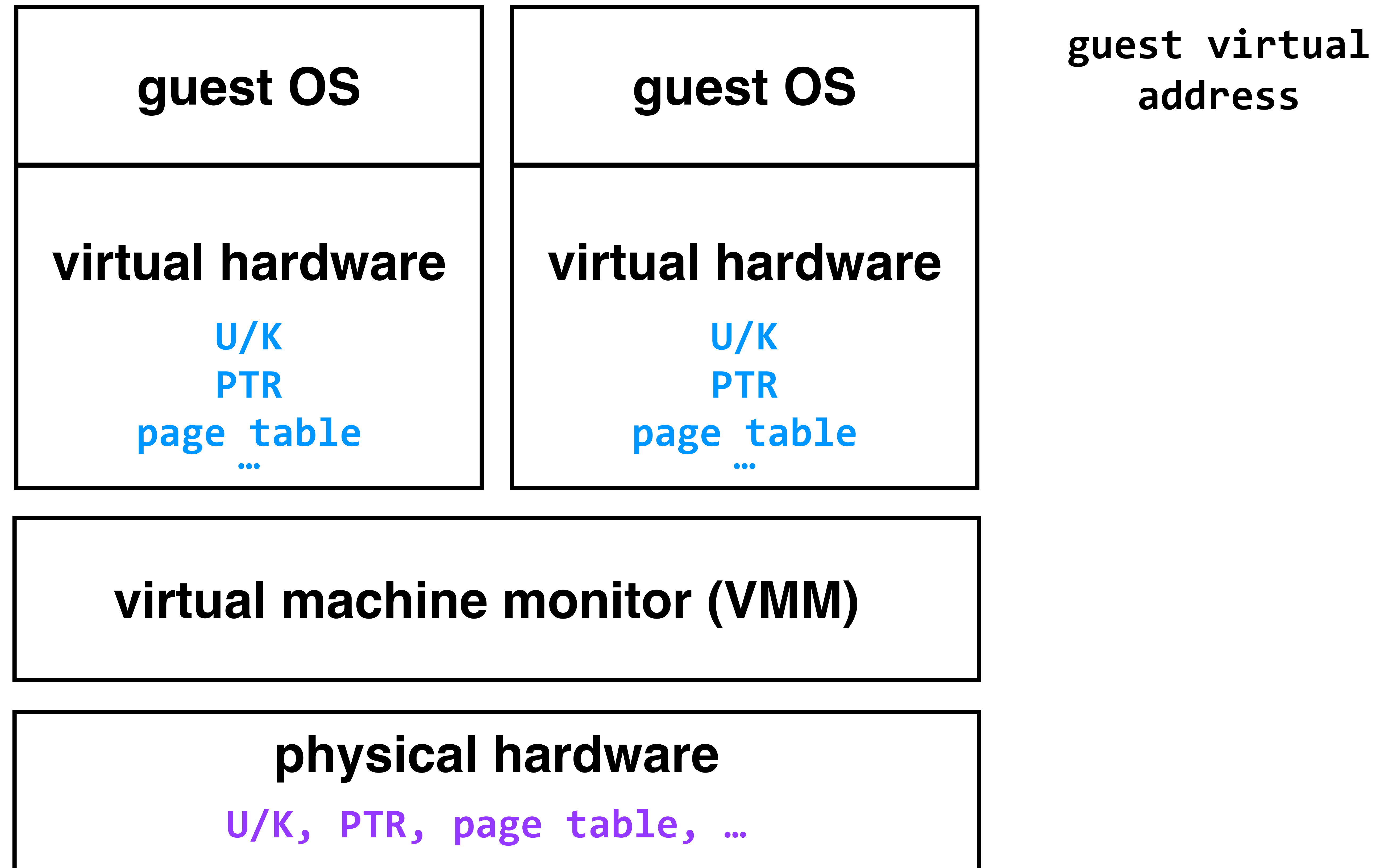


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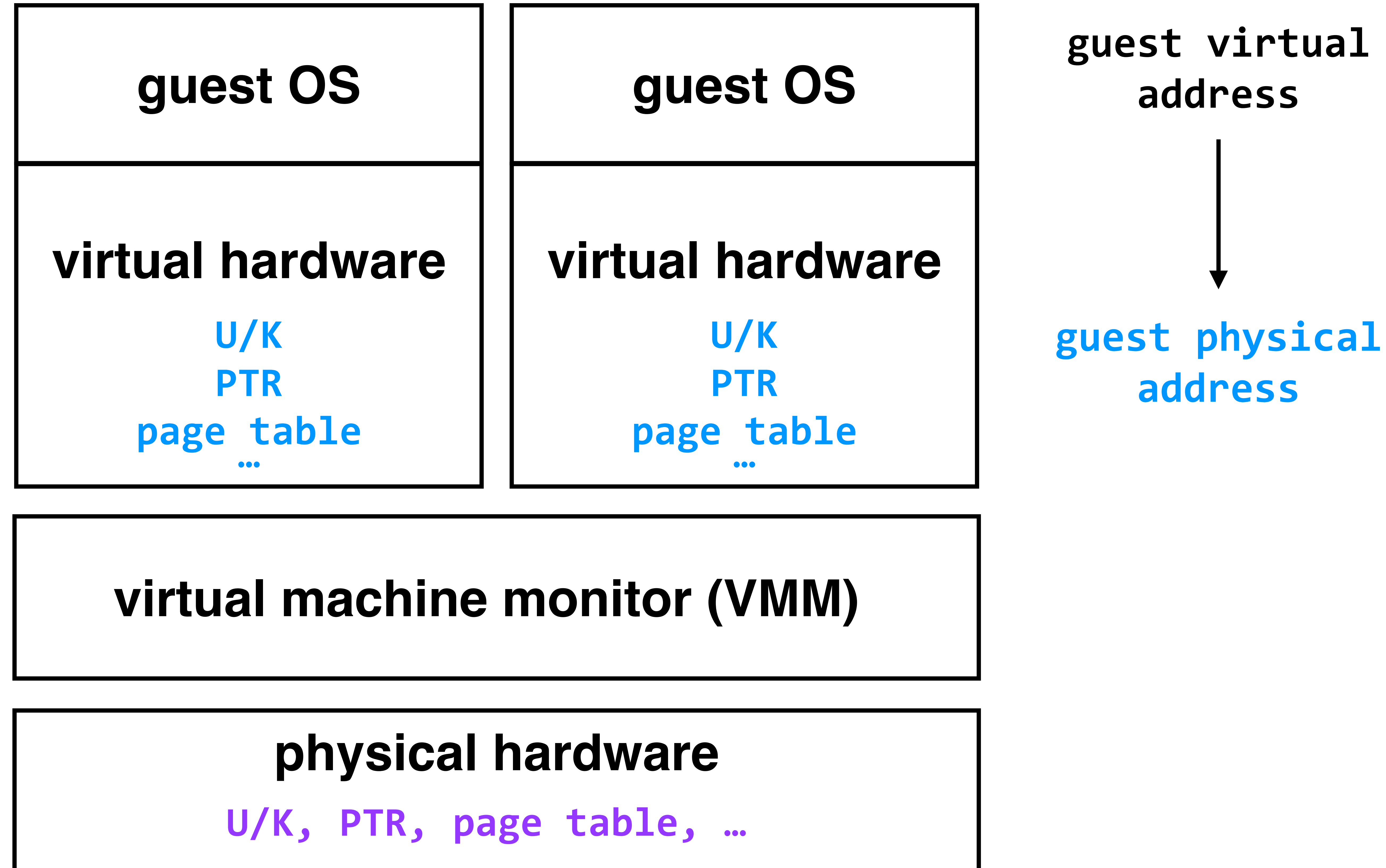


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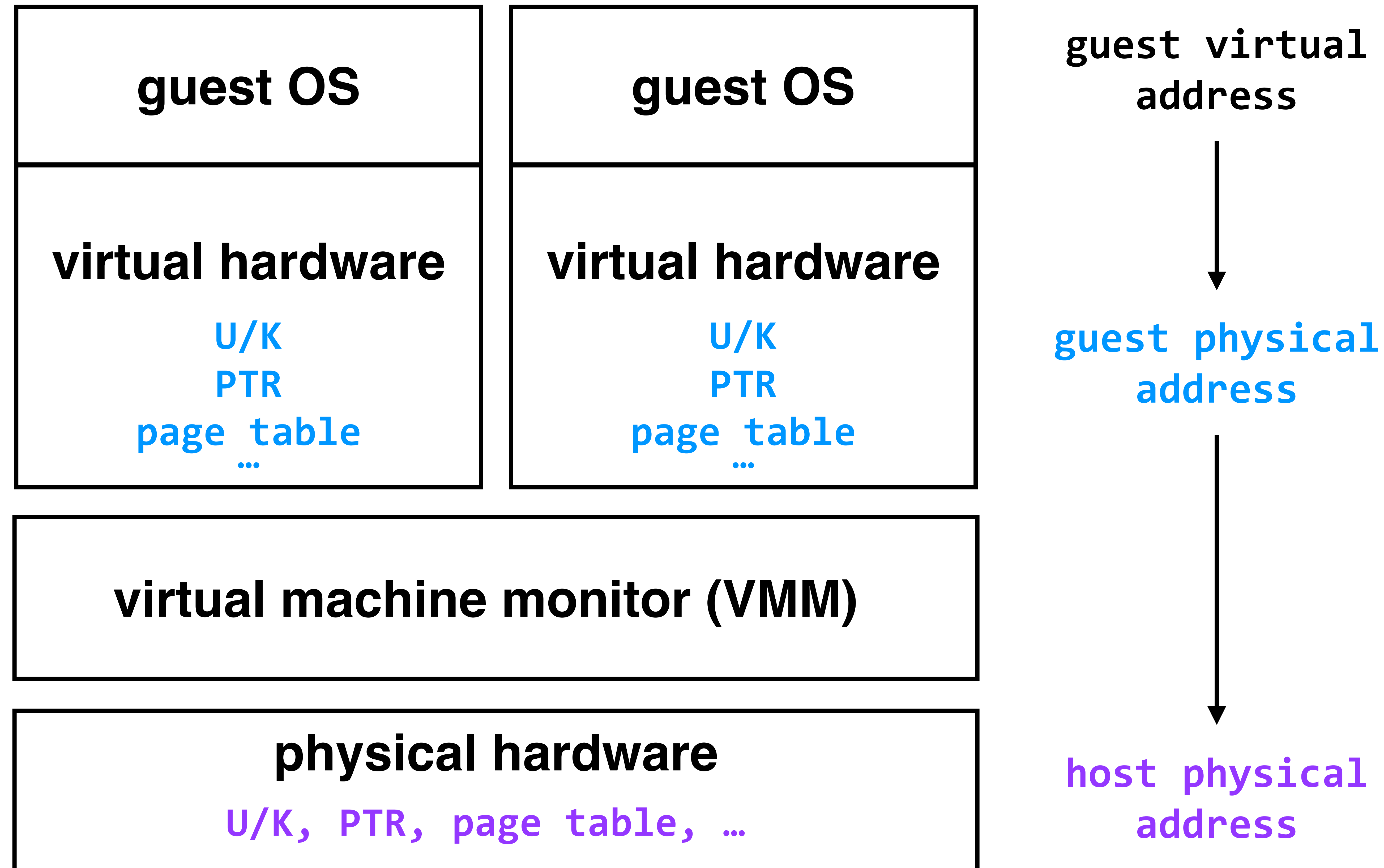


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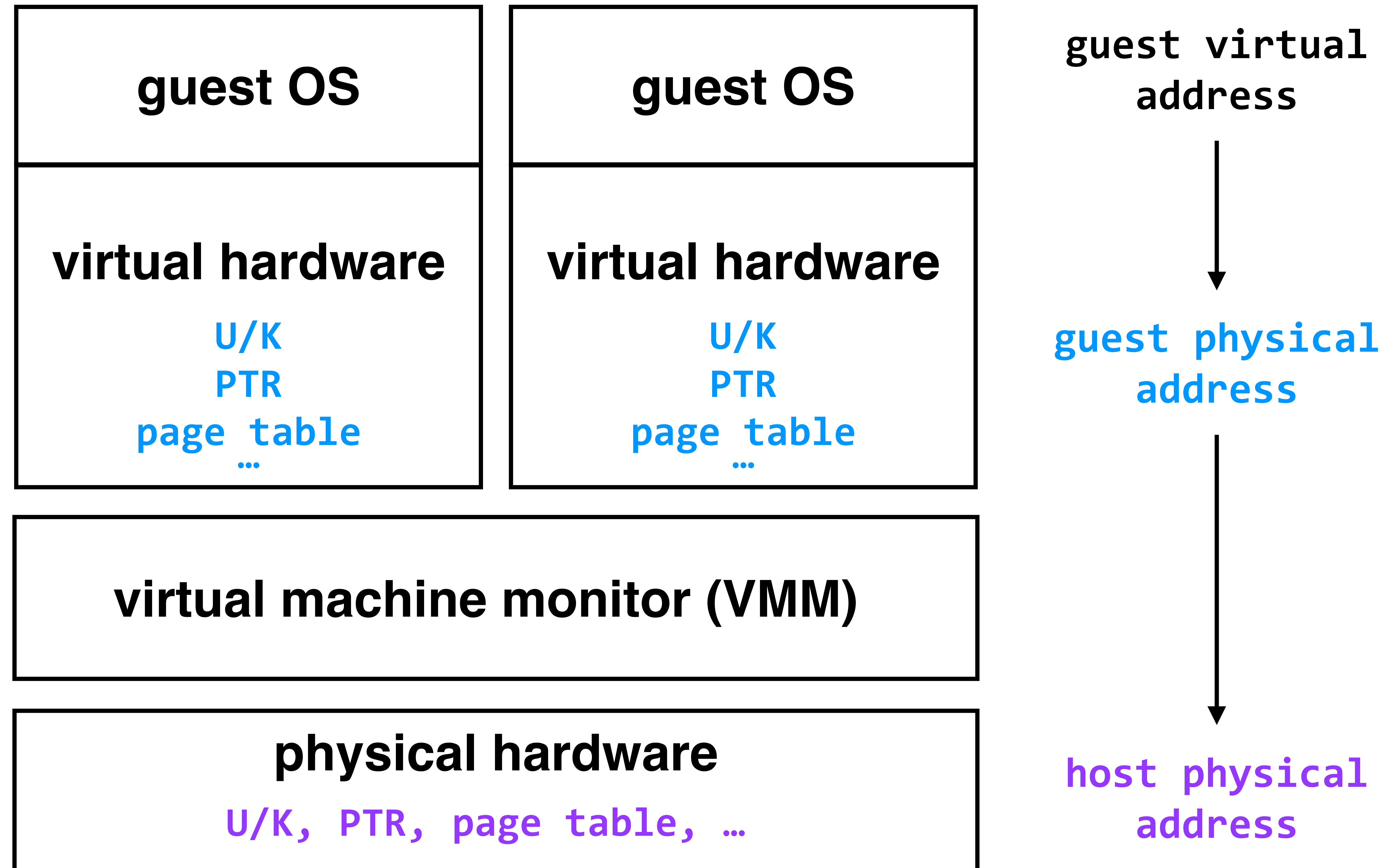


