What if VA space is really big?

- 64 bit architectures: 2^{64} bytes of VA space

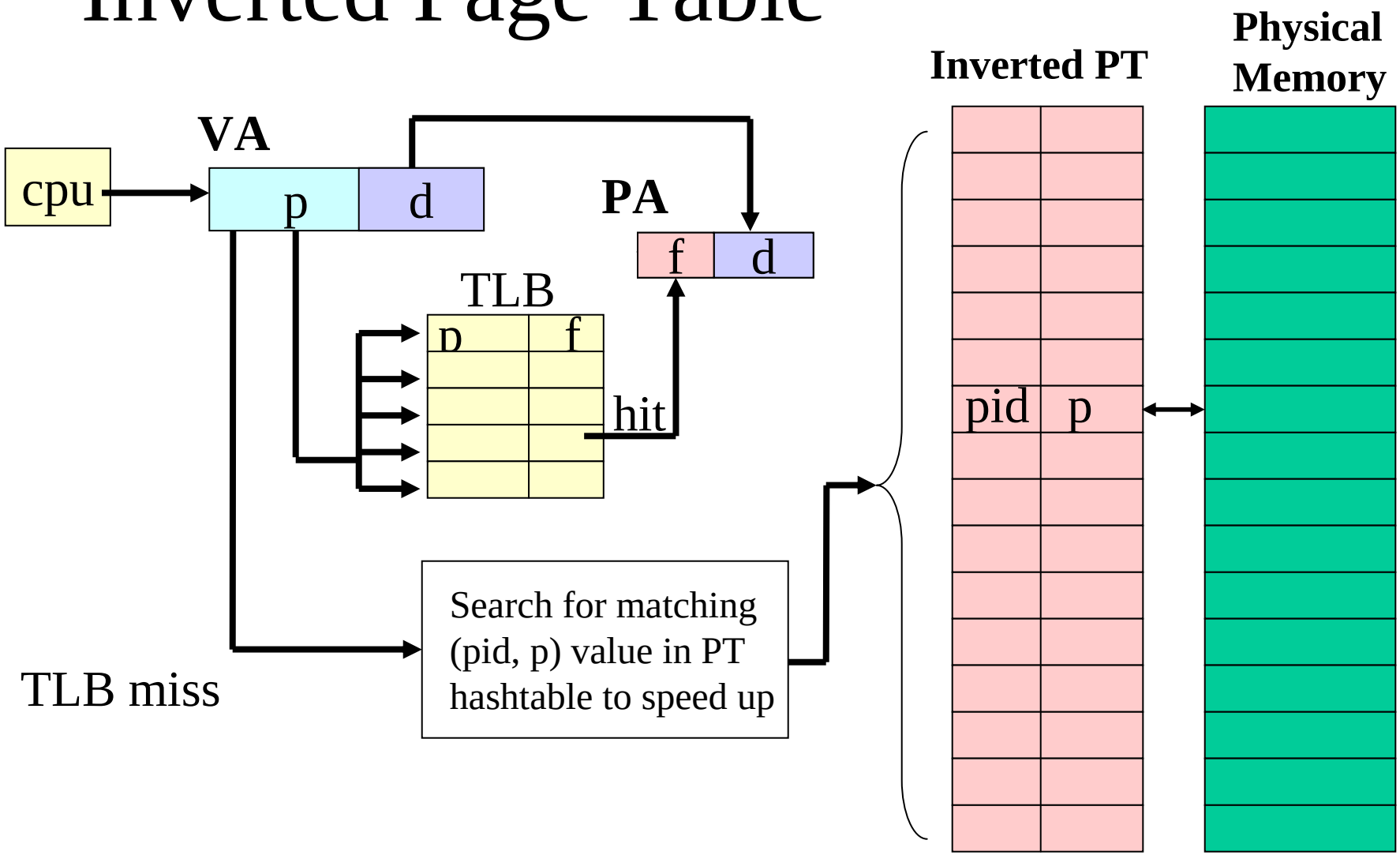
  ~ 7 levels of Page Tables

  Effective Access Time is way too slow

  Multiple Pi's PTs take up way too much of mem

- Solution: Inverted Page Tables
  - Idea: instead of mapping from VA to frame #
    keep mappings of frame# to VA
  - PA space much smaller than VA space
    inverted PT small (one entry per page FRAME)
  - Single, global PT for all processes in the system

Inverted Page Table



Effective Access Time = h(TLB time) + (1-h)((#search refs)(mem time) + TLB time)

