



# Computer Systems B

## COMS20012

Introduction to Operating Systems and Security

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## Paging

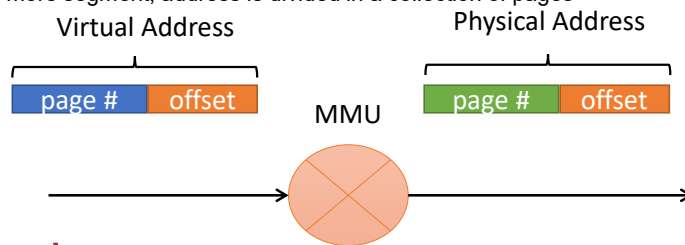
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# Paging

- Let's solve two problems at once:

- Makes allocation problem trivial
  - Fixed sized units called pages
  - No more bounds !
- Use space efficiently
  - Small fixed size (no need to use large chunk of memory to access a single byte)
  - No more segment, address is divided in a collection of pages



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## Good and Bad

- Good
  - Can allocate virtual address space with fine granularity
  - Only need to bring small pages that the process needs into the RAM
- Bad
  - Bookkeeping becomes more complex
  - Lots of small pages to keep track of

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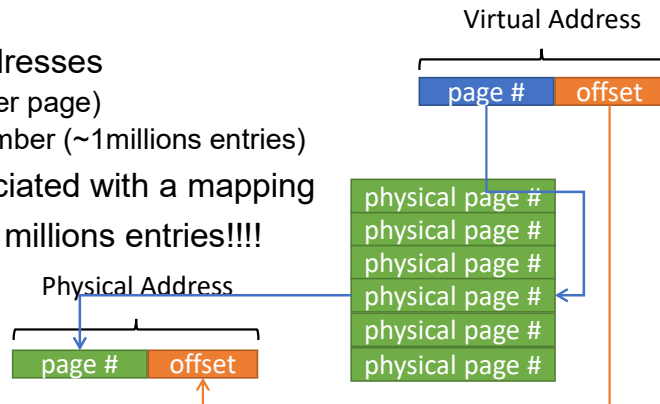
**Let's see how to deal with this!**

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## Single-level page table

- Need to keep around a mapping between virtual page and physical page
- Suppose 32bits addresses
  - 12bits offset (4kb per page)
  - 20 bits for page number (~1millions entries)
- Each process associated with a mapping
- Need a table with 1 millions entries!!!!

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## Problems

- Most address space are sparse
  - Not all pages are used
  - In our example most process would use less than 1 million pages
- That means a huge map full of NULL entries

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## Problems

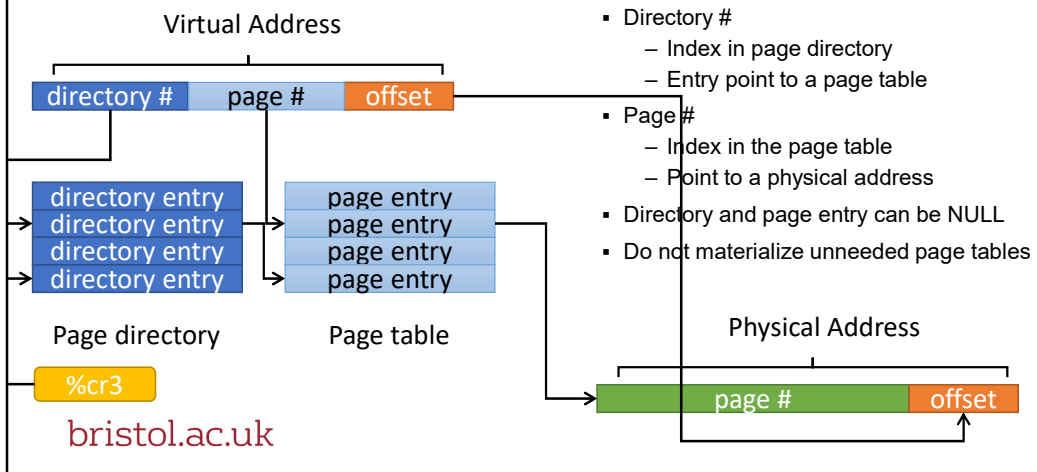
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**What a computer scientist do?**

**We add a level of indirection!**

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## Two-level page table



## Problem

- Address translation seems more complicated
  - ... and therefore slow
- How do we solve this?

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Thank you

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