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in this example, it means that the VMM needs to step in and translate guest physical addresses to host physical addresses

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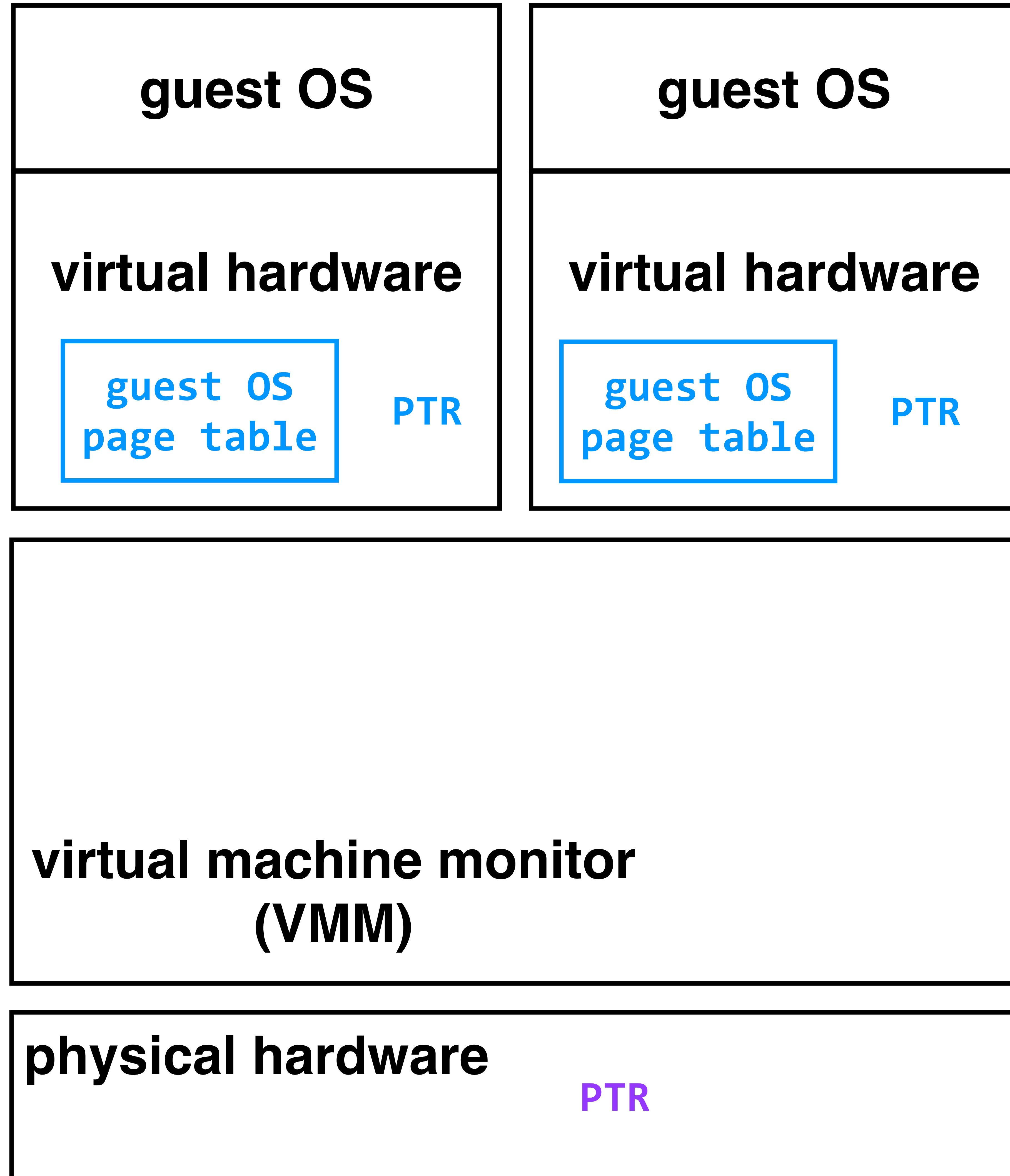

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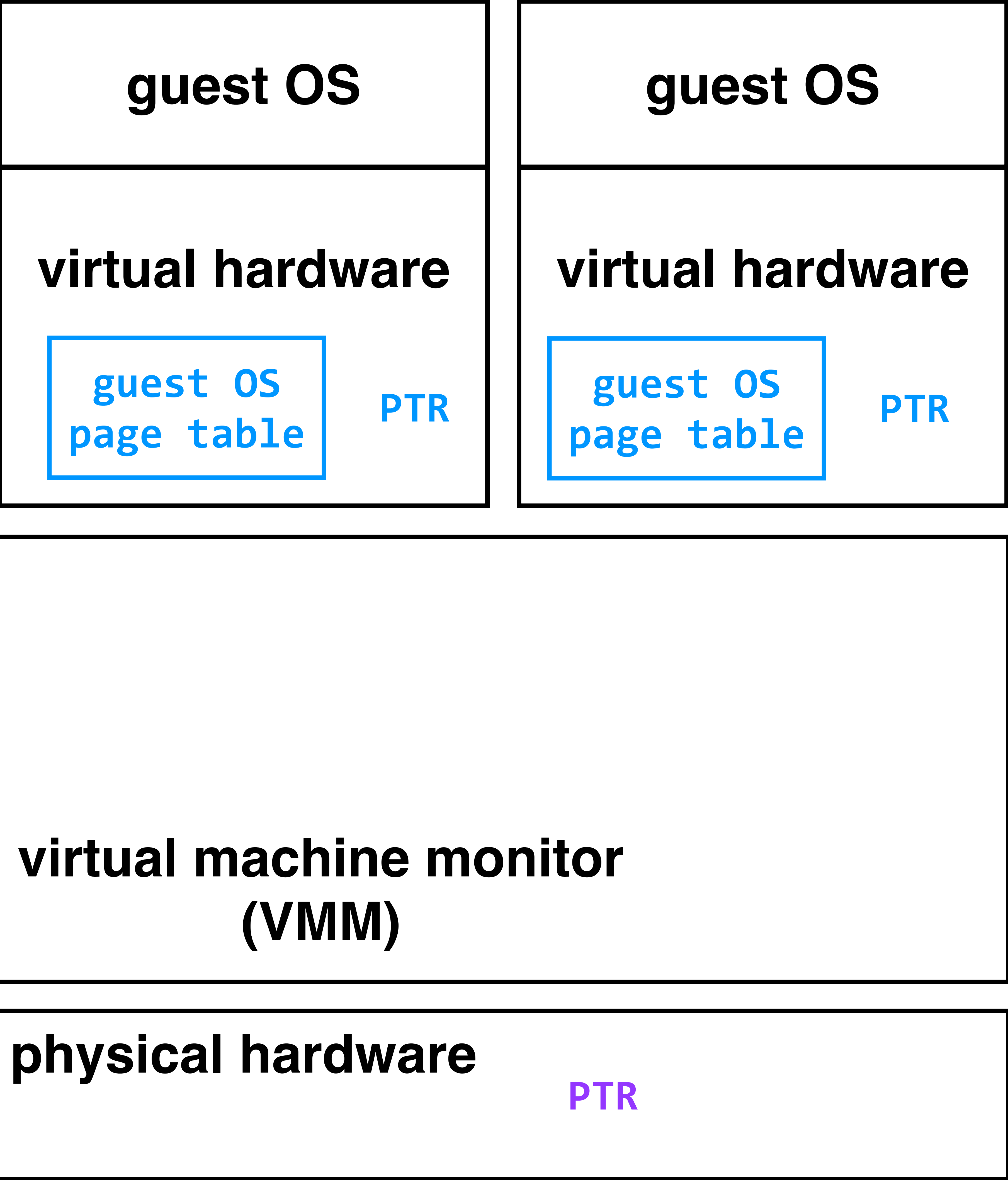

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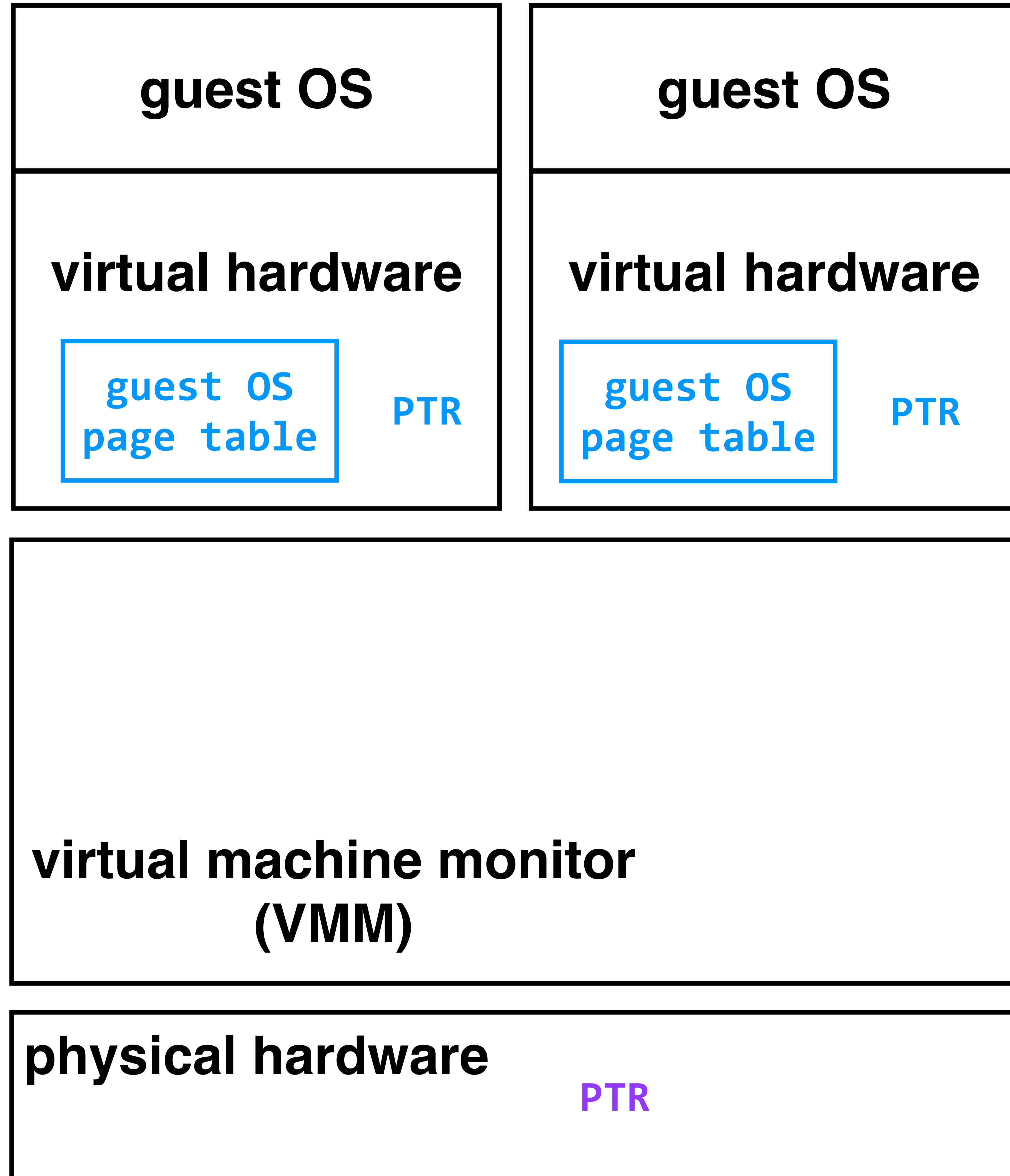


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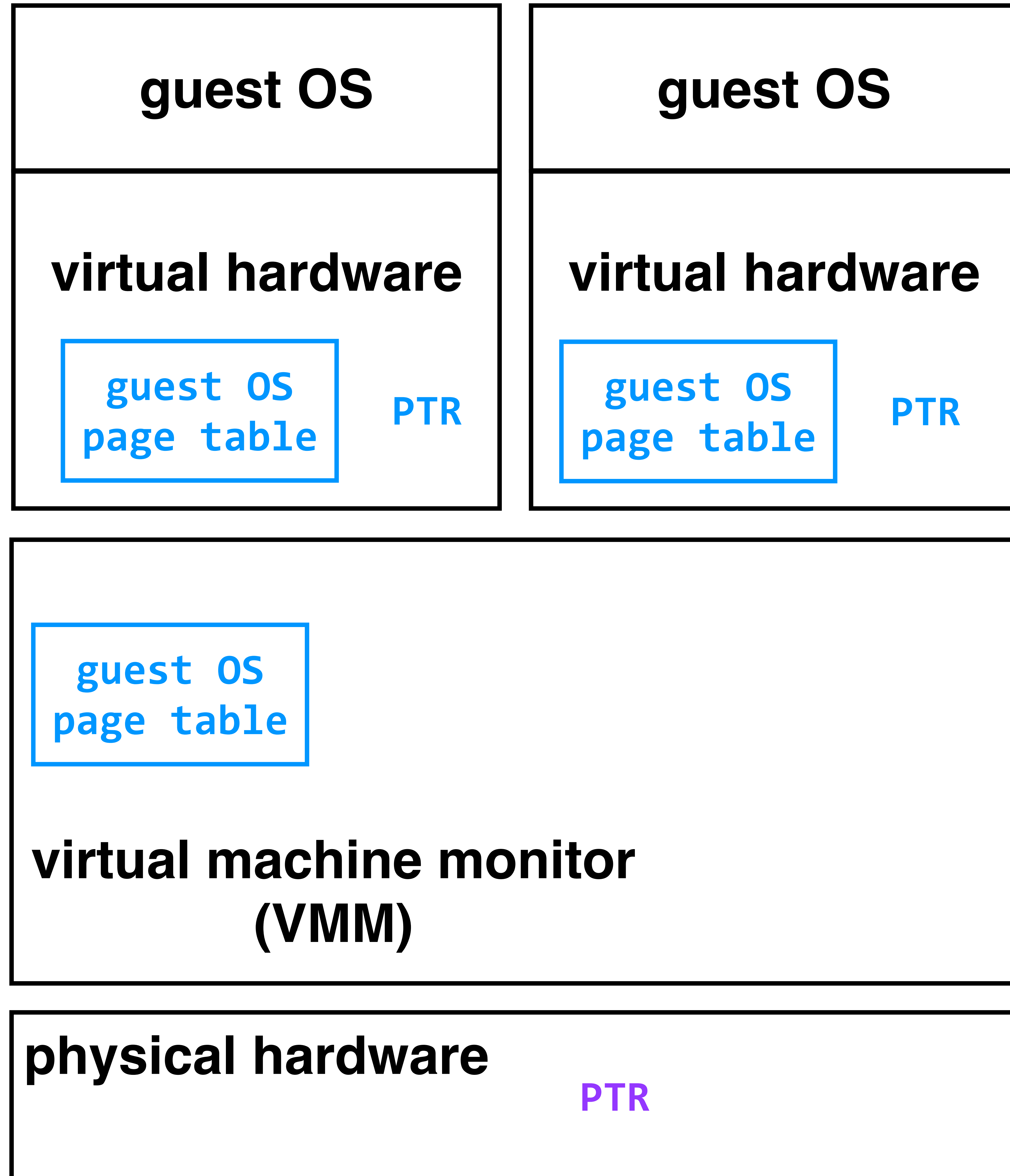