- Problem: What if page isn't in memory
  ➔ an entry for it is not in inverted PT
- Solution: We still need regular per-process PTs, but should rarely need to use them
- Problem: What if 2 or more processes share a physical page of memory (ex. system V shared memory)
  - For regular page tables this is not a problem
    - each sharing process' PT entry points to same physical frame
  - For inverted PTs we now need a list of info in each PT entry (pid1, page#), (pid2, page#), (pid3, page3) … OR we just keep one Pi's mapping in PT and handle other mappings as if the page was not in memory
    - Neither of these solutions is ideal
      more mem refs to either traverse a list or to traverse reg. PT levels

Segmentation

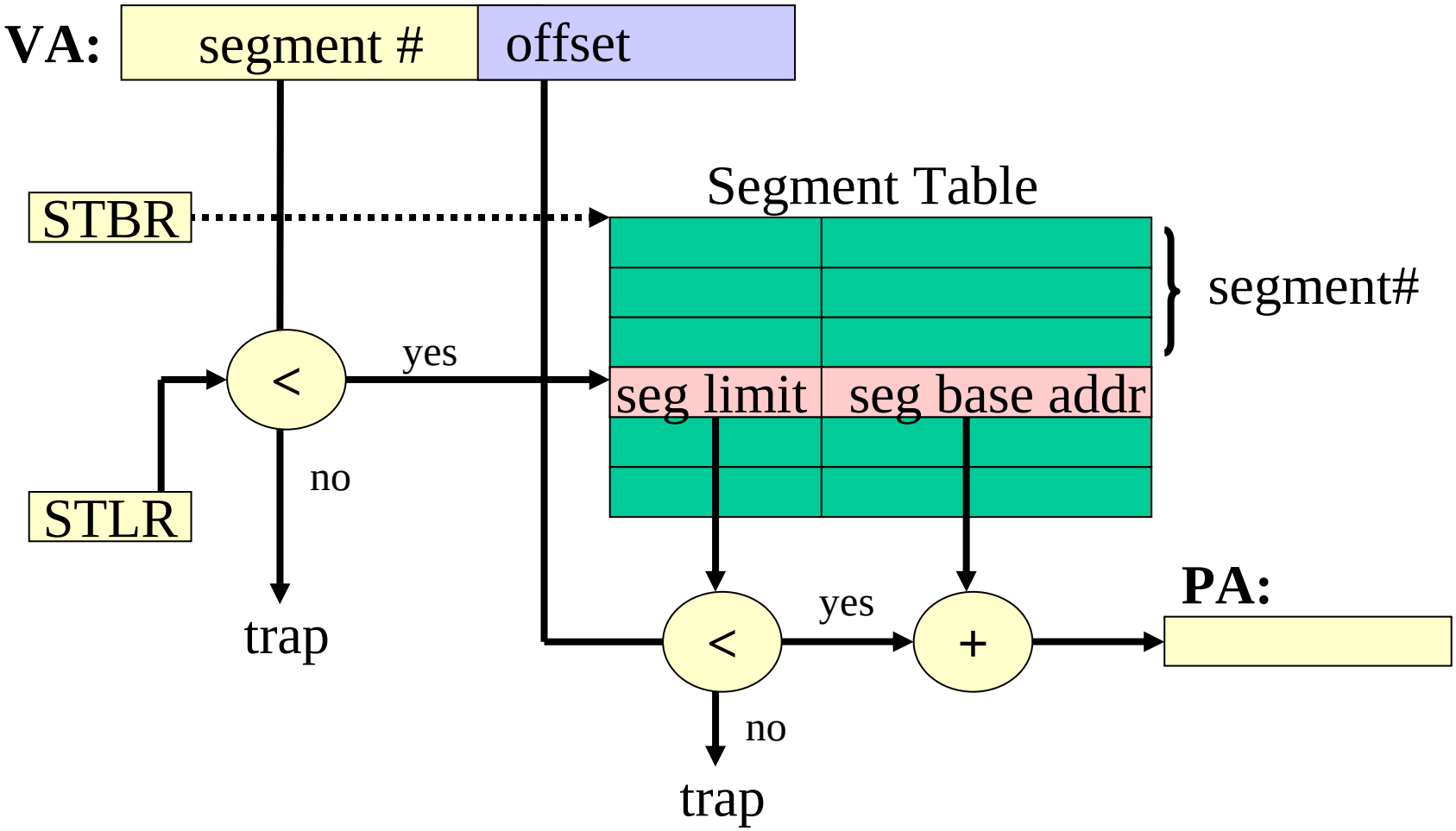
Another way to break-up a Pi's address space

- Better fits the way in wch we view Pi's addr space

Address space broken up into logical parts (segments):

