238P Operating Systems, Fall 2018

Final Review
Call Chain of a System Call

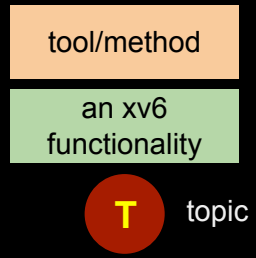
7 December 2018

Aftab Hussain
University of California, Irvine

a visual summary of what
we've done thus far

xv6 is a program

a legend of the diagrams to follow

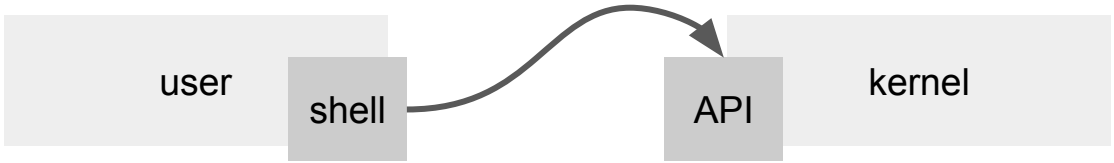


FRONT END

user

kernel

FRONT END



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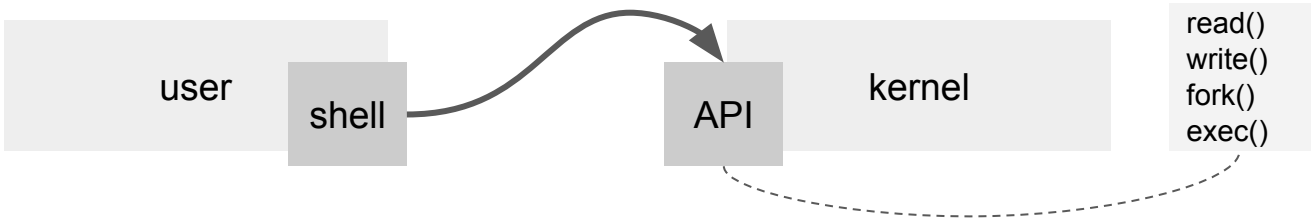

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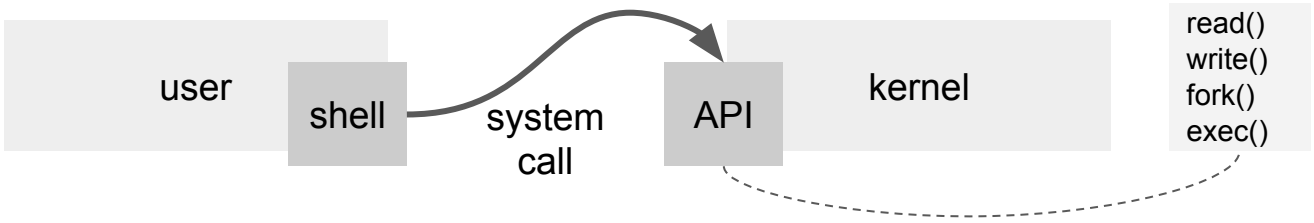

