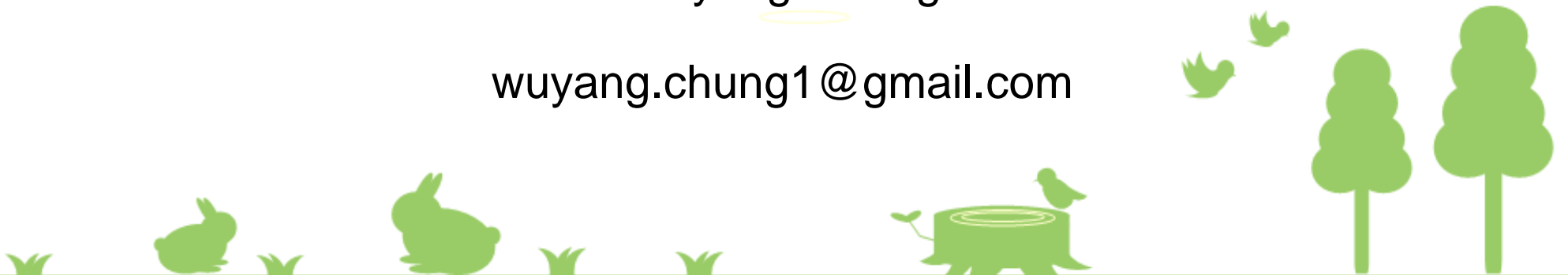# Segmentation Extension Proposal

Mar. 12, 2019

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Outline

- Why segmentation

- Segmentation hardware

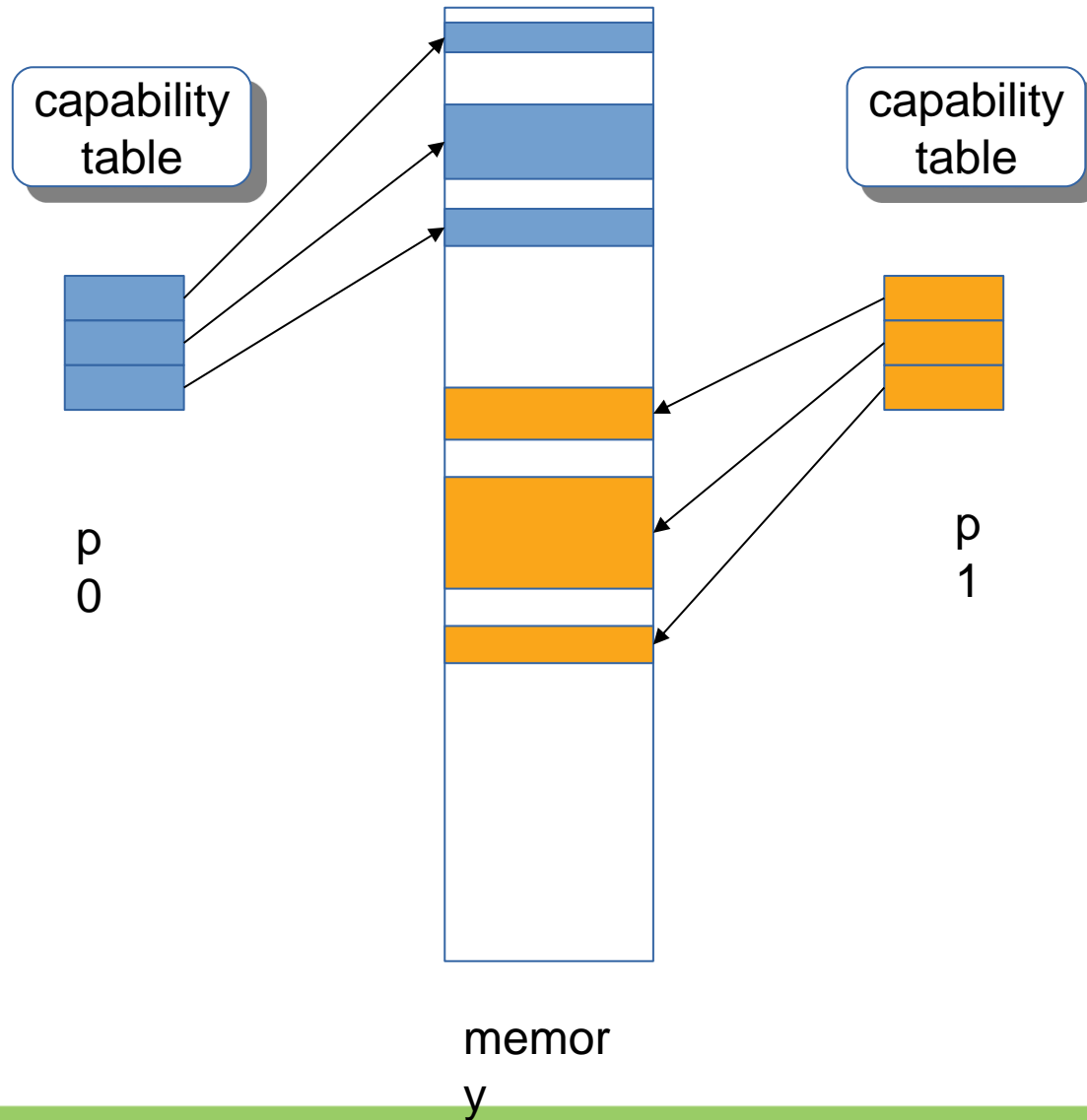- New instructions

- Benefits of segmentation

- Misc

Why Segmentation