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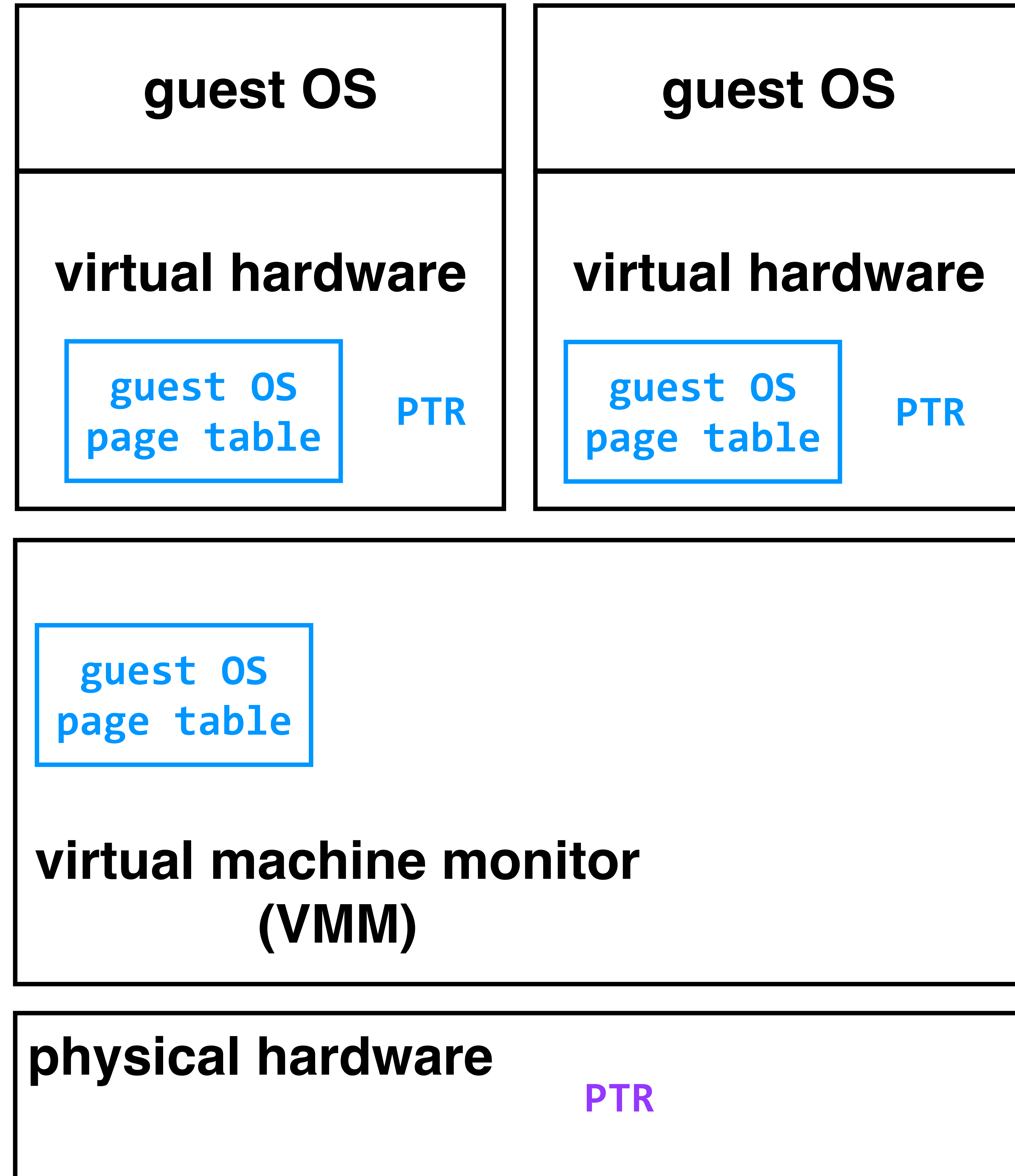


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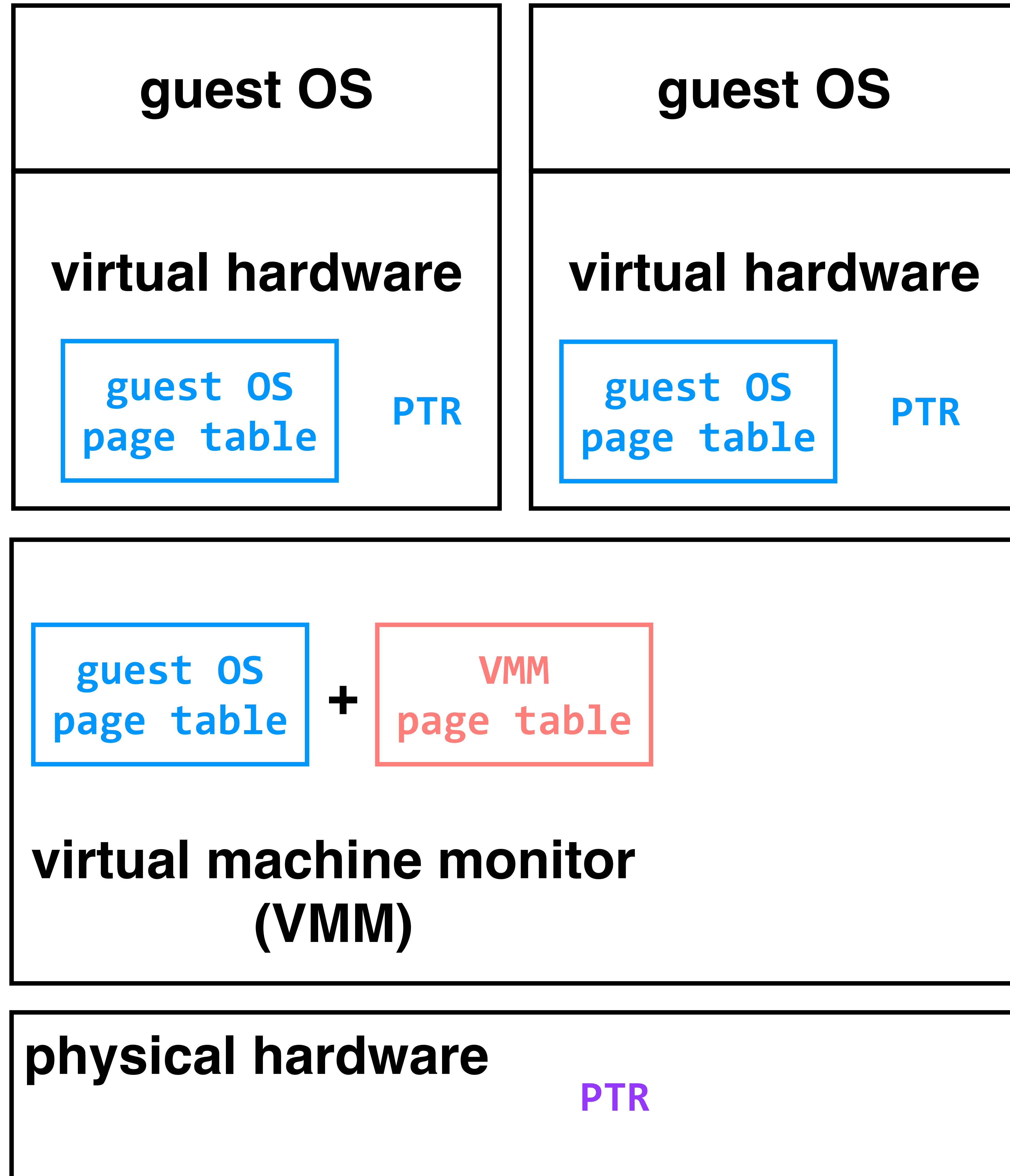


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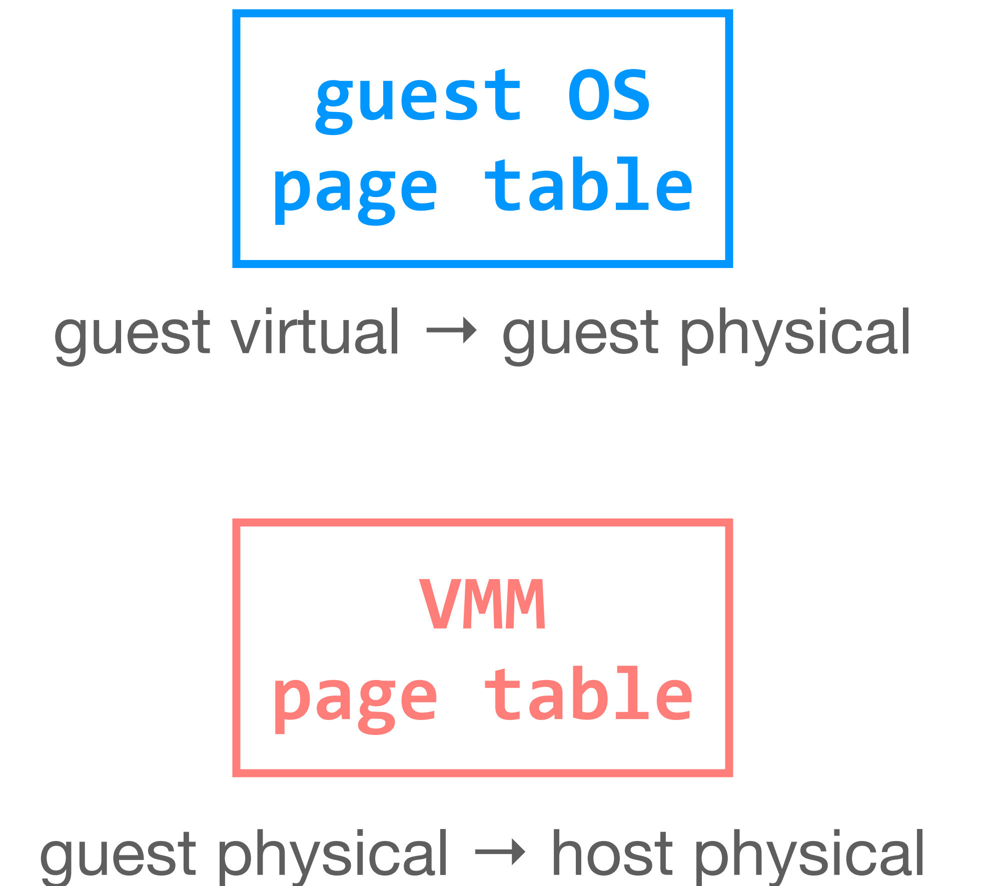

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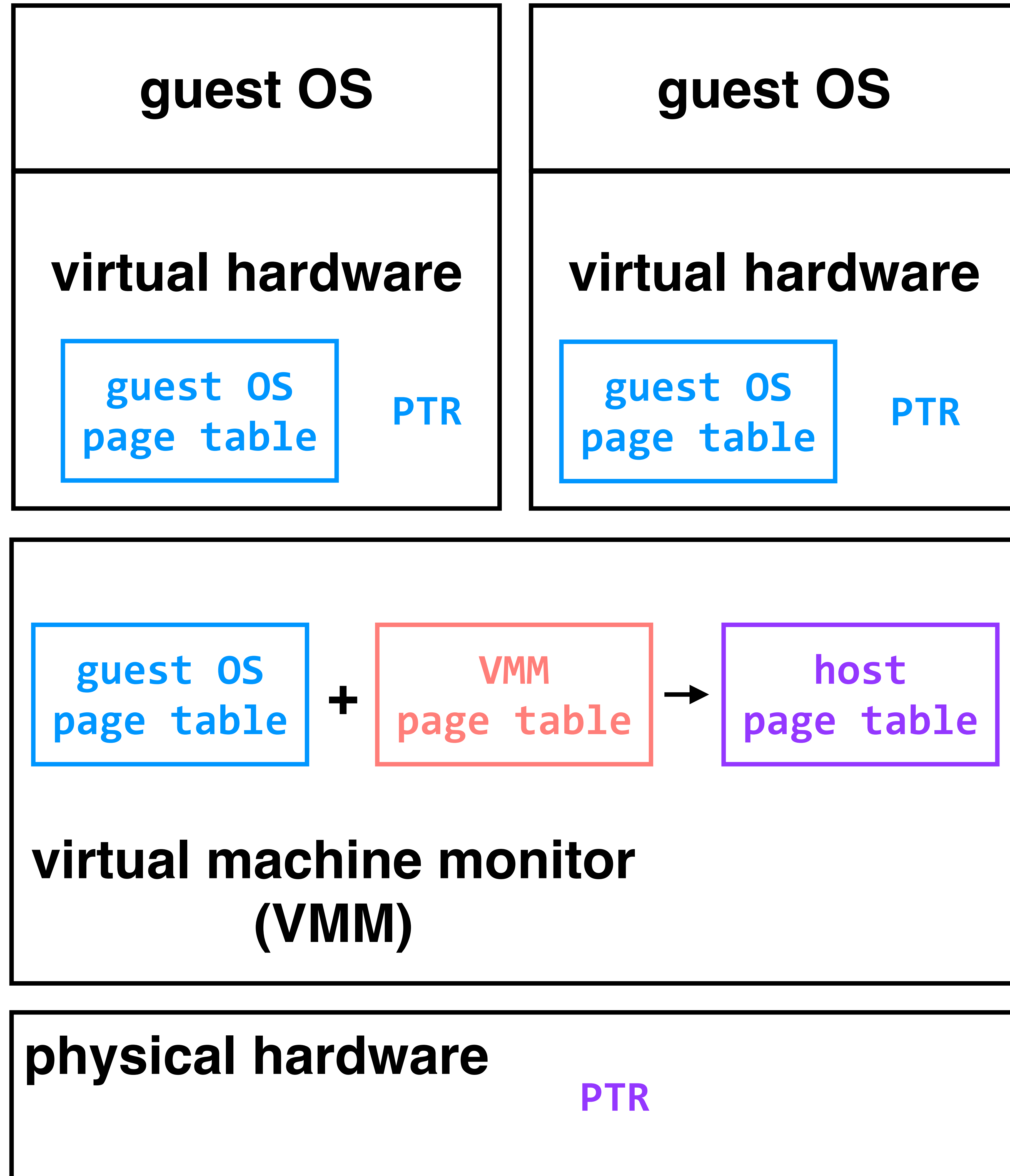


