

NSWI200

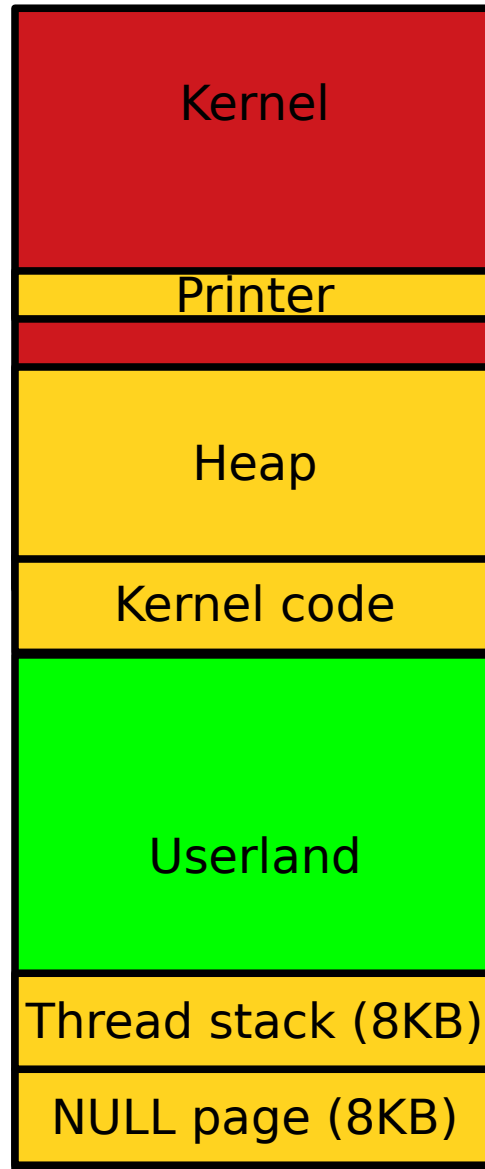
**Virtual Memory  
Management  
Milestone M05**