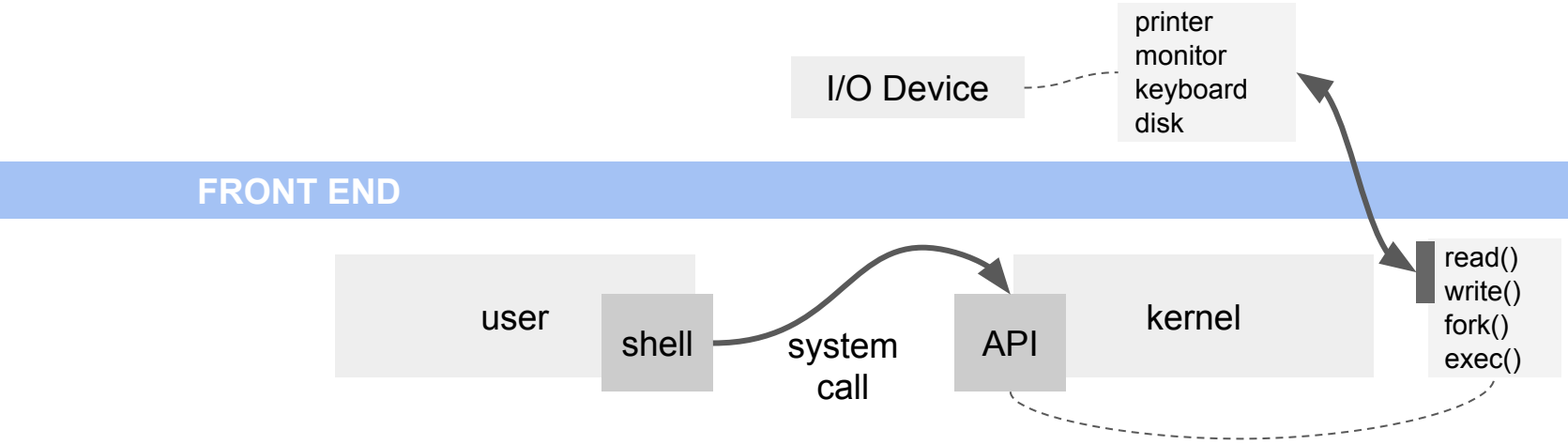
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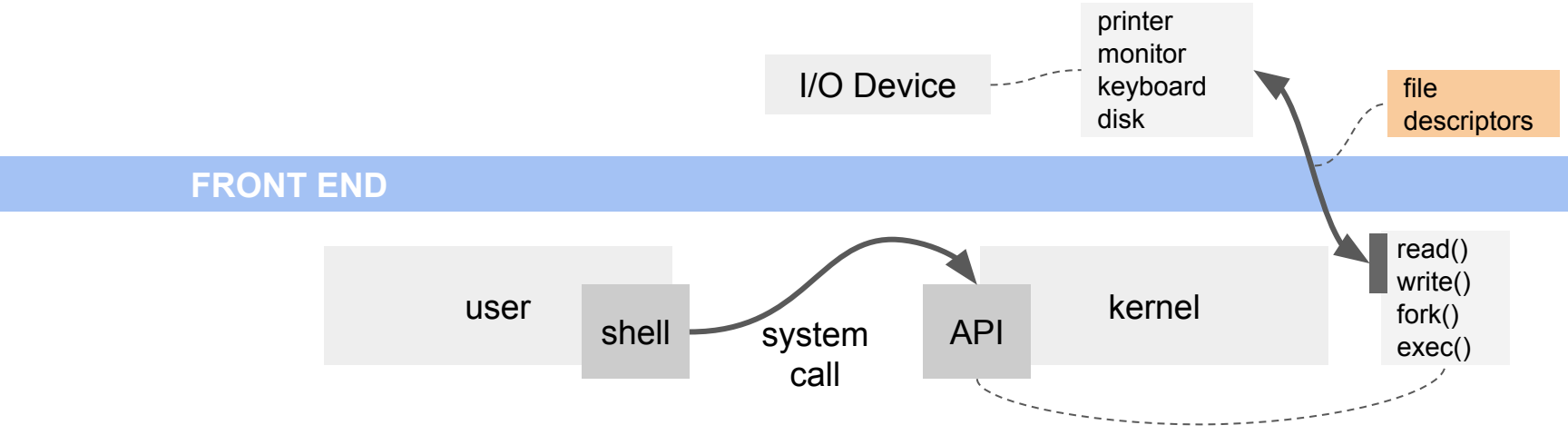
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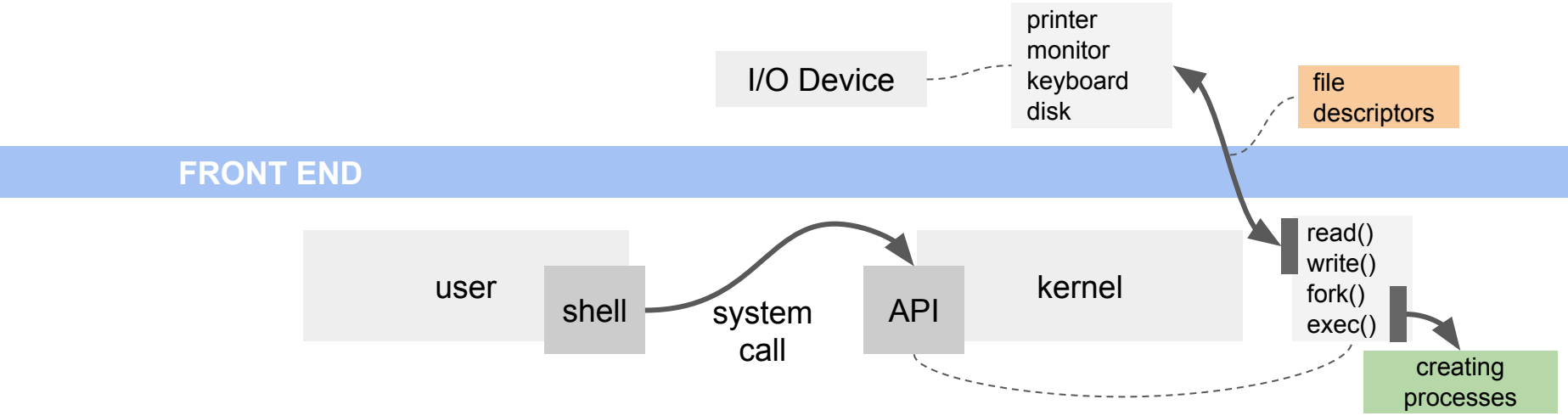
