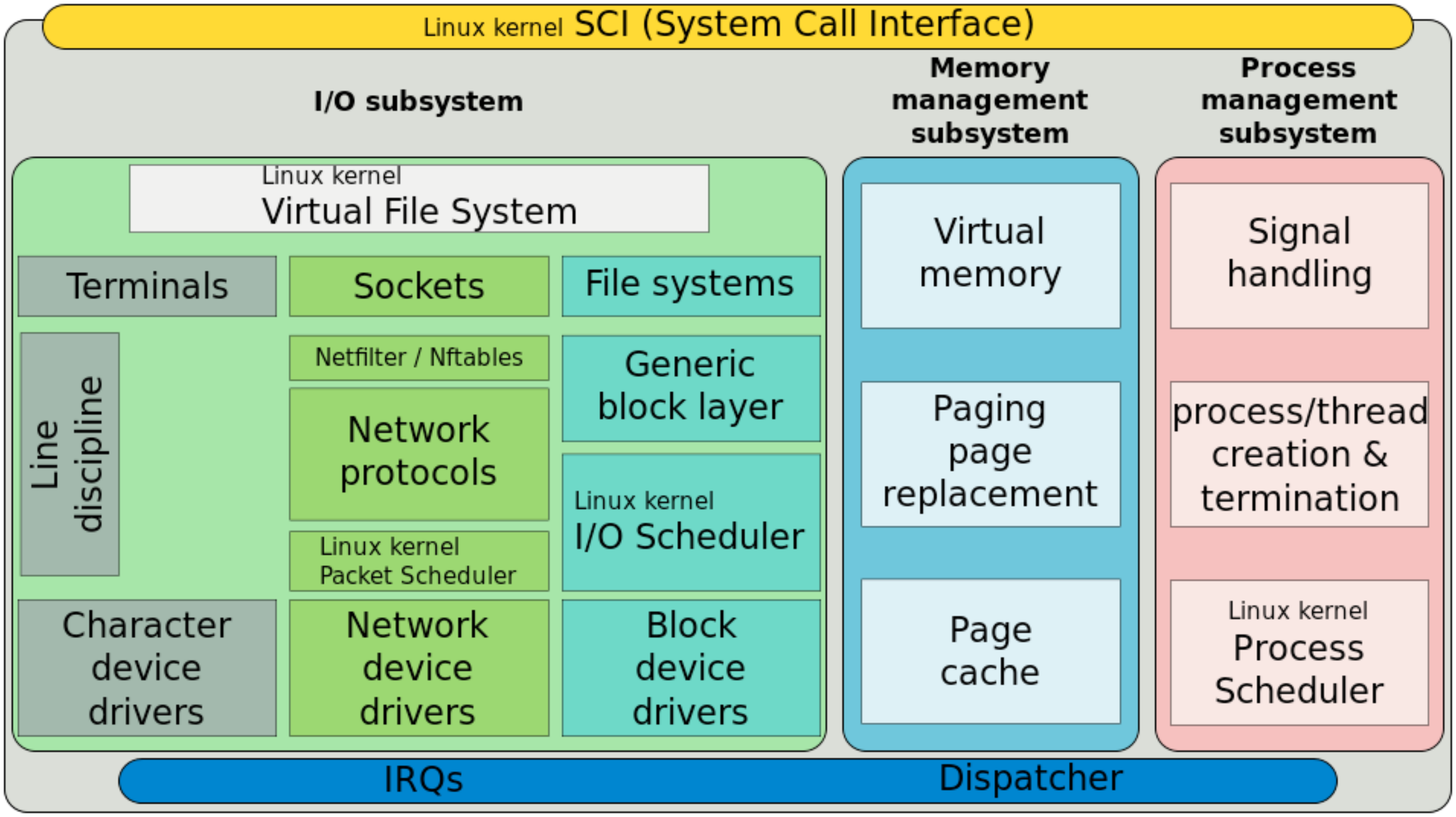