- Segmentation can be used to create multiple protection domains on a single address space
  - SASOS: Single Address Space Operating System
  - Reduce context switch overhead
  - Data sharing is easy among processes
  - ...
- Other benefits
  - I/O segment
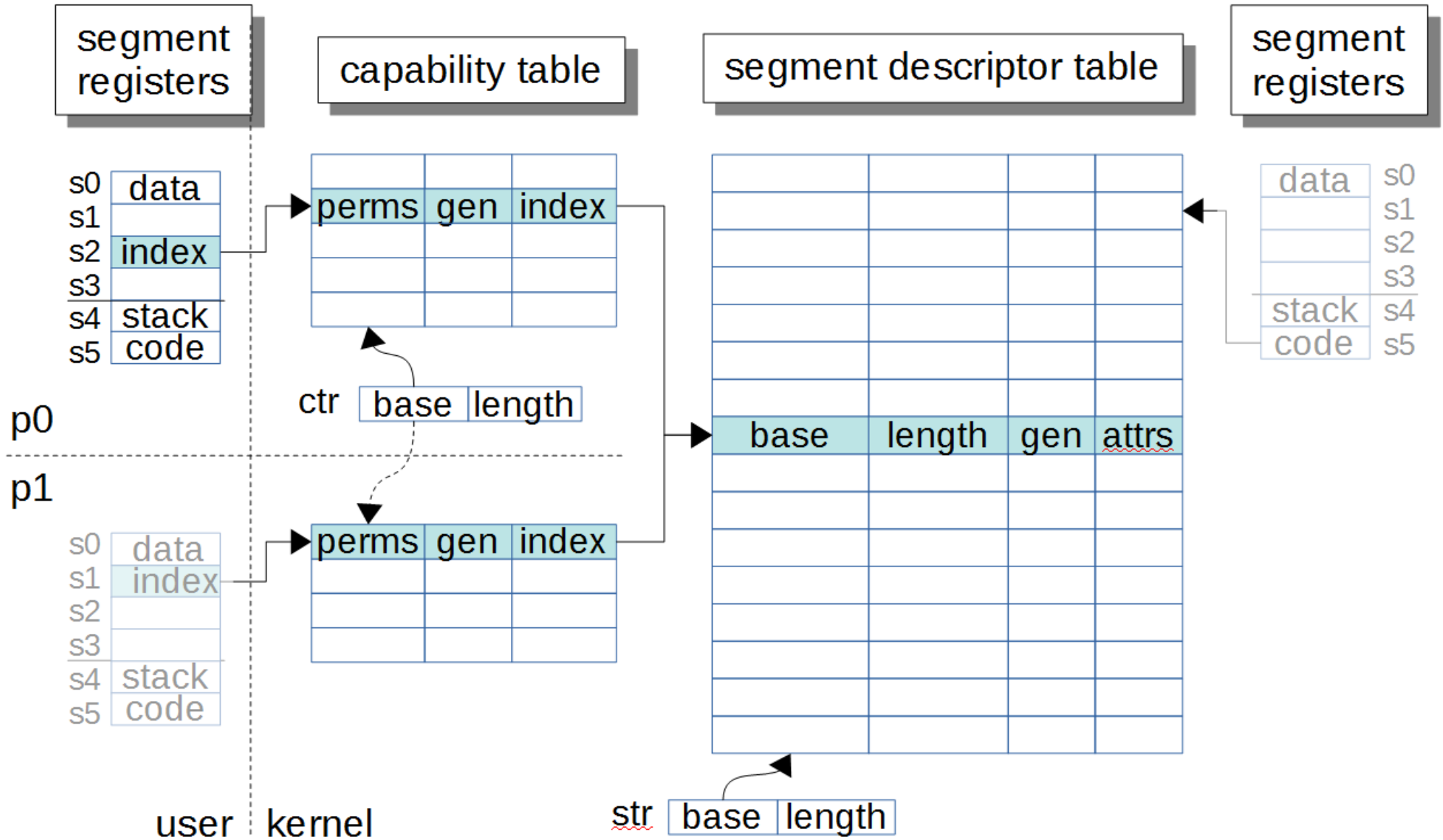 - Physical memory segment
  - Software-managed TLB