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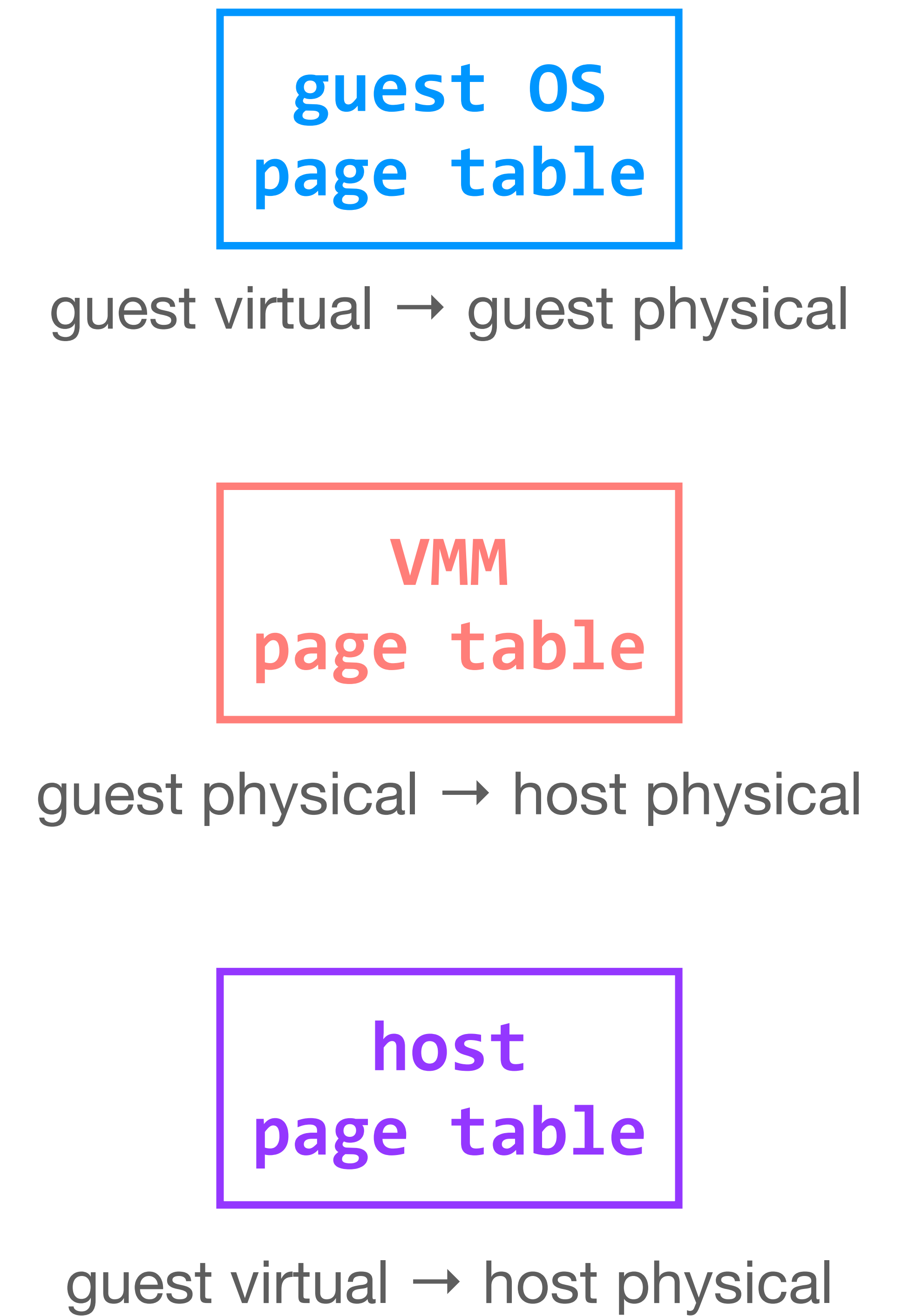

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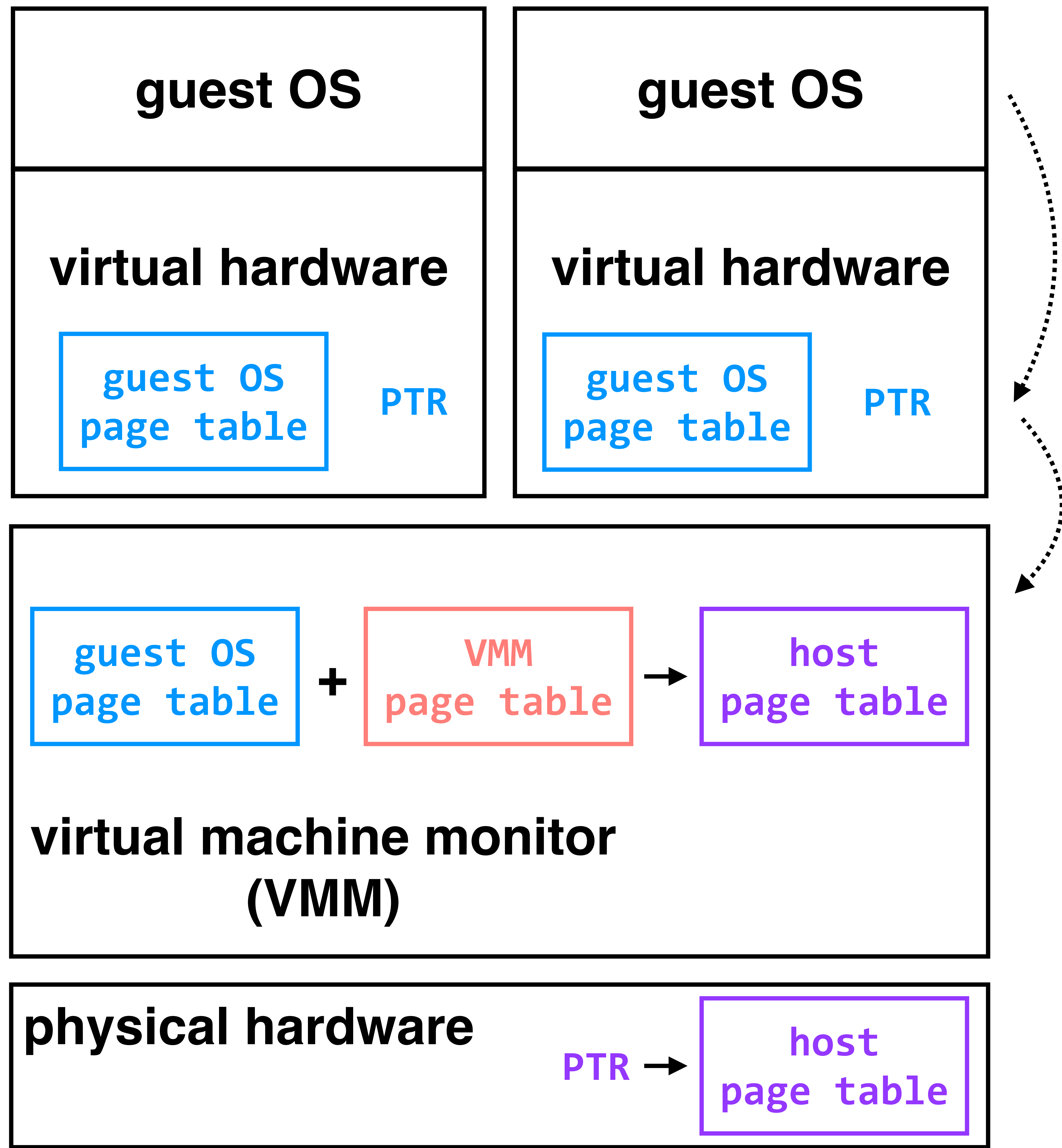


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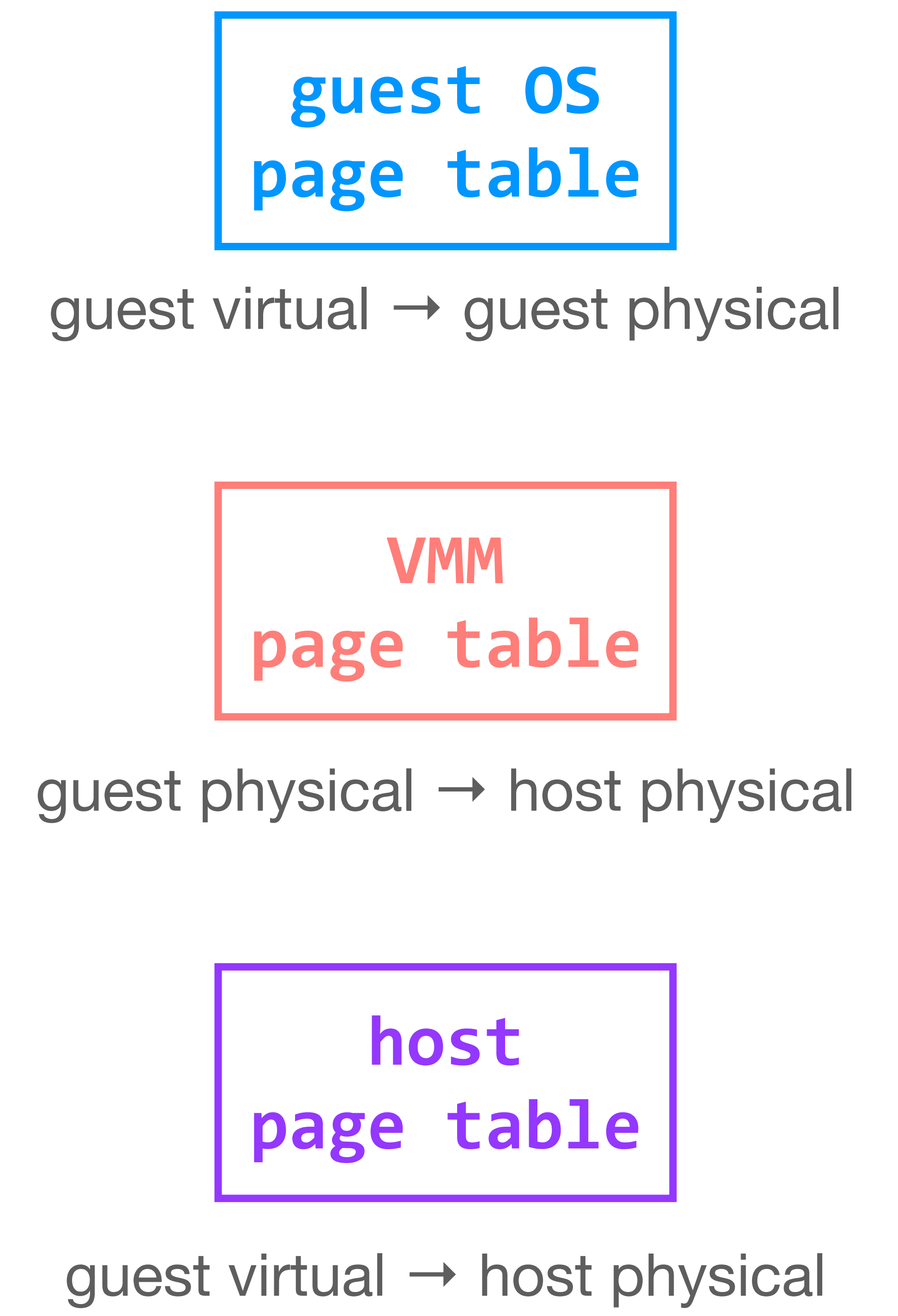
3. physical hardware uses the host page table



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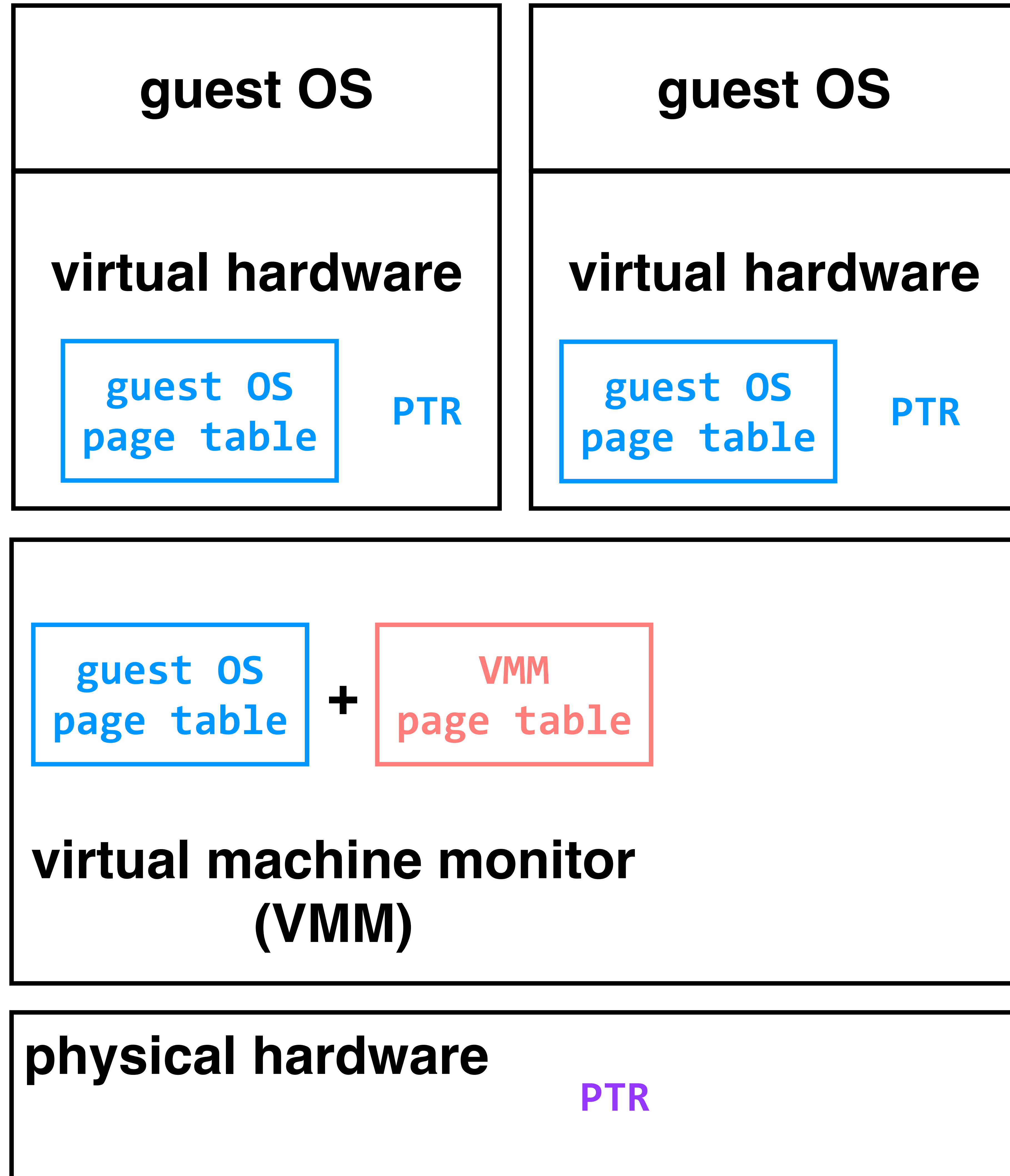