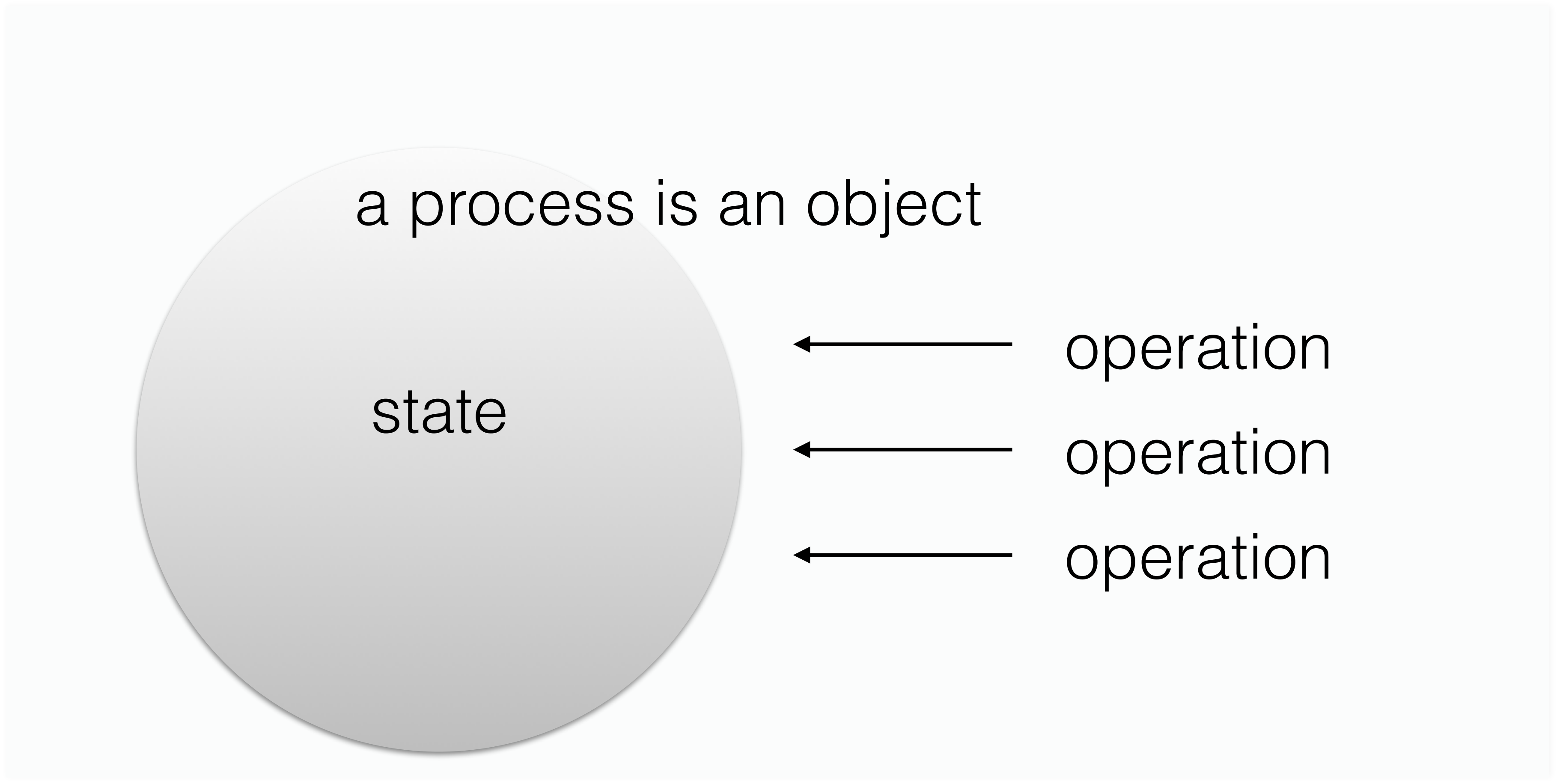
# Operating systems