Segmentation Hardware

capability table

capability table
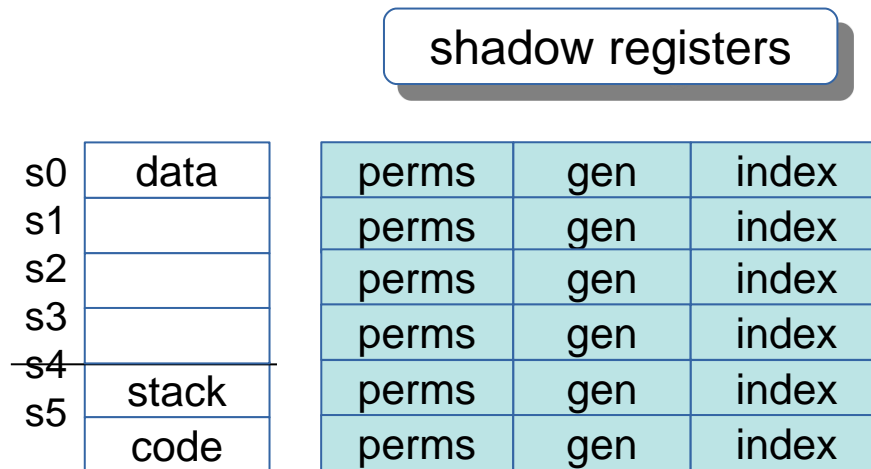
p 0

p 1

memory

Segmentation Hardware (2)
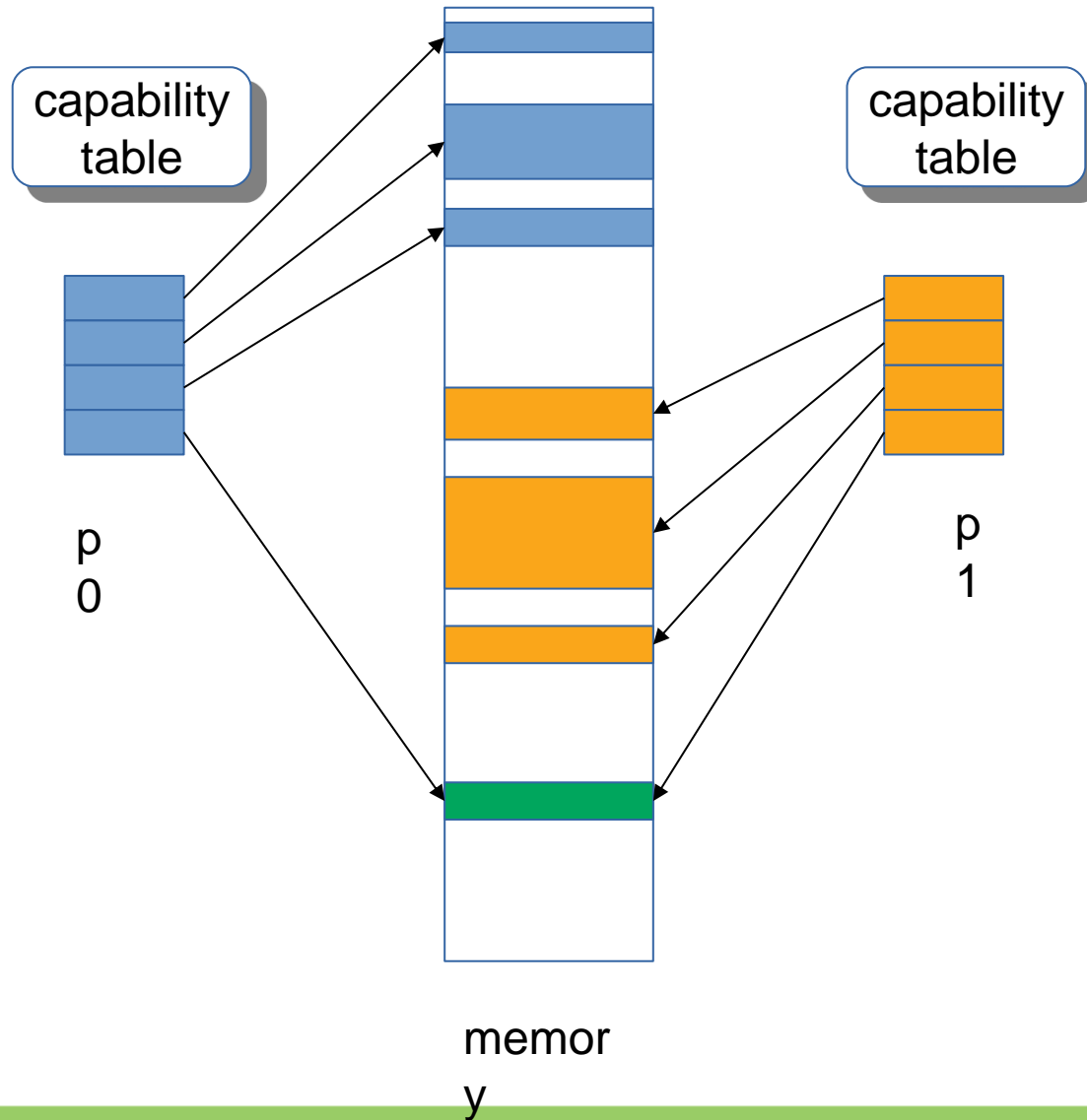
Segmentation Hardware (3)

Segmentation Hardware (4)

- Segment TLB
  - Cache segment descriptors

- Segment shadow register
  - Cache capability

		shadow registers		
s0	data	perms	gen	index
s1		perms	gen	index
s2		perms	gen	index
s3		perms	gen	index
s4	stack	perms	gen	index
s5	code	perms	gen	index

New Instructions

- Load/Store with segment override
  - LW x1, *s1*:imm[x2]

- Load/Store segment registers, ctr register and str register
  - LSR s0, imm[x1], SSR s0, imm[x1]
  - LCTR imm[x1], LSTR imm[x1]