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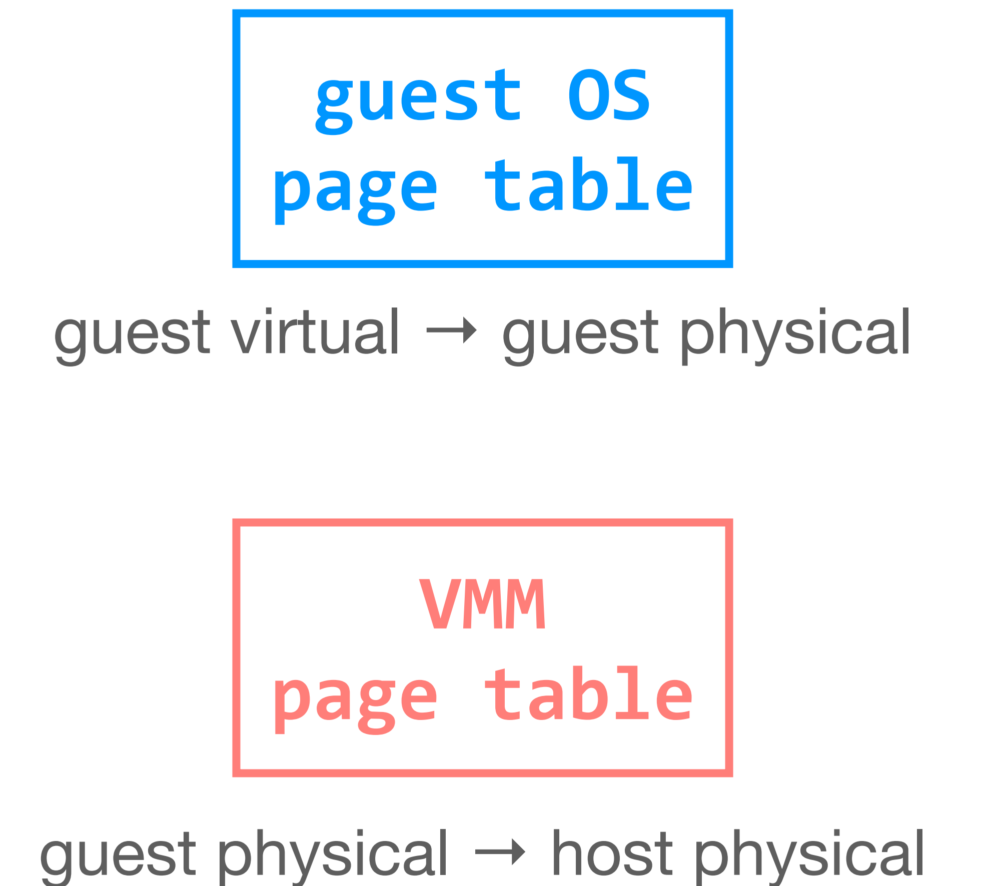
in modern hardware, the physical hardware is aware of both page tables, and performs the translation from guest virtual to host physical itself



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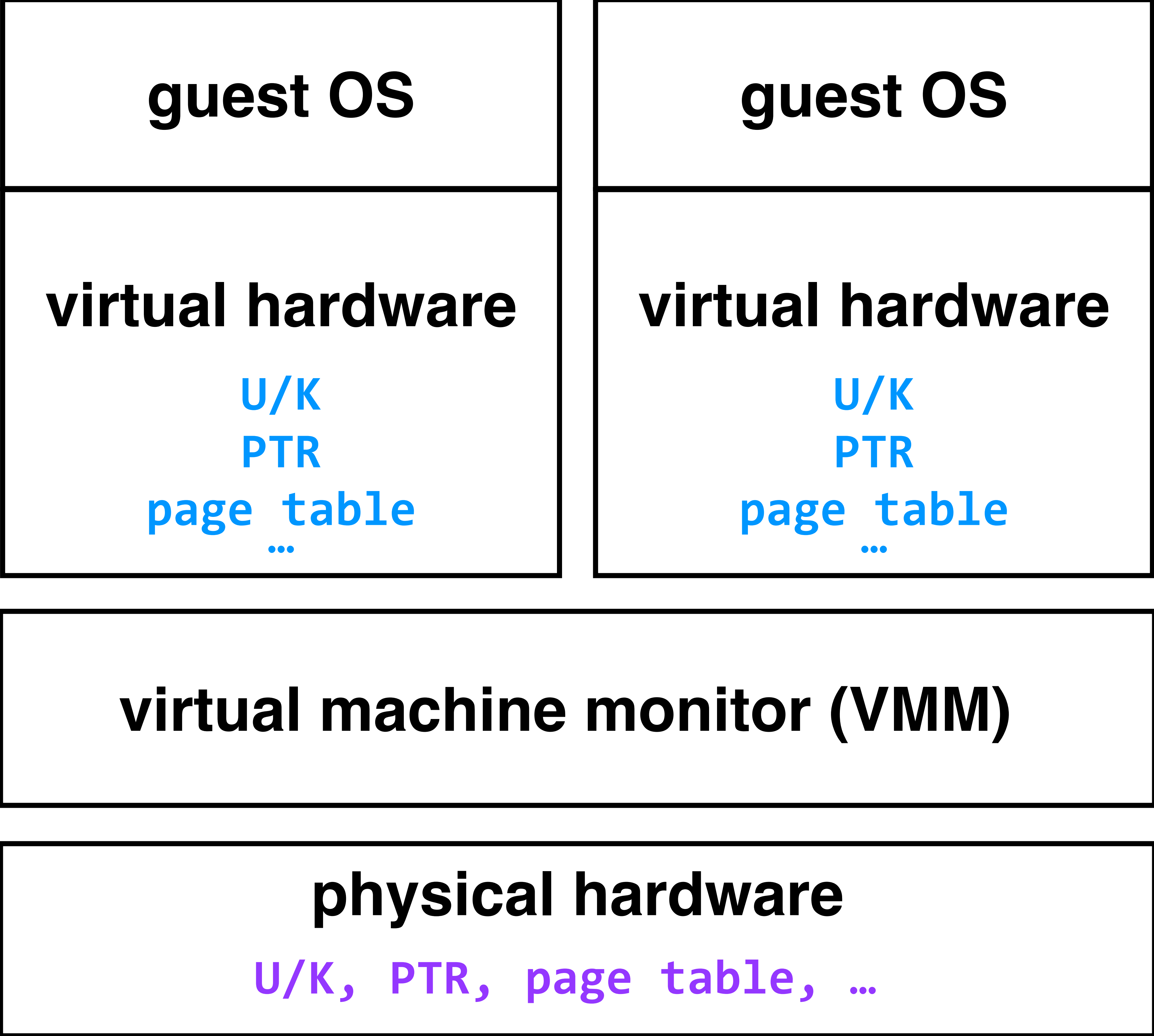

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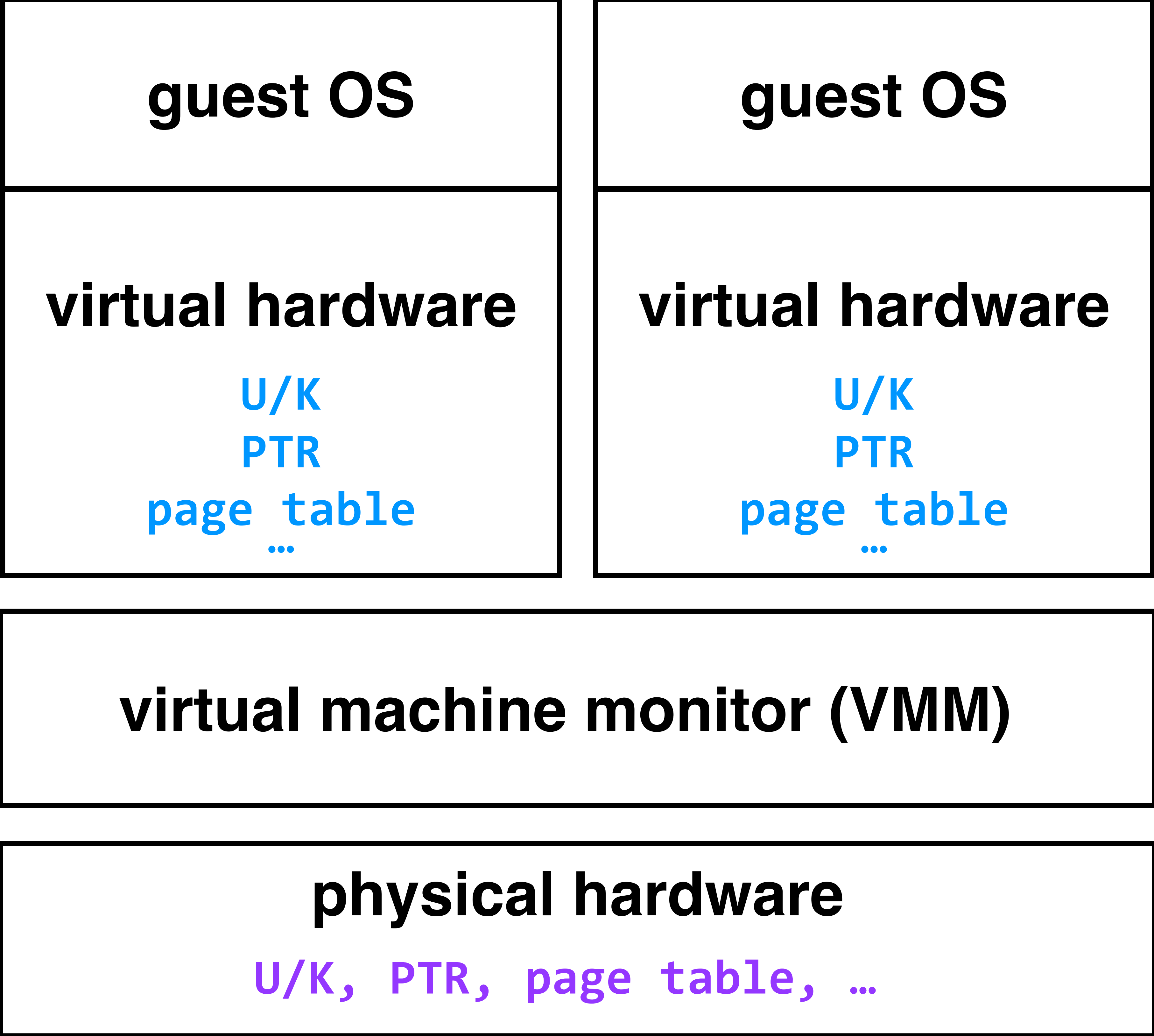


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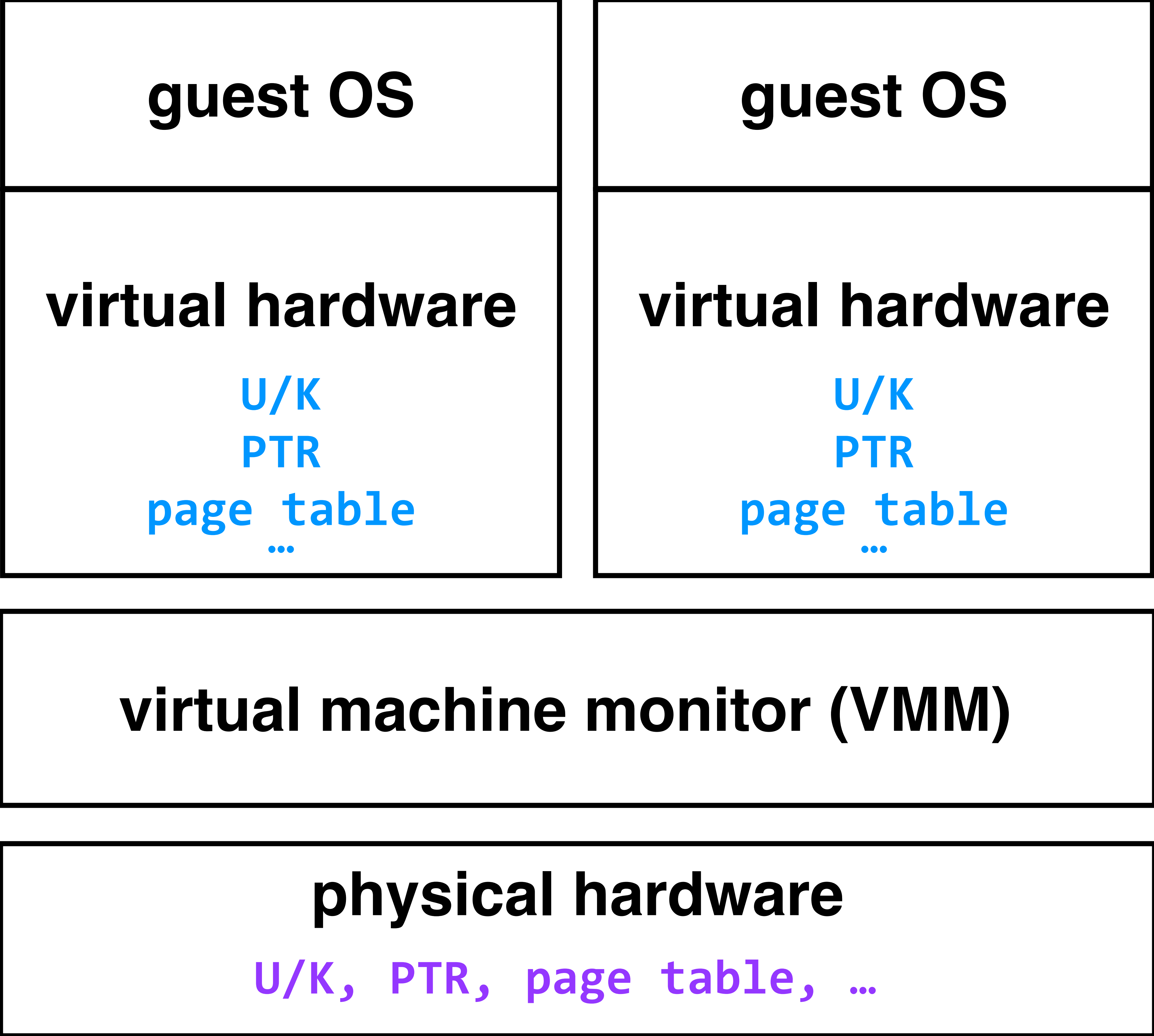