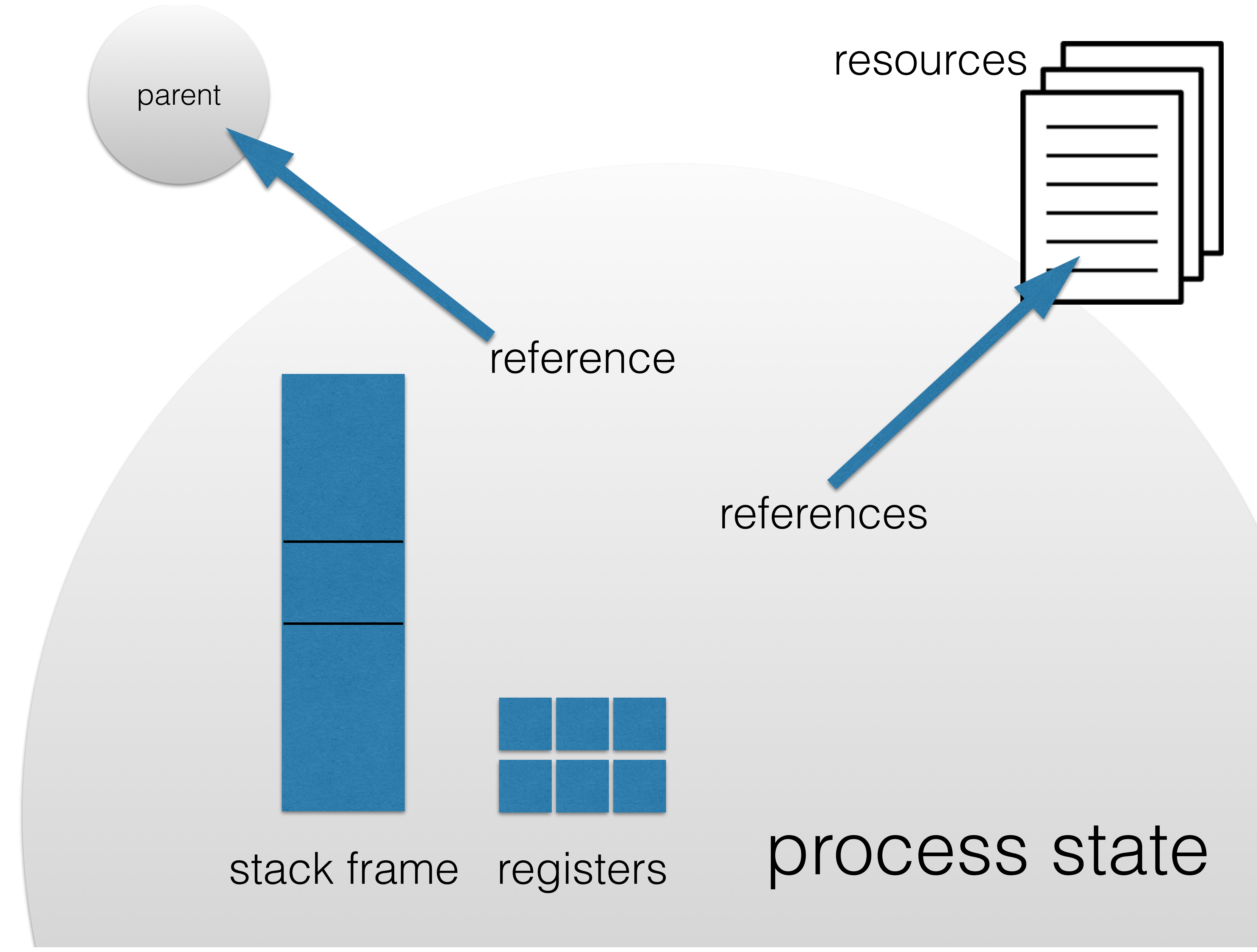
Processes

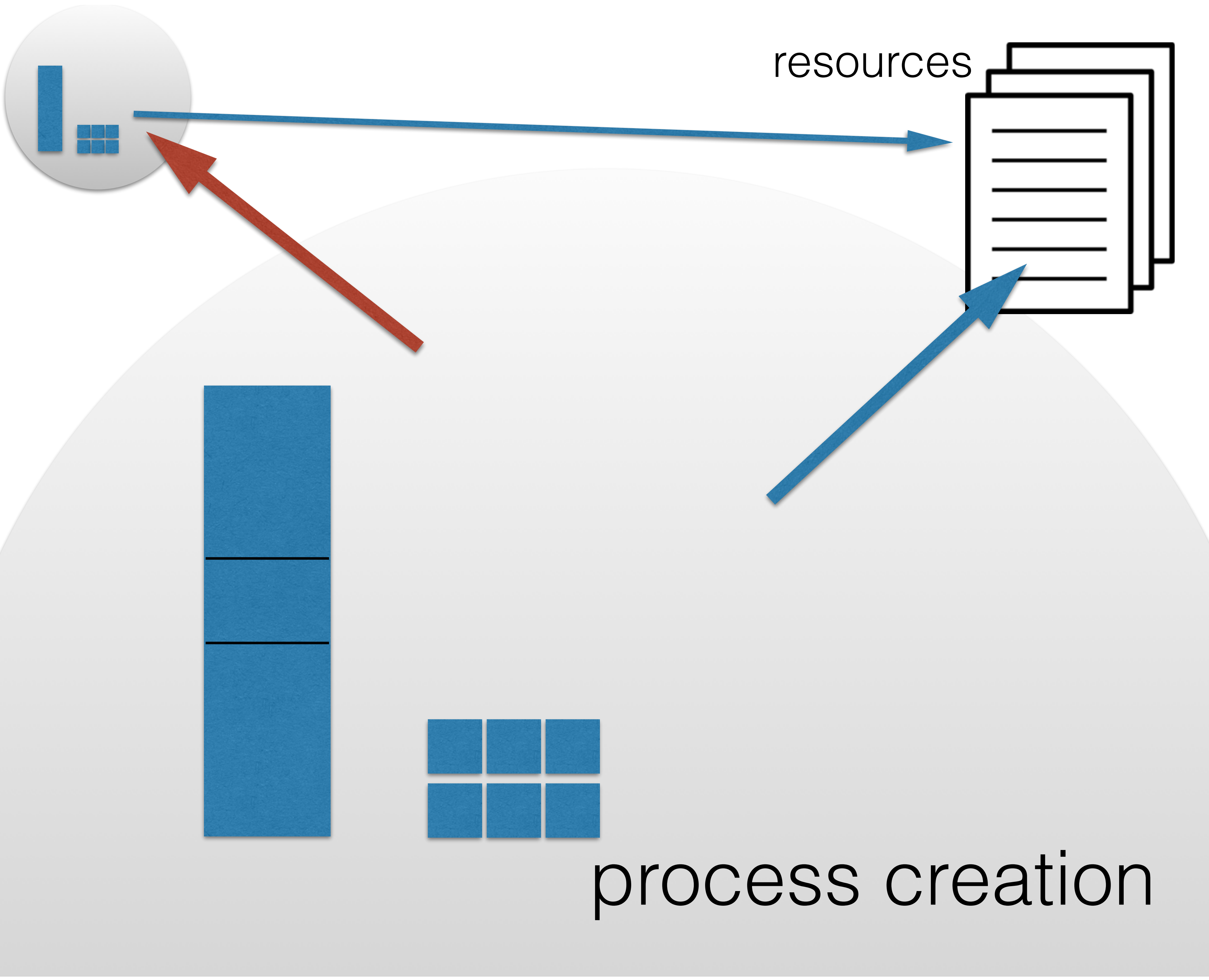

Linux kernel SCI (System Call Interface)
I/O subsystem
Memory management subsystem
Process management subsystem
Linux kernel Virtual File System
Terminals
Sockets
File systems
Line discipline
Netfilter / Nftables
Network protocols
Linux kernel Packet Scheduler
Generic block layer
Linux kernel I/O Scheduler
Character device drivers
Network device drivers
Block device drivers
Virtual memory
Paging page replacement
Page cache
Signal handling
process/thread creation & termination
Linux kernel Process Scheduler
IRQs
Dispatcher