- Far function call and return
  - For shared library
  - Far call
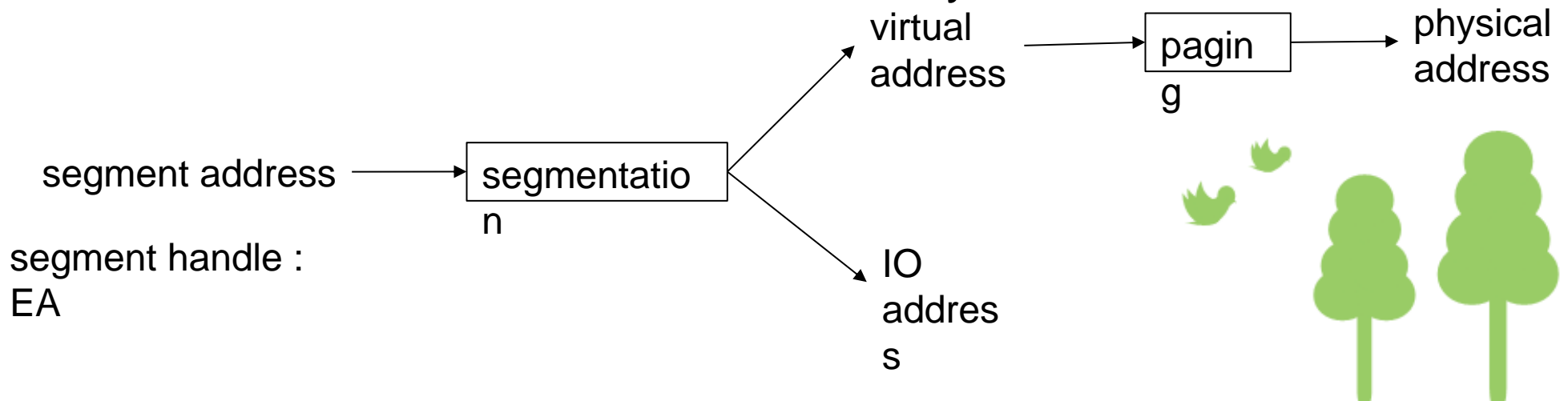   - SJAL link_addr, *callee_seg*, imm

Benefits of Segmentation

- On systems without paging
    - Segmentation can be used instead of PMP (Physical Memory Protection).
   - It's more easy to implement shared library with segmentation.

Benefits of Segmentation (2)

- On systems with paging
  - I/O segment
    - No page TLB entry is needed for device driver to access its hardware device.
    - One set of load/store instructions can be used to load/store from/to either memory or I/O.

virtual address → paging → physical address

segment address → segmentation

segment handle : EA

IO address

Benefits of Segmentation (3)

- On systems with paging
  - Physical memory segment
    - Improve the performance of big-memory workloads
      - Arkaprava Basu, Jayneel Gandhi, Jichuan Chang, Mark D. Hill, Michael M. Swift. Efficient virtual memory for big memory servers. In Proc. ISCA, 2013.

Segment address ⟶ [segmentation] ⟶ physical address

segment handle : EA

[paging]
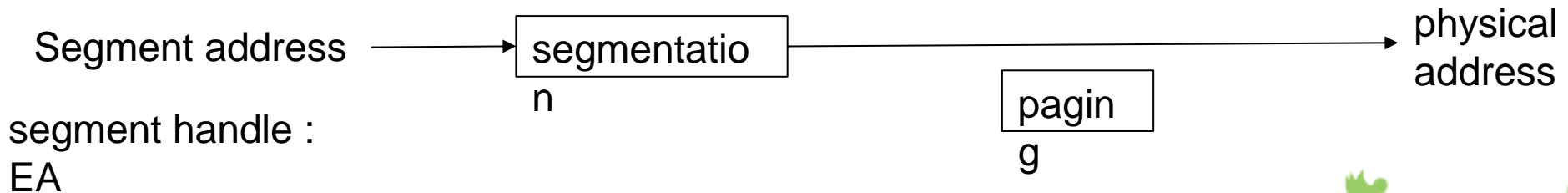
Benefits of Segmentation (4)

- Software-managed TLB
  - Prerequisite
    - Segment/page TLB miss can not happen during TLB miss handling.
  - How
    - Make kernel's code, data and stack segment as physical memory segment.
    - Make kernel's code, data and stack segment descriptors always resident in segment TLB.