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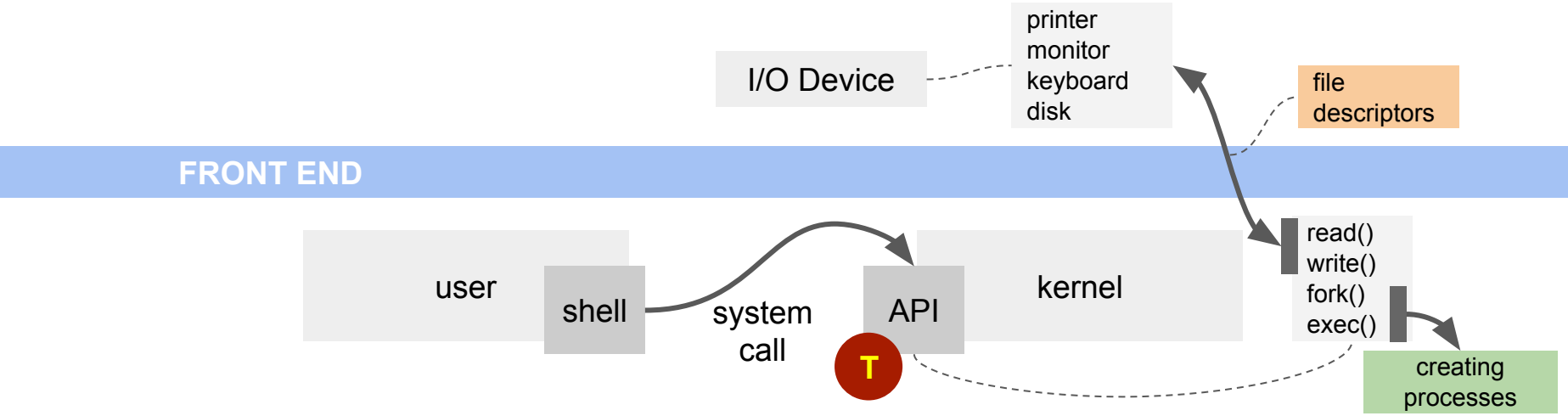
creating
processes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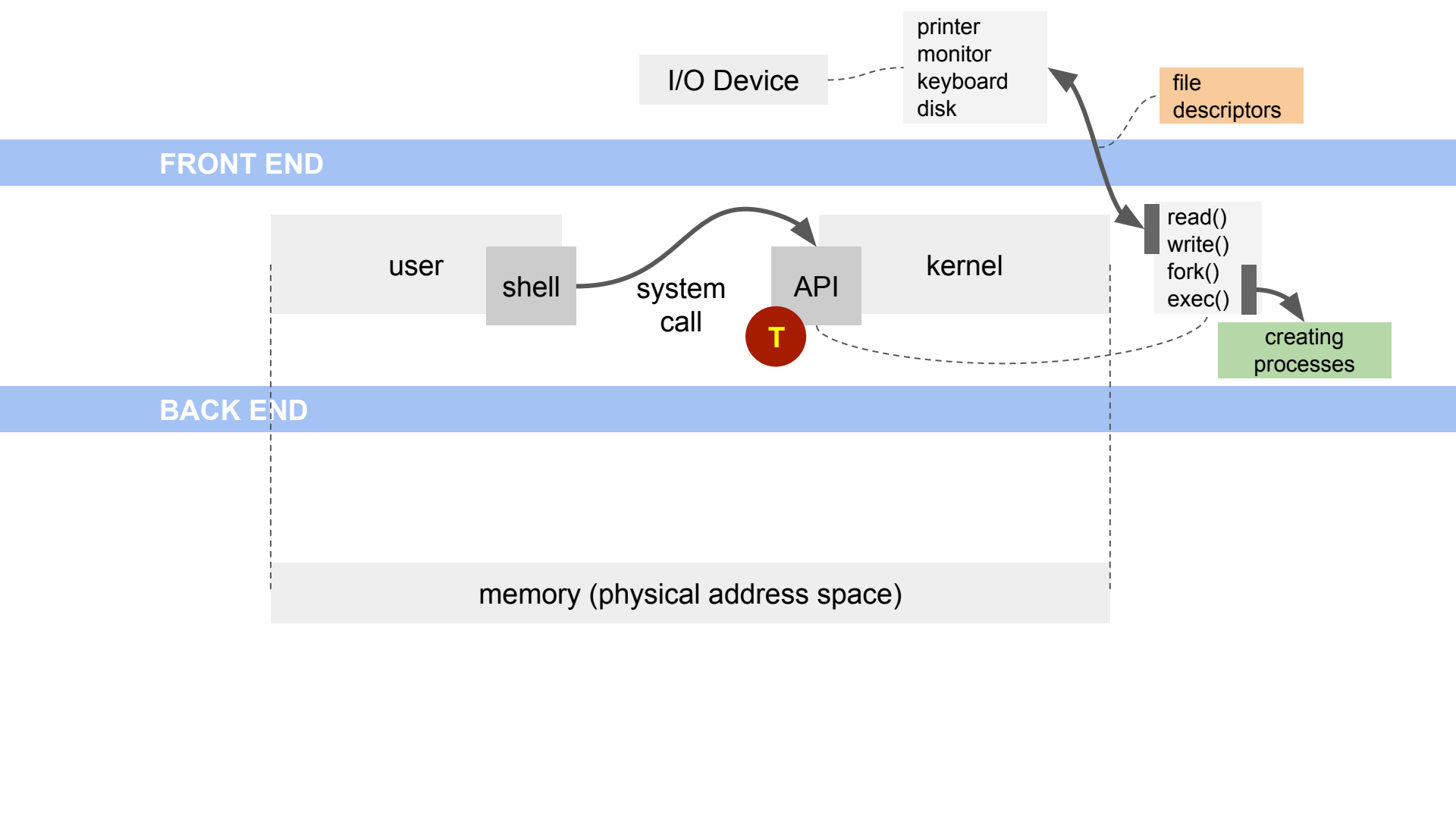
Any running program -- i.e., *a process* -- must be in memory, so the CPU can run it.