# What is a process?

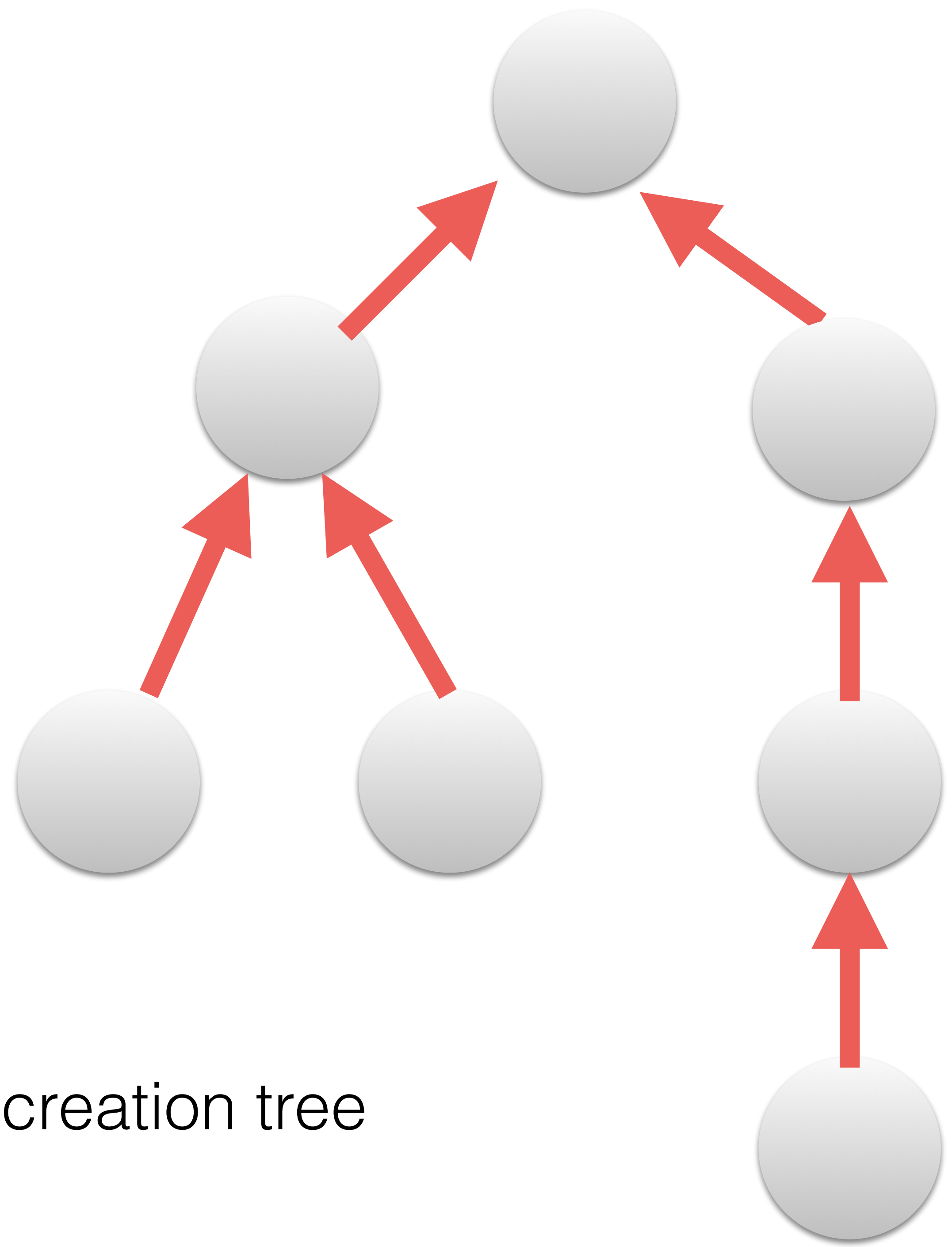
a **running** program



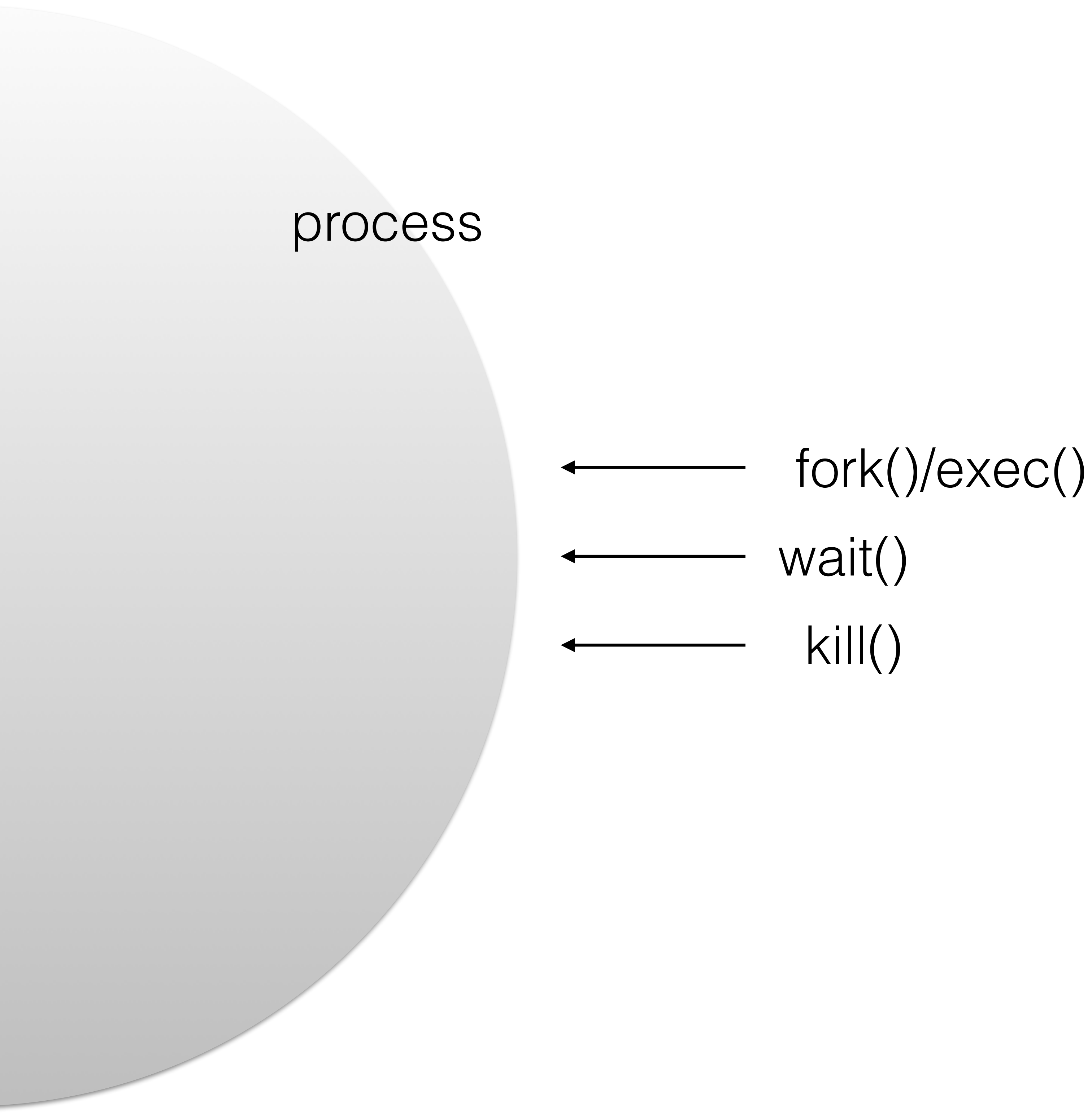

parent
resources
reference
references
stack frame
registers
process state



## process creation



process creation tree


process
fork()/exec()
wait()
kill()