Misc.

- Stack growth direction
  - Stack should grow upwards.
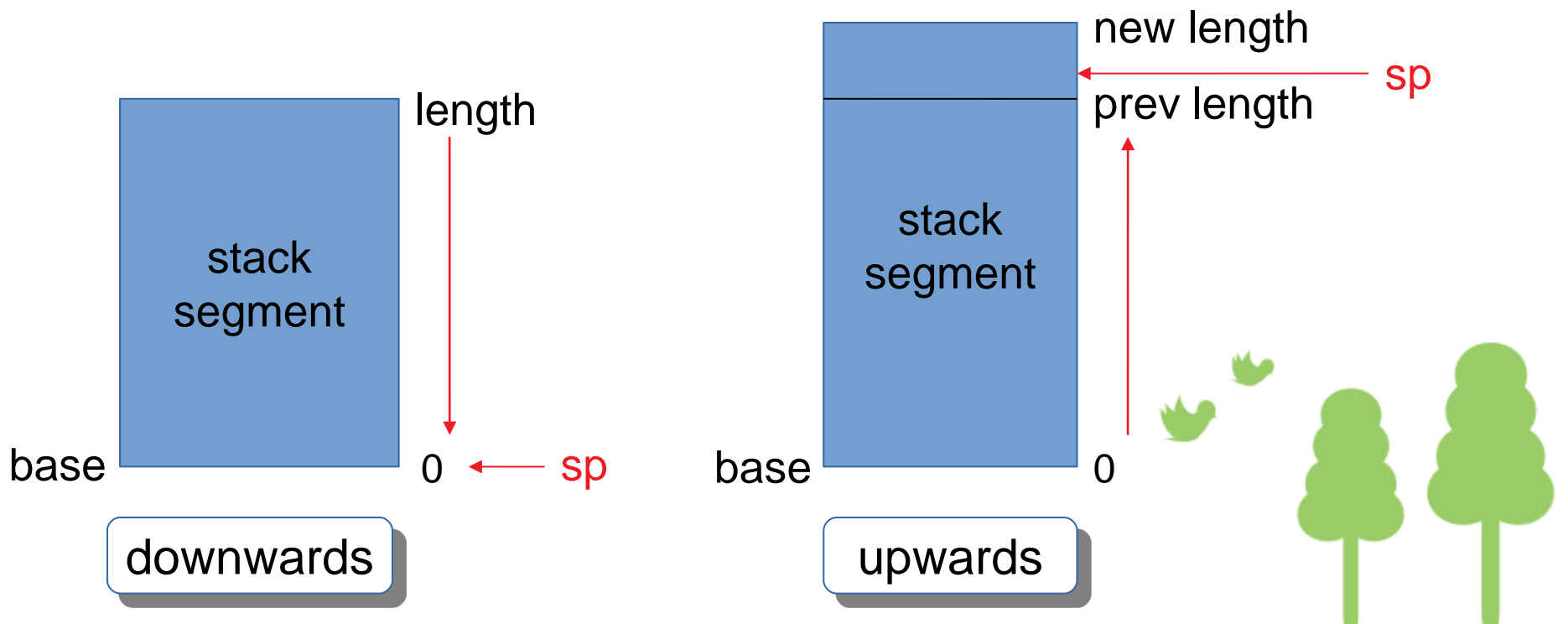
Misc. (2)

- Compiler support is needed.
    - Far code/data pointer
    - Shared library

- OS change is needed.
    - MASOS → SASOS

Thanks.