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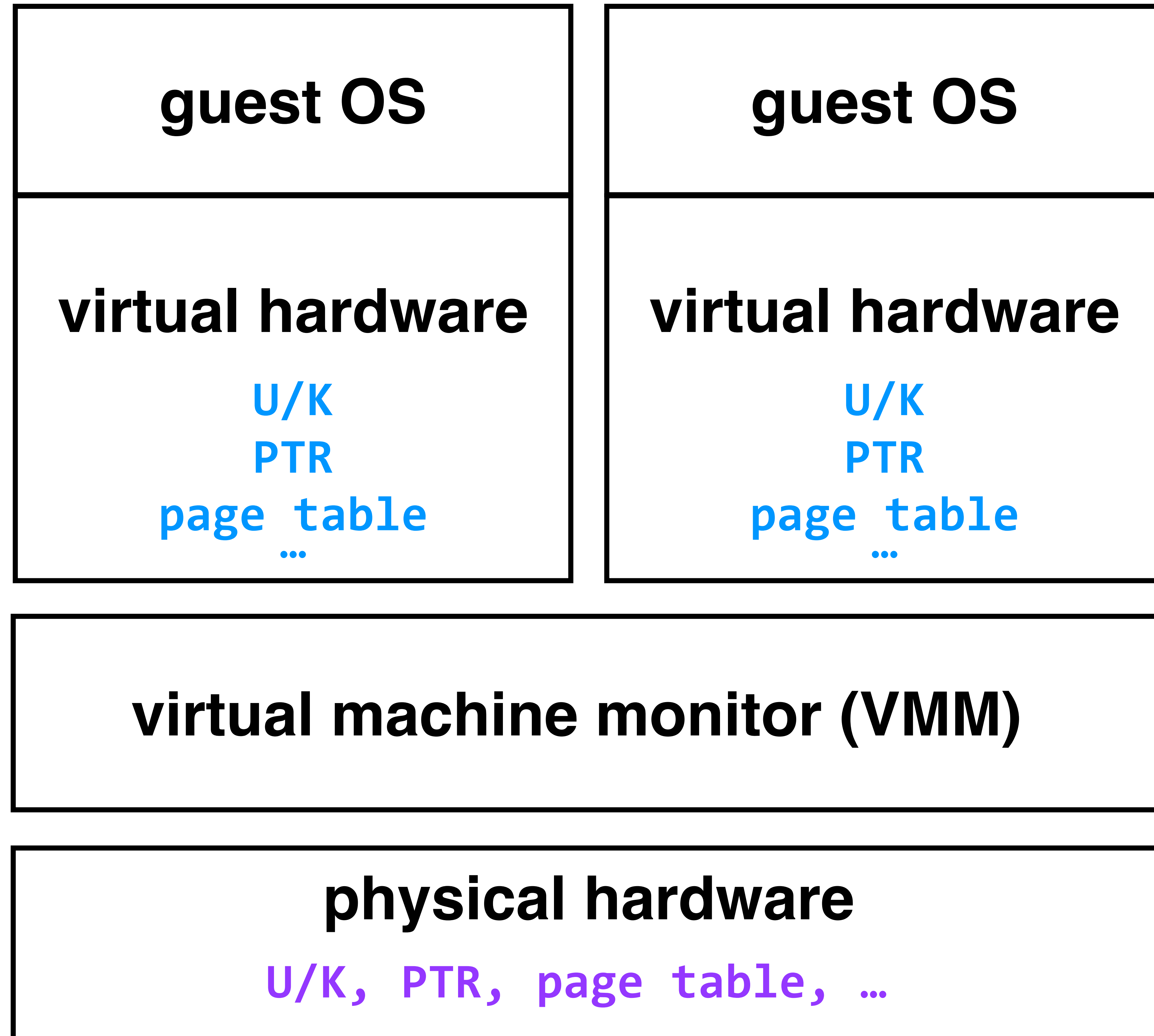


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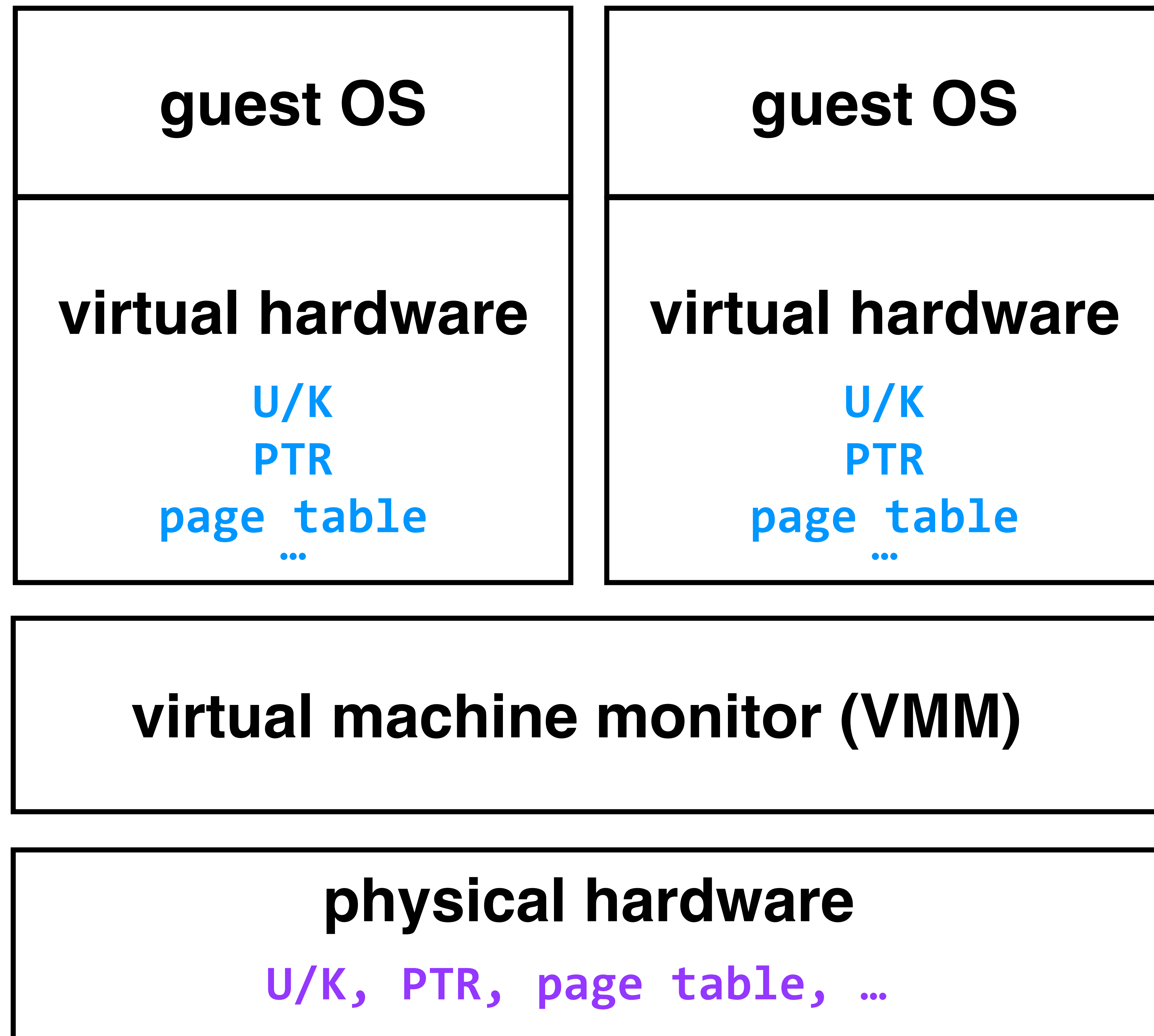


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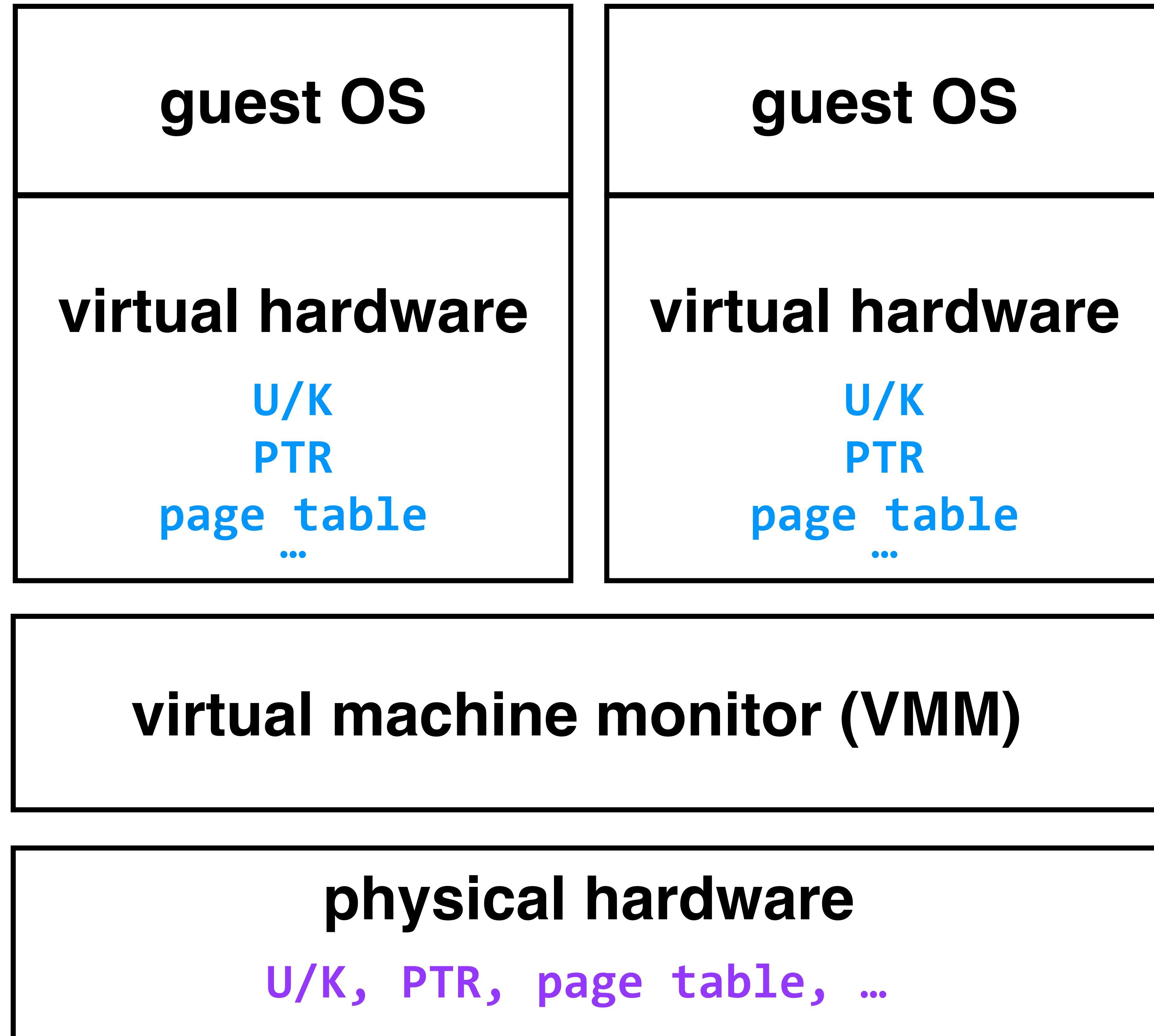


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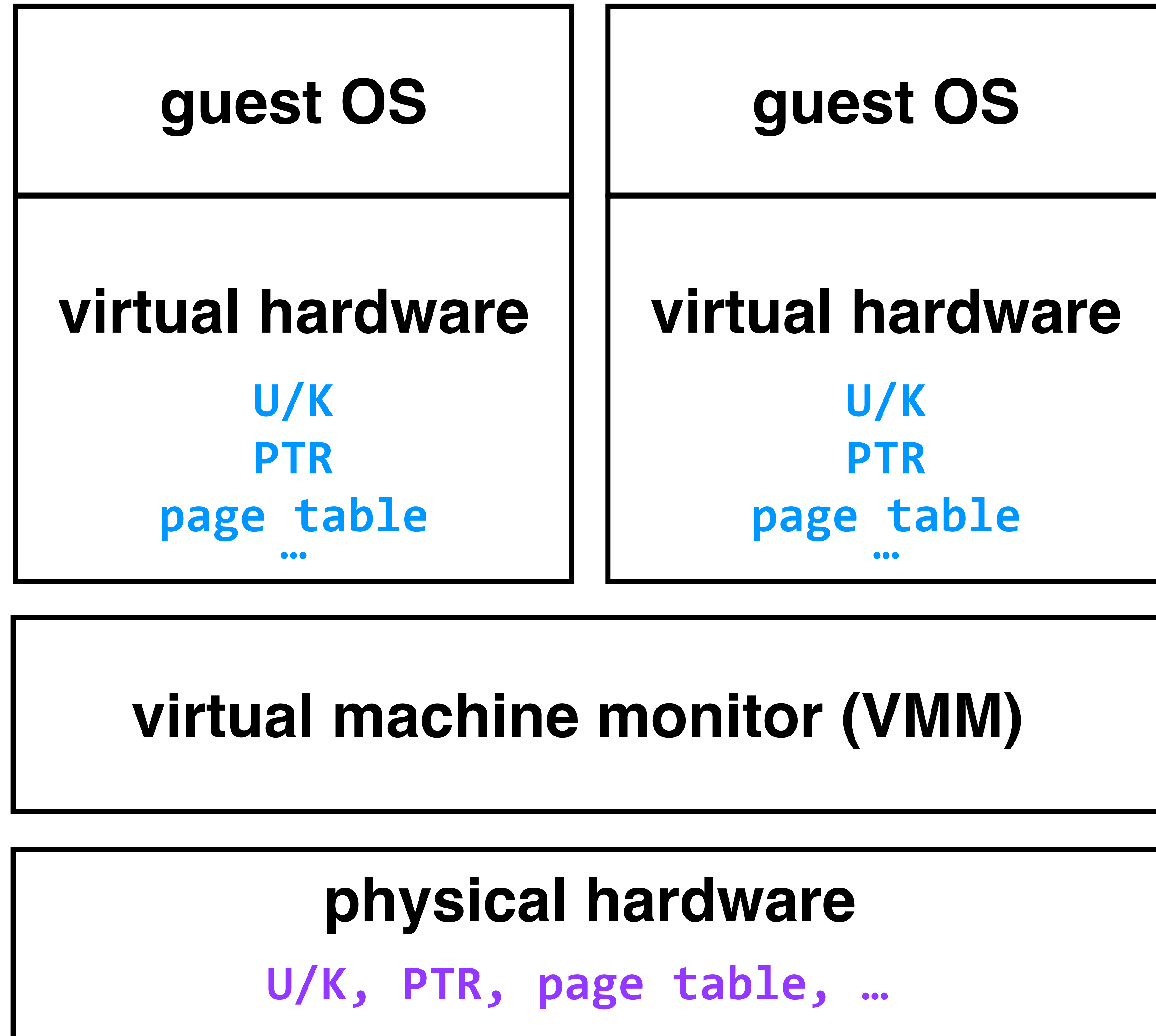