- segment for heap, stack, data, code, …
- each segment is a logically contiguous chunk of Pi
- Can set different permissions on different segments
  - e.g. read only access to code segment
- Each segment can be a different size
- Sharing parts of address space is easier
  - Put all objects want to share in the same segment
    - HW will check protections and length of shared segments
  - e.g. two running emacs programs can share same code segment

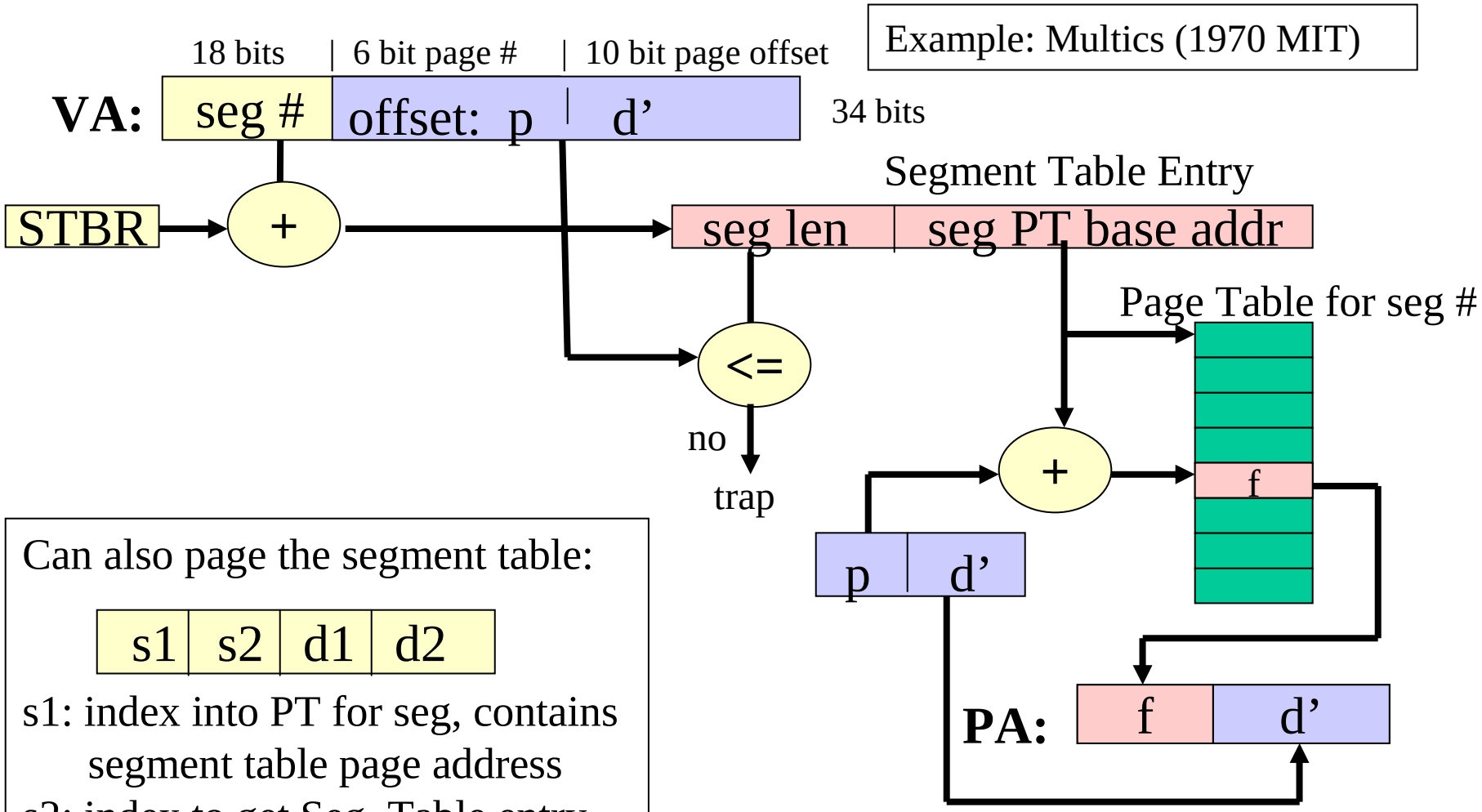
- Need HW support: segment table base & limit regs



However: problem of variable sized contiguous segments in memory

➔ External Fragmentation

Solution: Paged Segmentation



Can also page the segment table:

s1	s2	d1	d2

s1: index into PT for seg, contains segment table page address
s2: index to get Seg. Table entry
d1: index into PT for segment get f
d2: offset into physical page