# Processes and Java

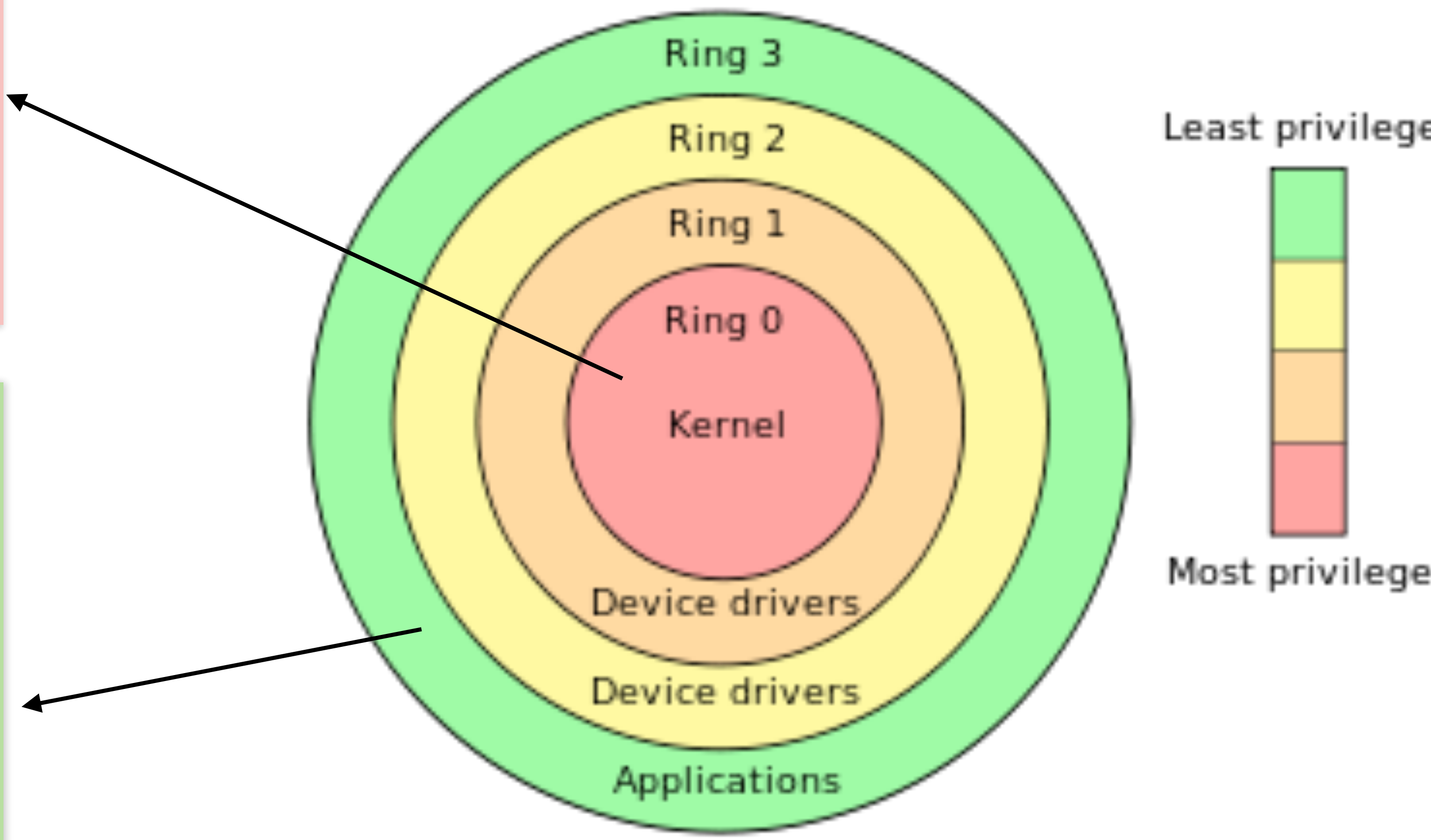
- one process per JVM
- similar ideas in Java Threads API which run "Runnable" objects (see https://docs.oracle.com/javase/8/docs/api/java/lang/Thread.html)
- BUT significant differences between processes and threads (later)

# User vs kernel mode

privileged access to

- CPU instructions
- memory addresses
- hardware

- must use syscalls
- isolation provides protection
- crashes are recoverable



## Limited direct execution

- What?
- Why?
- How?