# Virtual Address Space

4 GiB

2 GiB

0



Kernel

Printer

Heap

Kernel code

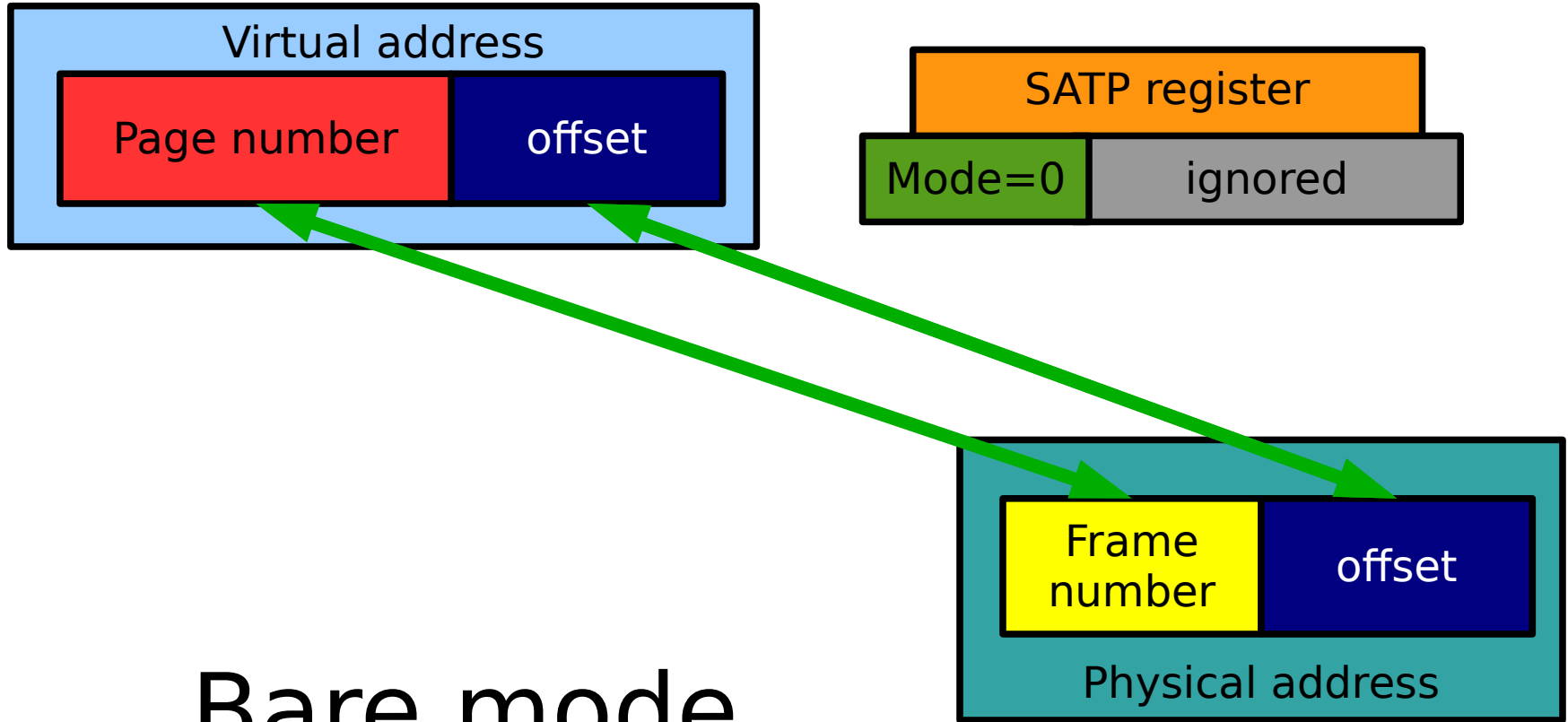
Userland

Thread stack (8KB)

NULL page (8KB)

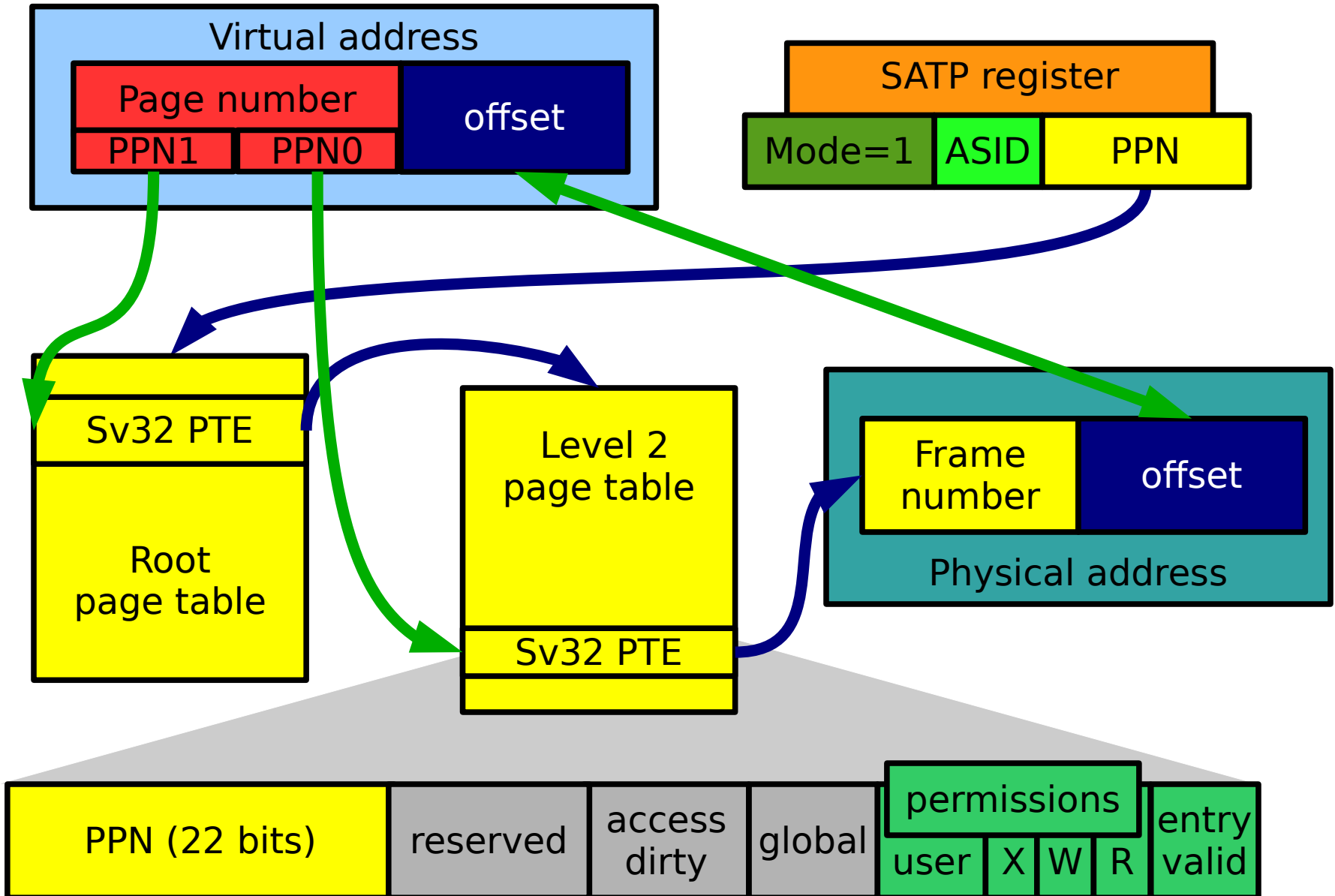
**RISC-V**

# RISC-V Sv32



Bare mode  
translation  
(used before M05)