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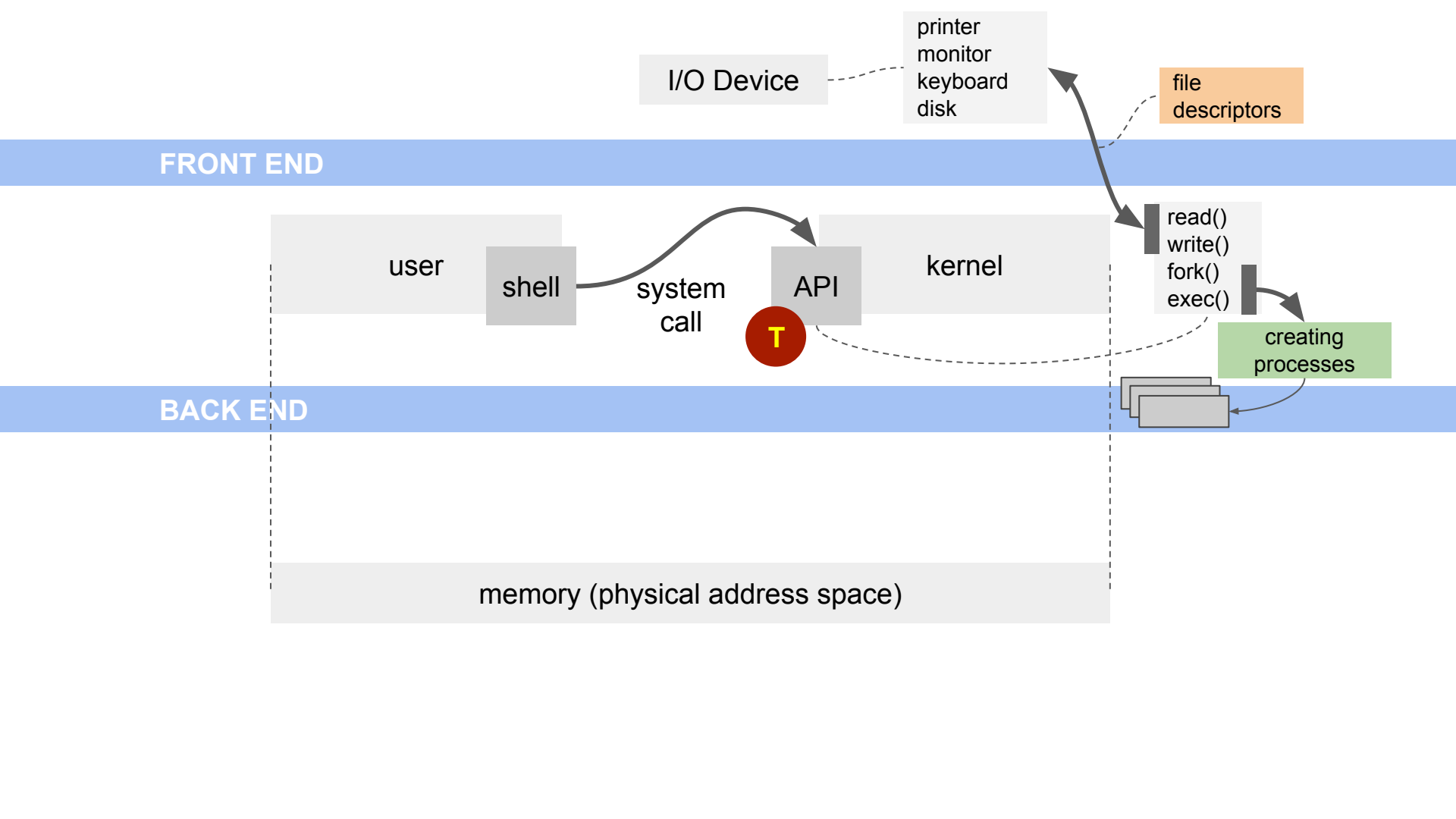
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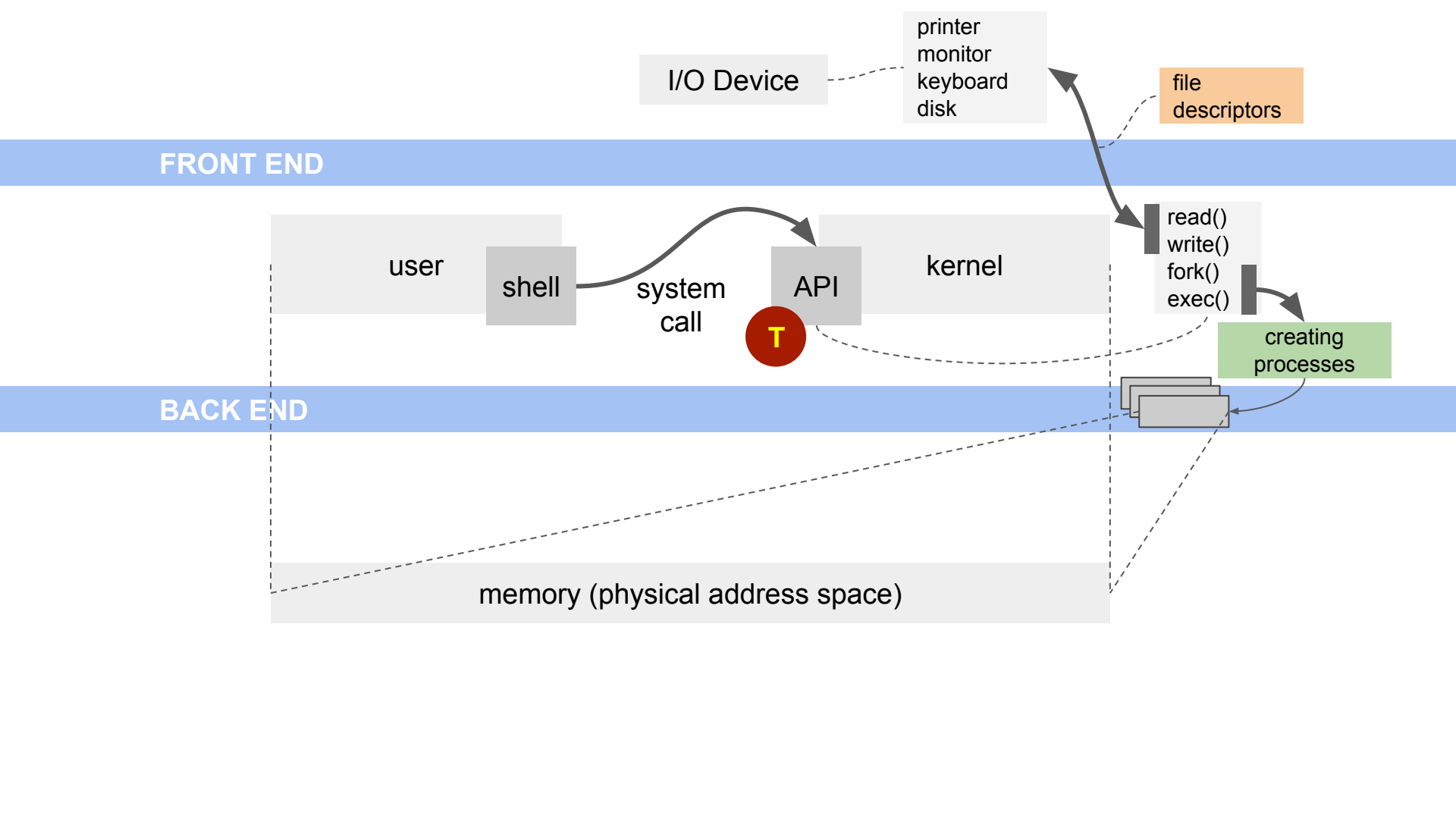
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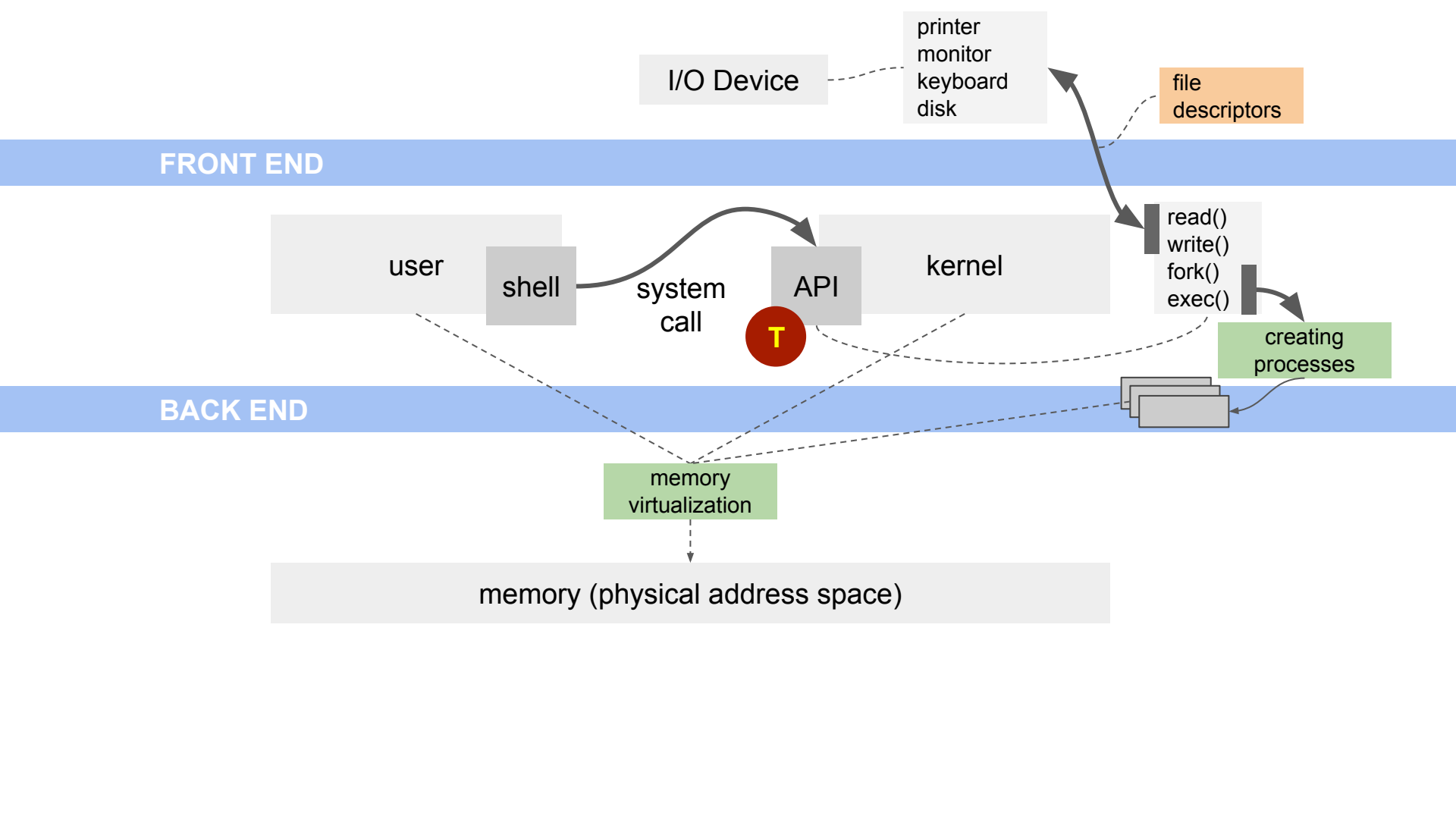