## Traps

hardware traps (interrupts): generated by hardware in need of attention

- clock chip interrupts every 100 msec
- disk block ready to be retrieved
- more difficult to think about as may happen concurrenlty

trap: caused by current running process

- system call/software interrupt
- exceptions: division by 0, illegal memory access

## Trap handling

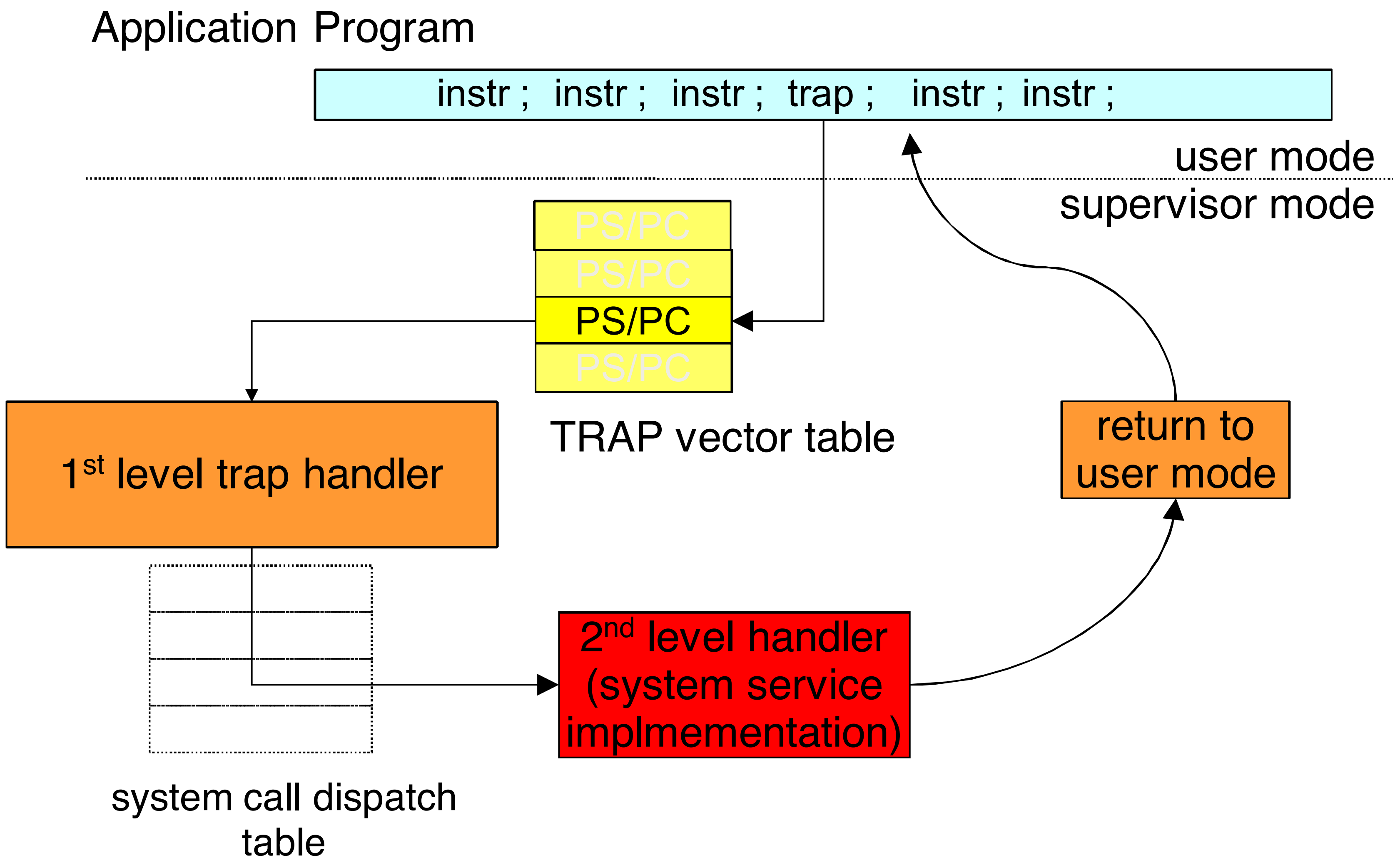
normal processor execution

- read instruction
- advance program counter
- execute instruction
- repeat

upon trap, trap handler

- saves register context on stack
- switch from user to kernel mode

# System call trap gates



Application Program
instr ; instr ; instr ; trap ; instr ; instr ;
user mode
supervisor mode
PS/PC
PS/PC
PS/PC
PS/PC
TRAP vector table
1st level trap handler
return to user mode
2nd level handler (system service implmementation)
system call dispatch table