# RISC-V Sv32



**MIPS R4000**

# Virtual Address Space

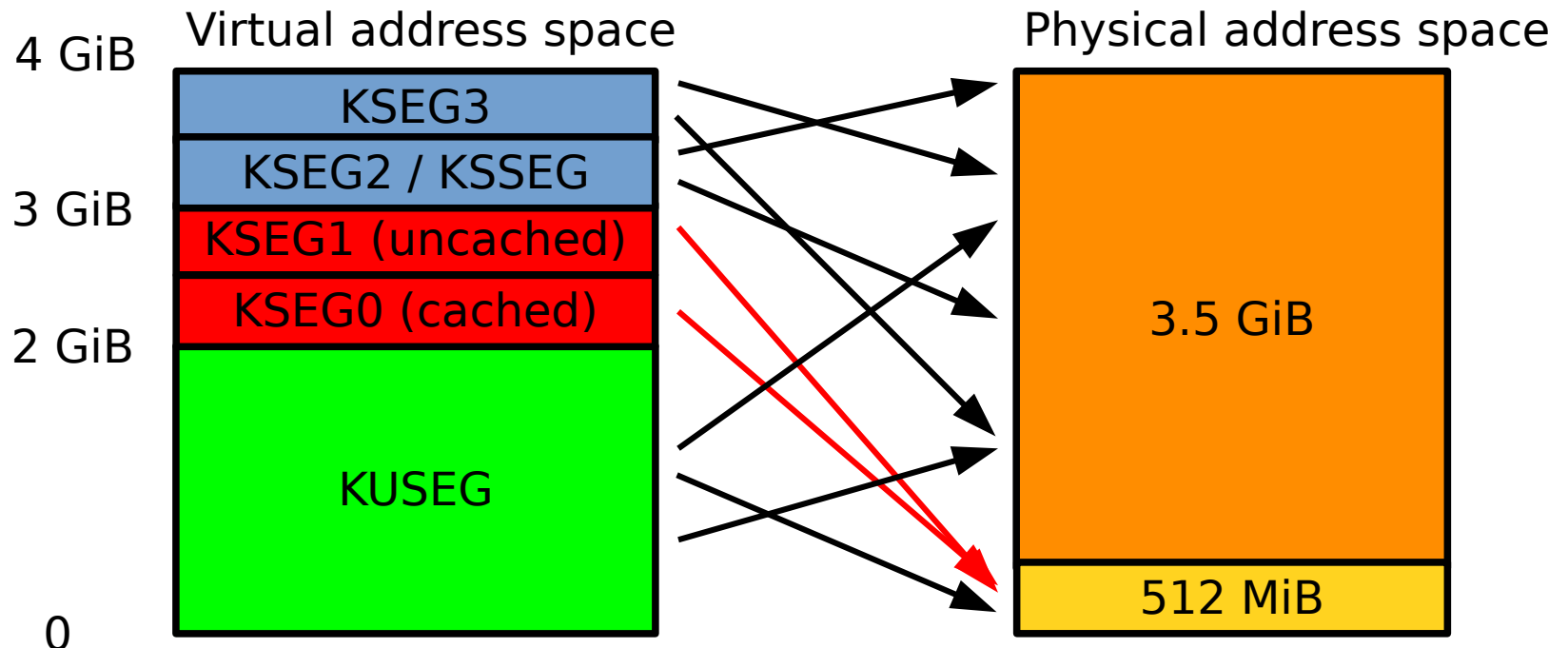
Hard-wired segments (top 3 bits)

- KSEG0, KSEG1 – identity mapping
- KUSEG, KSEG2, KSEG3 – TLB

unprivileged, TLB mapped

privileged, identity mapped

privileged, TLB mapped



# Translation Lookaside Buffer (TLB)

- 48 records (software-managed), each entry contains:
  - Page size mask (from 4 KiB up to 16 MiB)
  - Two virtual pages (stored as VPN2)
  - Two frame addresses (FPN)
  - ASID
  - Extra bits: global, dirty, valid
- Translation
  - Match entry based on ASID (EntryHi) and virtual address
  - On miss
    - TLB exception (usually “refill”)
    - Entry added (OS searches its data structures, e.g. hierarchical page tables)
    - Instruction restarted



# MIPS R4000 TLB