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creating
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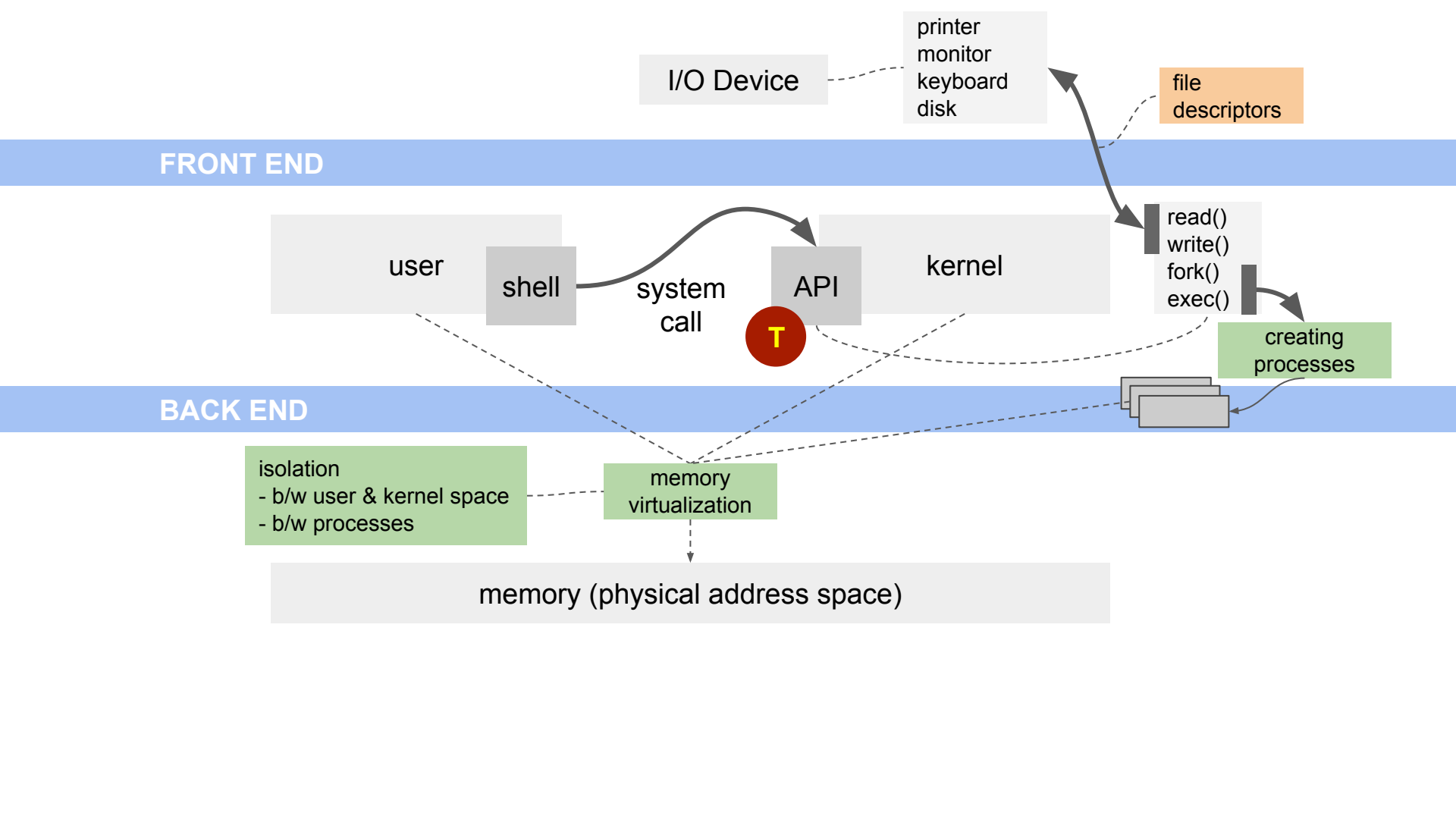
BACK END
memory
virtualization
memory (physical address space)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- b/w