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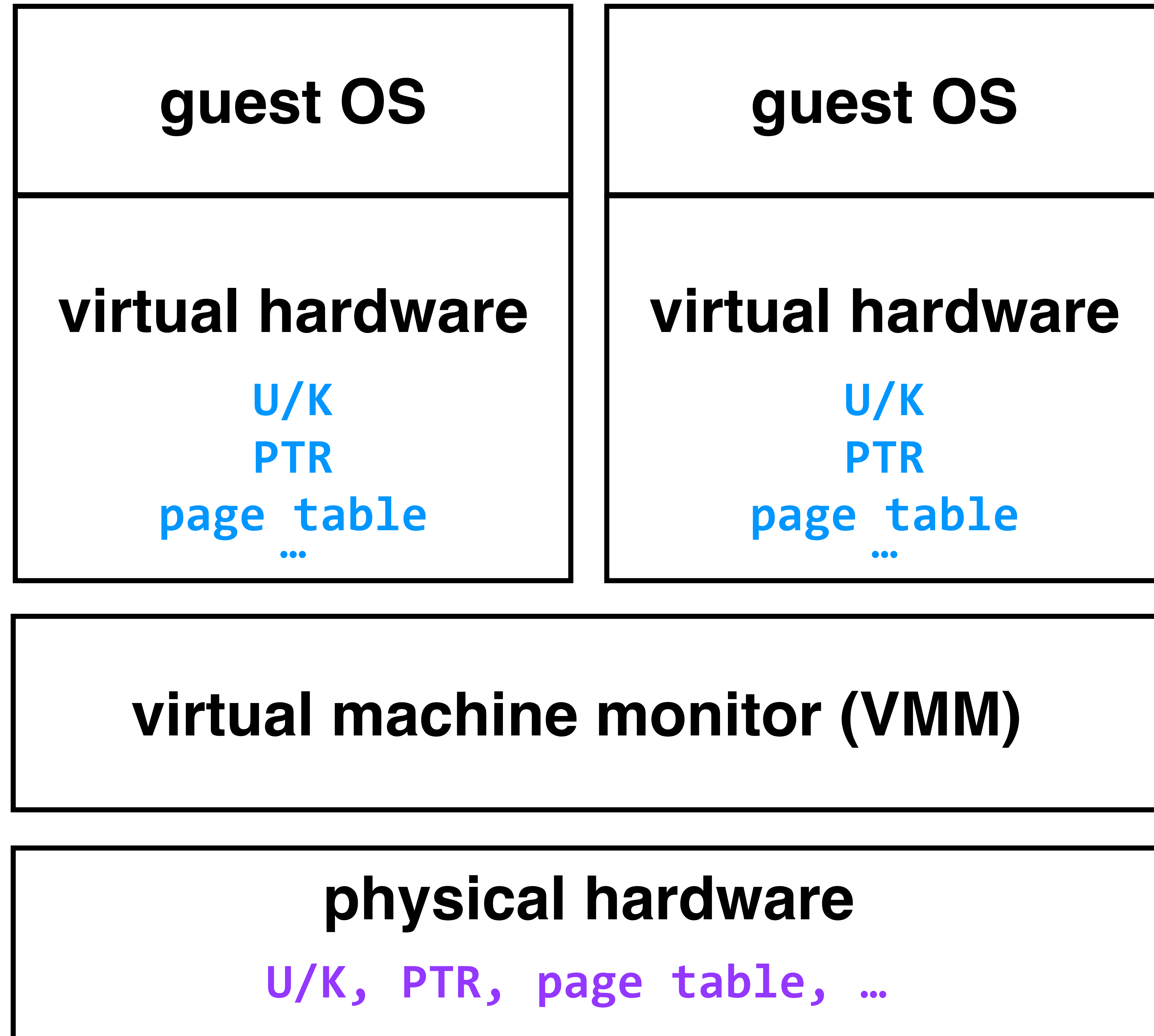


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**hardware support:** architecture provides a special operating mode for VMMs in addition to user mode, kernel mode

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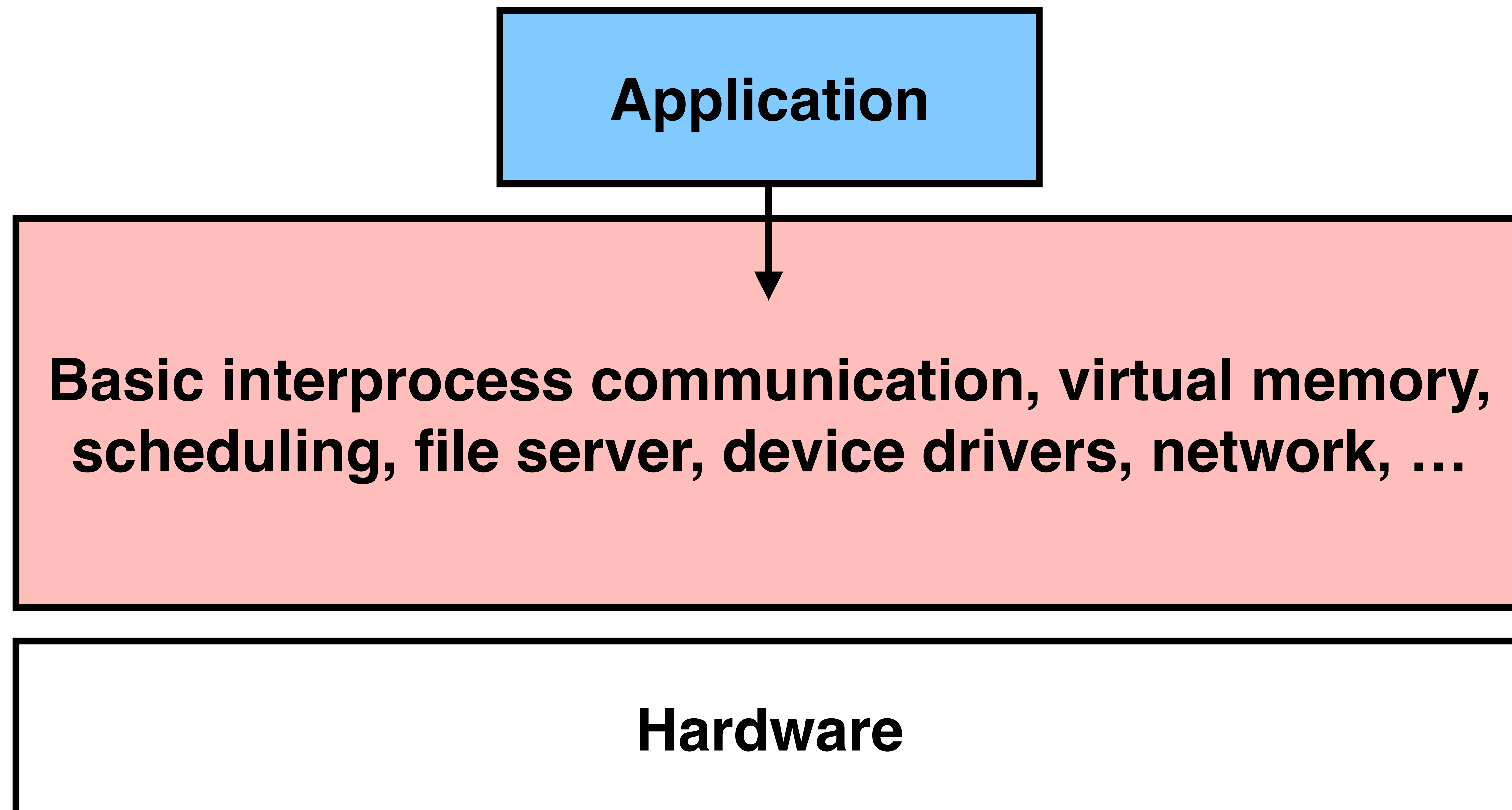

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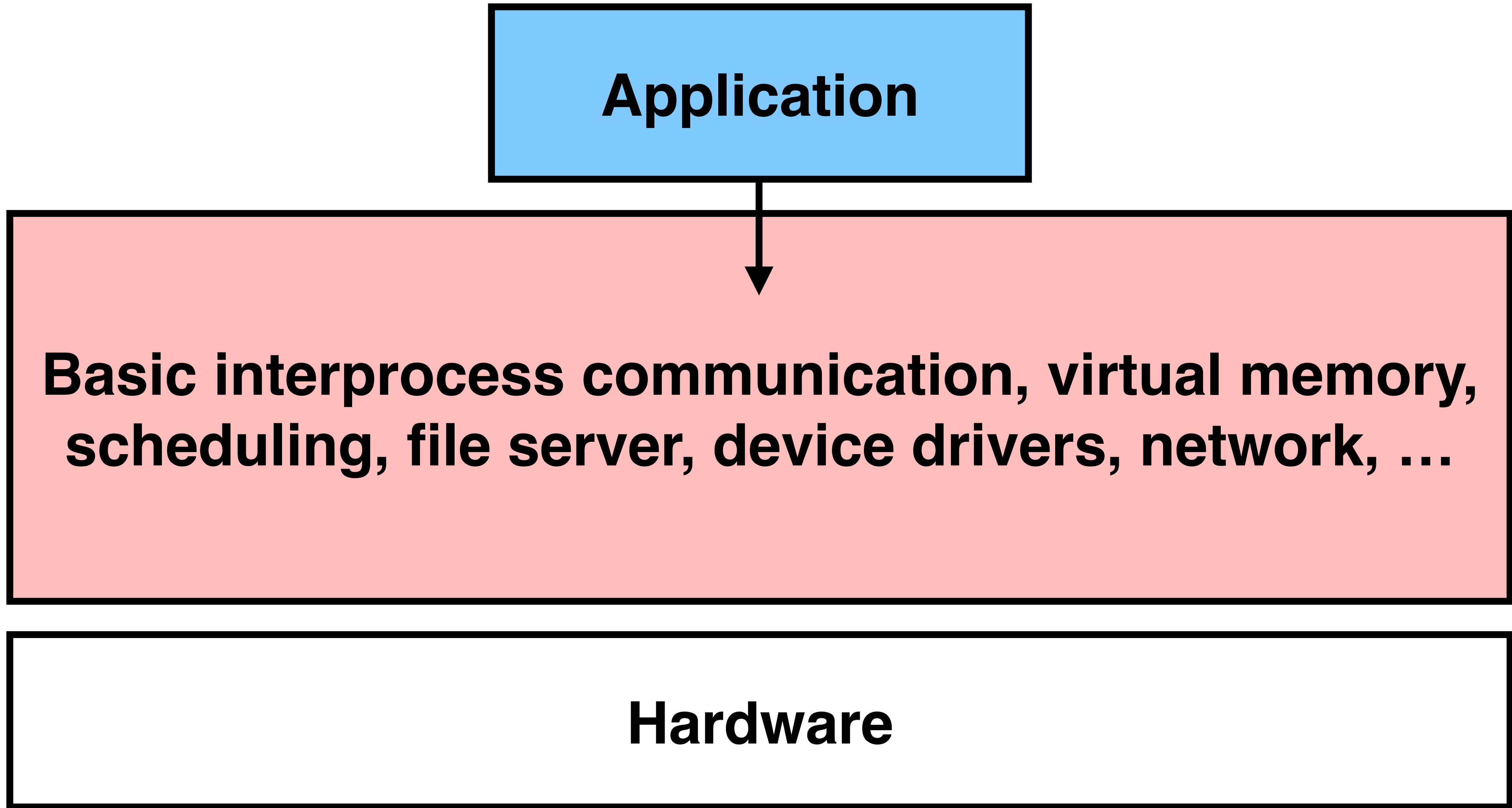
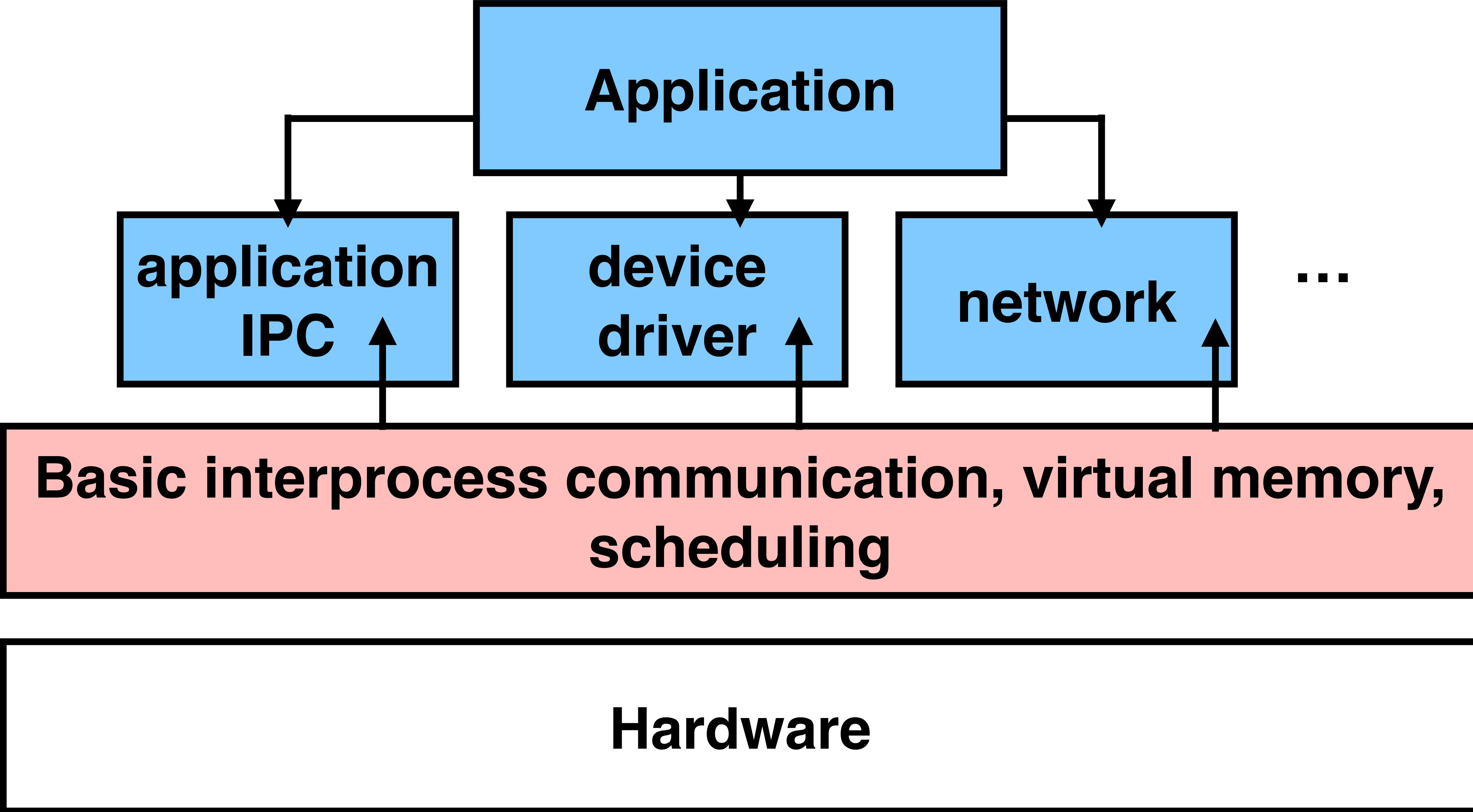



