Virtualisation

Learning Outcomes

- Note: this is a bonus lecture, this is not official assessable content
- An understanding of hypervisors, and modern extensions to the VM system

Virtualisation

- A “virtual” system X is a system Y that is different to X but simulates it for some purposes.
  - Virtual memory
  - Virtual machine
  - Virtual terminal
- A common process:
  - Yesterday’s system
  - Today’s compatibility trick
  - Tomorrow’s interface

Virtual Terminals

- A VT100 terminal

  Photographed at the Living Computer Museum by Jason Scott

- This was a “terminal”
  - An endpoint
  - Not a computer
- Created standards
  - ANSI
  - Virtual terminals
  - Terminal emulators

Related Processors

- ARM LTD design:
  - Cortex M-0: microprocessor
    - Optional MPU, no MMU
  - Mid-range microprocessors
  - High-end CPUs
    - Google Tensor
    - Mac M-1
  - Instruction sets are somewhat compatible

Processes as VMs

- On a simple microprocessor
  - One set of CPU registers
  - One view of memory
- In an OS
  - One set of CPU registers per process
  - One view of memory per process
  - “Virtual” microprocessor?

And Repeat...

- What does a “virtual” processor look like?

Second Level Translation

- Guest virtual

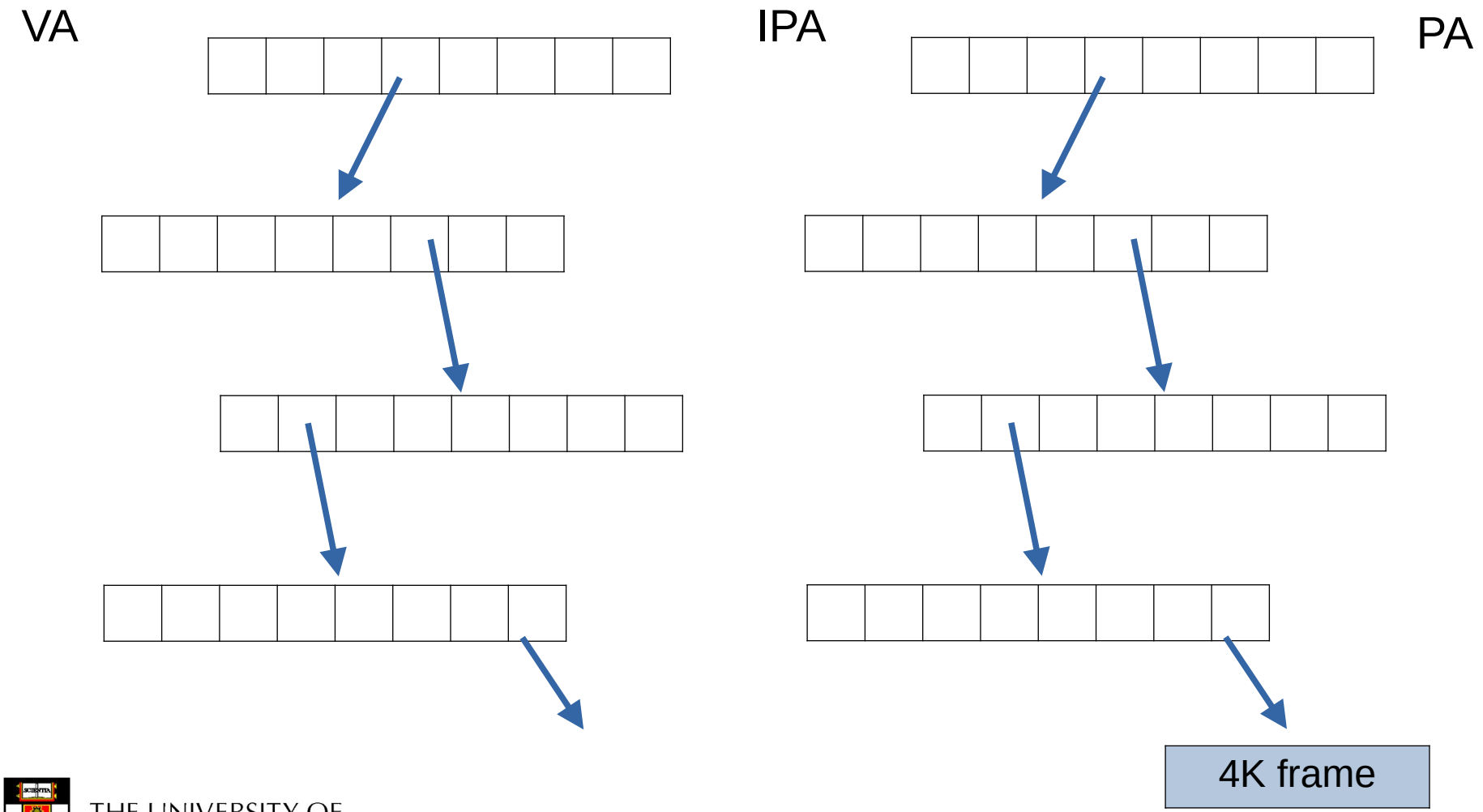
Translation

- Guest physical
- Intermediate phys

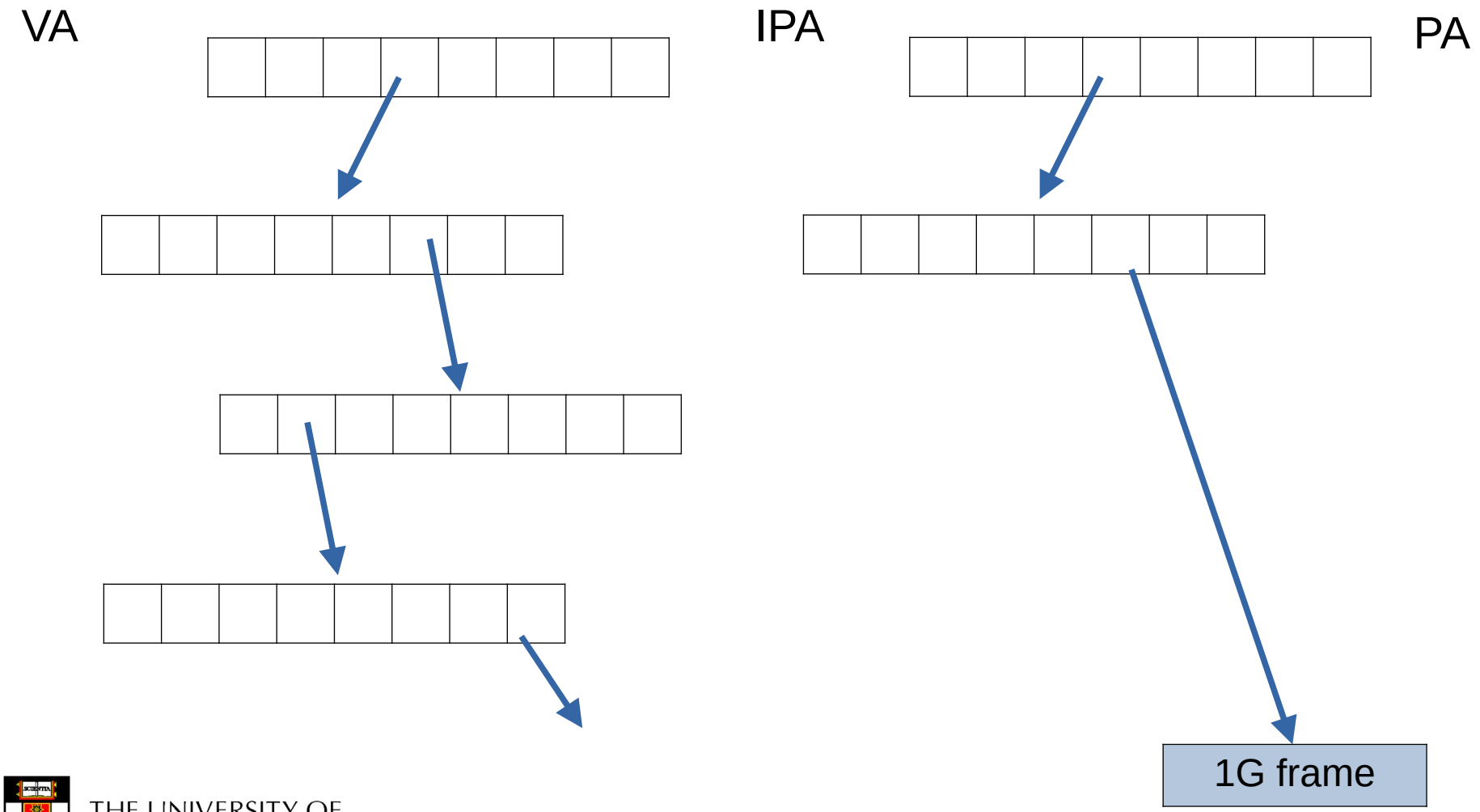
Translation

- Physical

Second Level Translation



Large Mappings



Hypervisor Support

- OS is “supervisor” of regular system
- Add a super-supervisor = hypervisor
- Add more of the same:
  - Additional page tables
  - Additional exception levels
    - EL0 - EL3 replace User/Kernel
  - Additional exception/interrupt entry paths

Page Faults

- Referencing an invalid page triggers a page fault
  - An exception handled by the OS
- Broadly, two standard page fault types
  - Illegal Address (protection error)
    - Signal or kill the process
  - Page not resident
    - Get an unused frame
    - Load page from disk
    - Update page (translation) table (enter frame #, set valid bit, etc.)
    - Restart the faulting instruction

Summary

- Common evolution:
  - Yesterday's obsolete system
  - Today's compatibility trick
  - Tomorrow's interface
- Virtual Machines
  - Guest virtual OSs
- Modern setup gives good uses for large pages and additional page-table features