user & kernel space
- b/w processes
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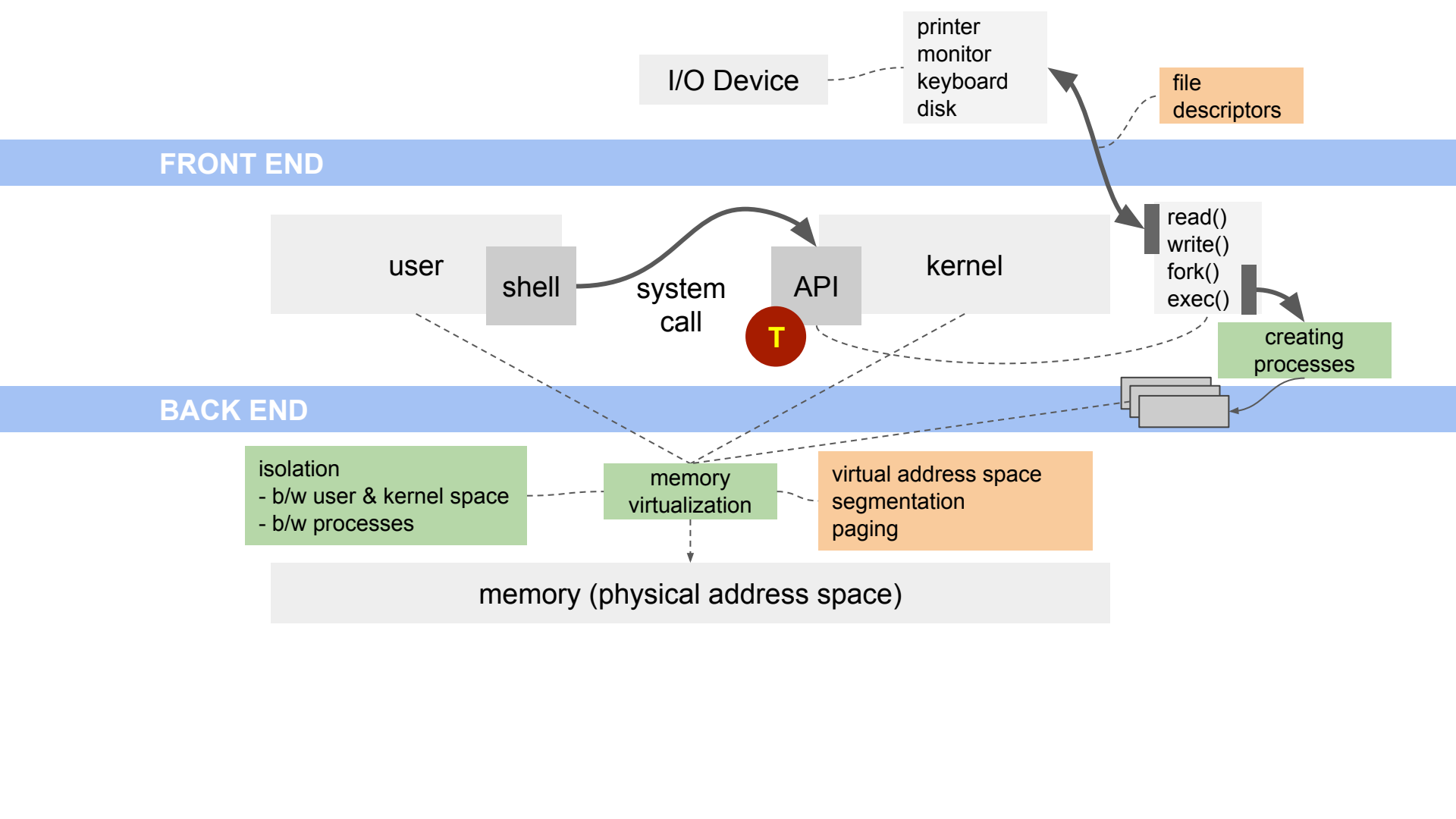
virtualization
memory (physical address space)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- b/w user & kernel space