**microkernels:** enforce modularity by putting subsystems in user programs



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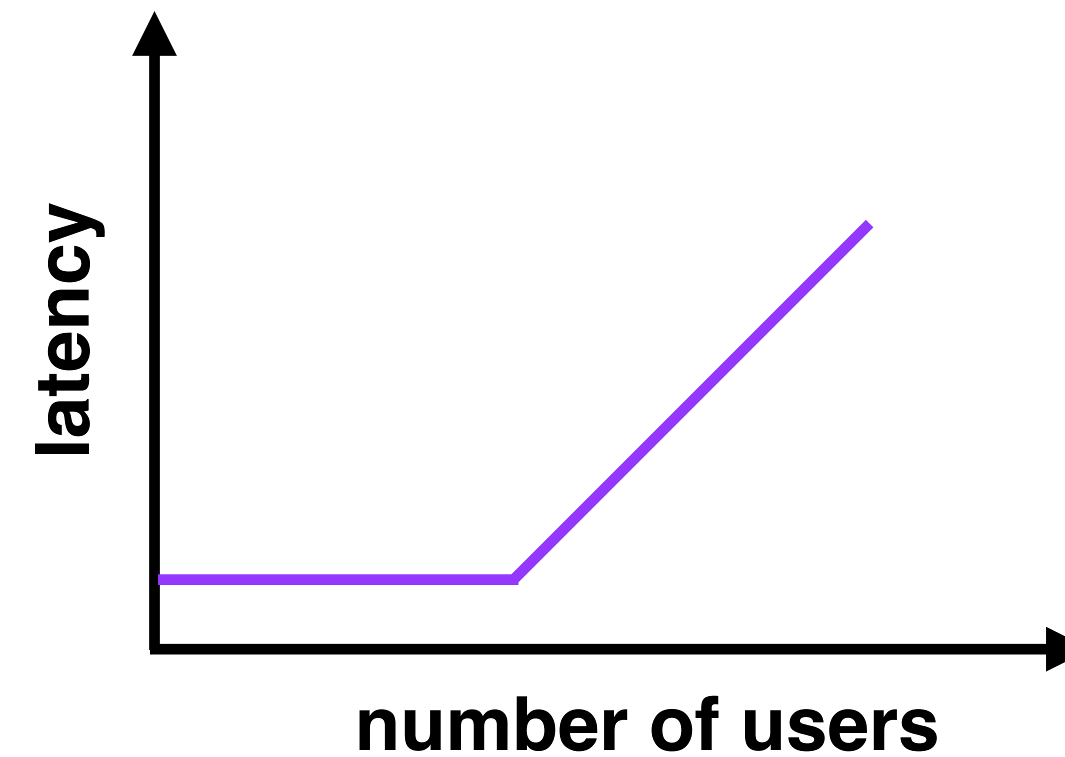


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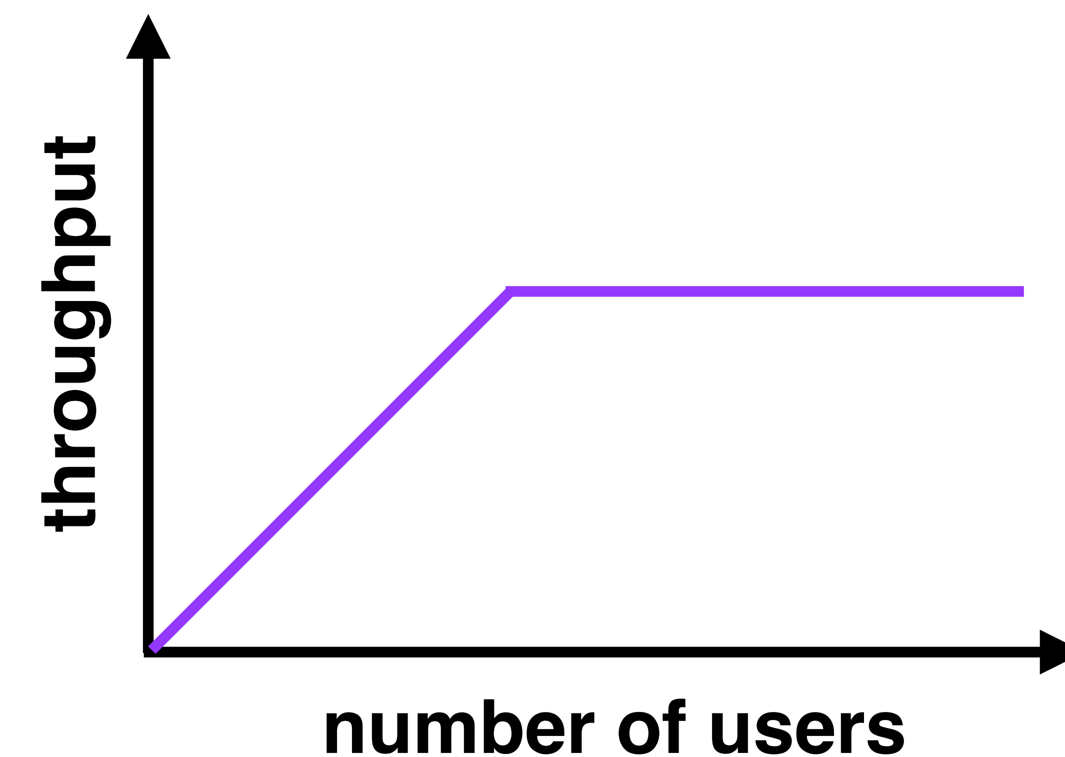

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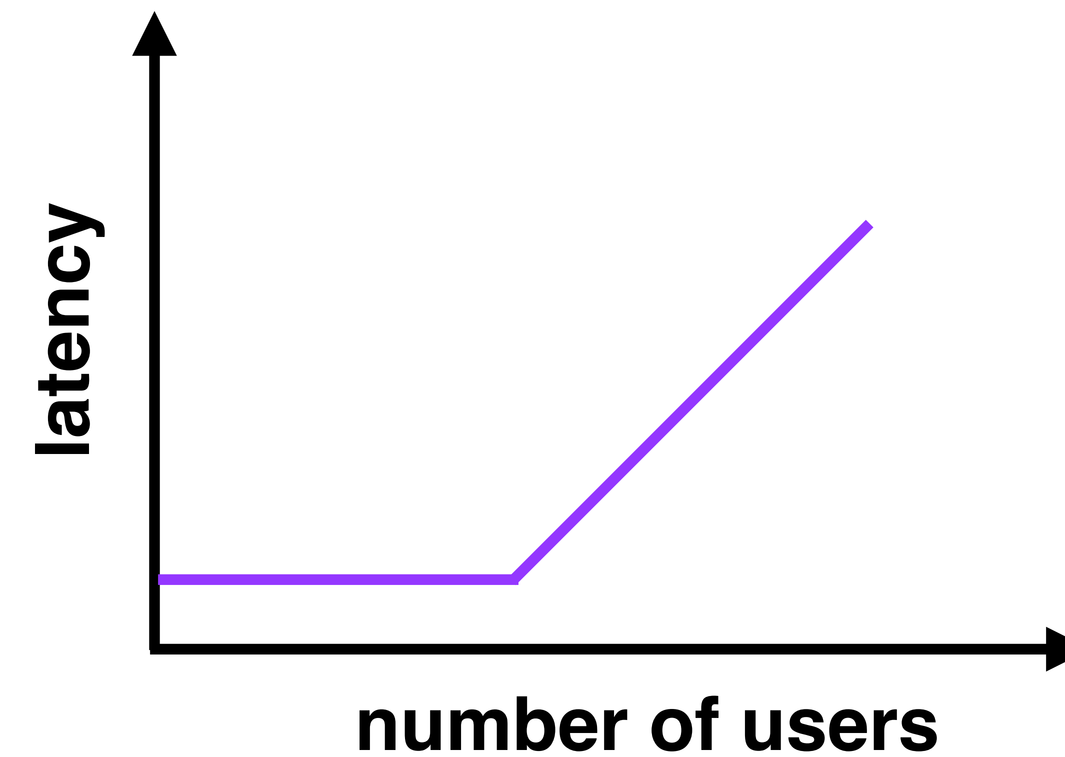


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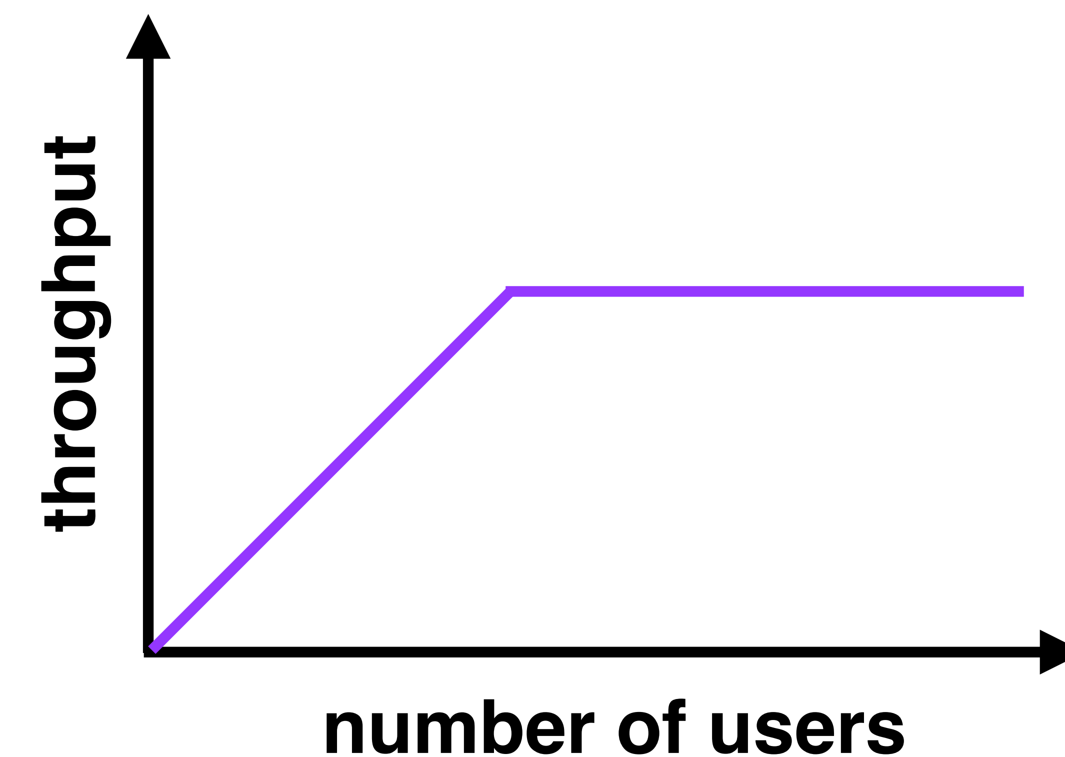


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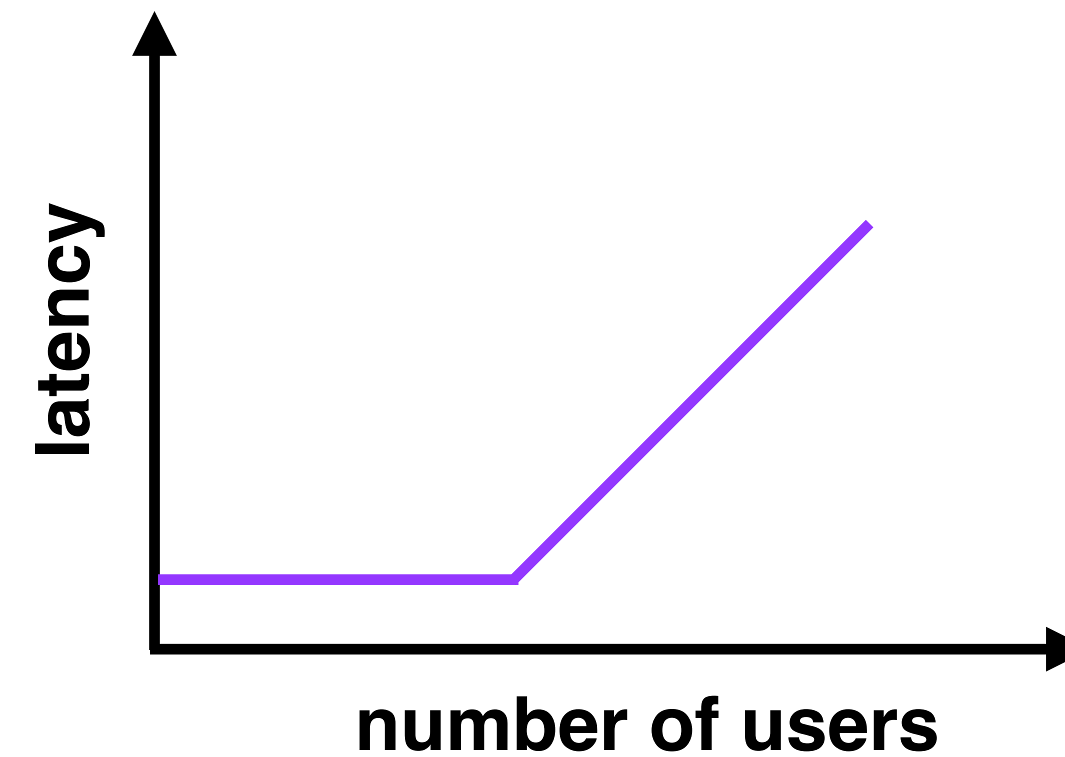


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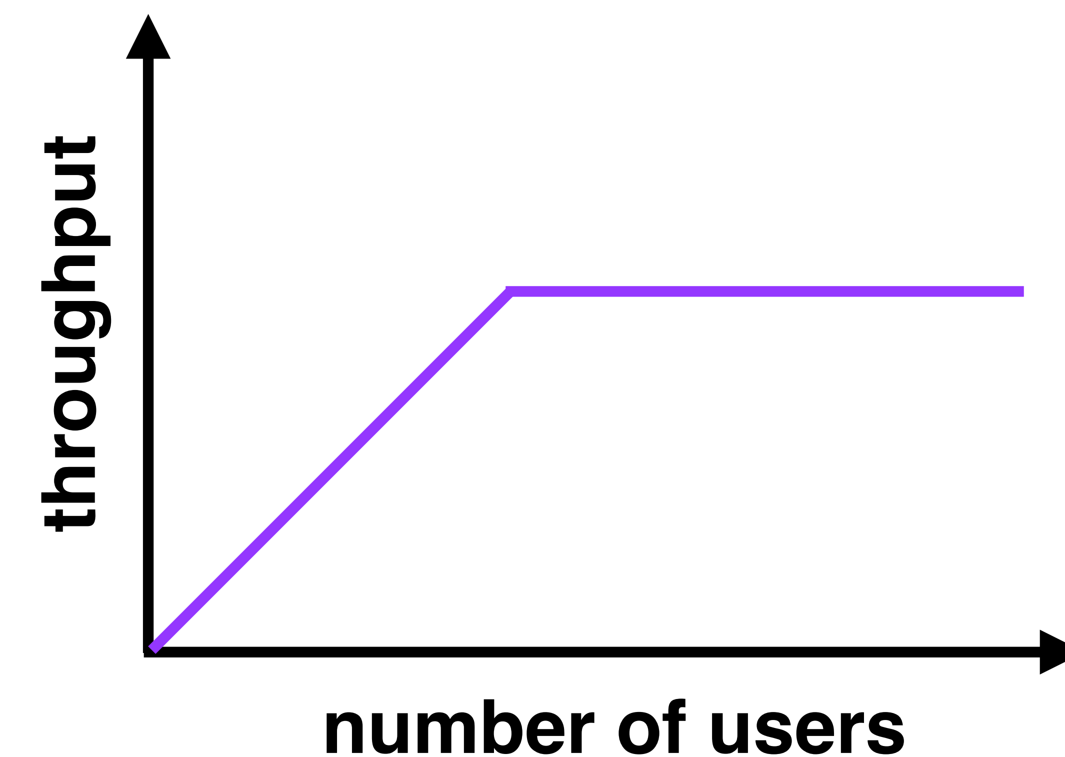


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**utilization:** what fraction of resources are being utilized? this puts our performance measurements in context

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**performance** affects all aspects of system design. **throughput**, **latency**, and **utilization** are important metrics (but not the only ones), and we have general, systems-level techniques for attempting to improve them (e.g., caching, batching). knowing when to apply them requires a solid understanding of the system itself and how it's used