- b/w processes
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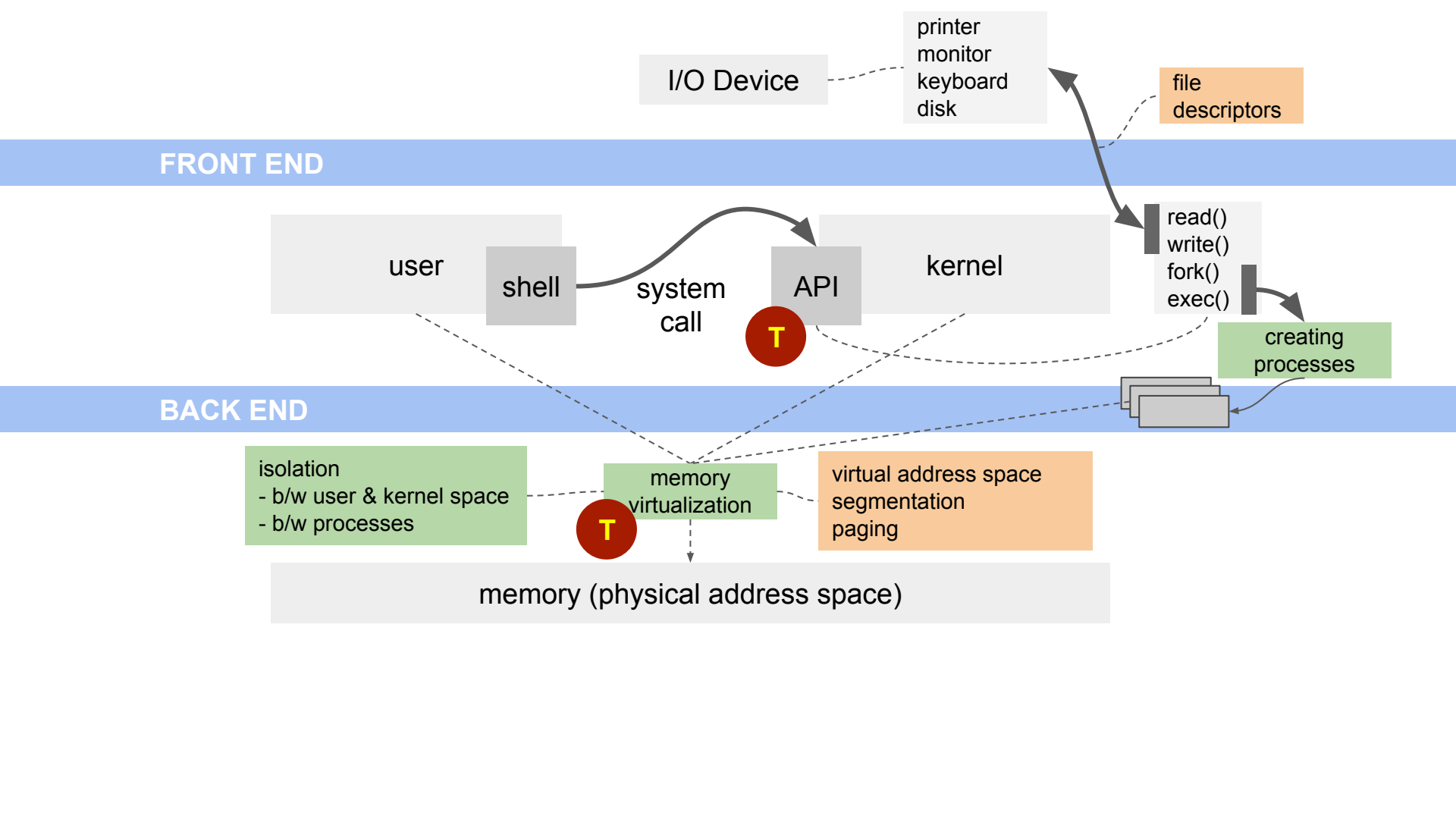
virtualization
virtual address space
segmentation
paging
memory (physical address space)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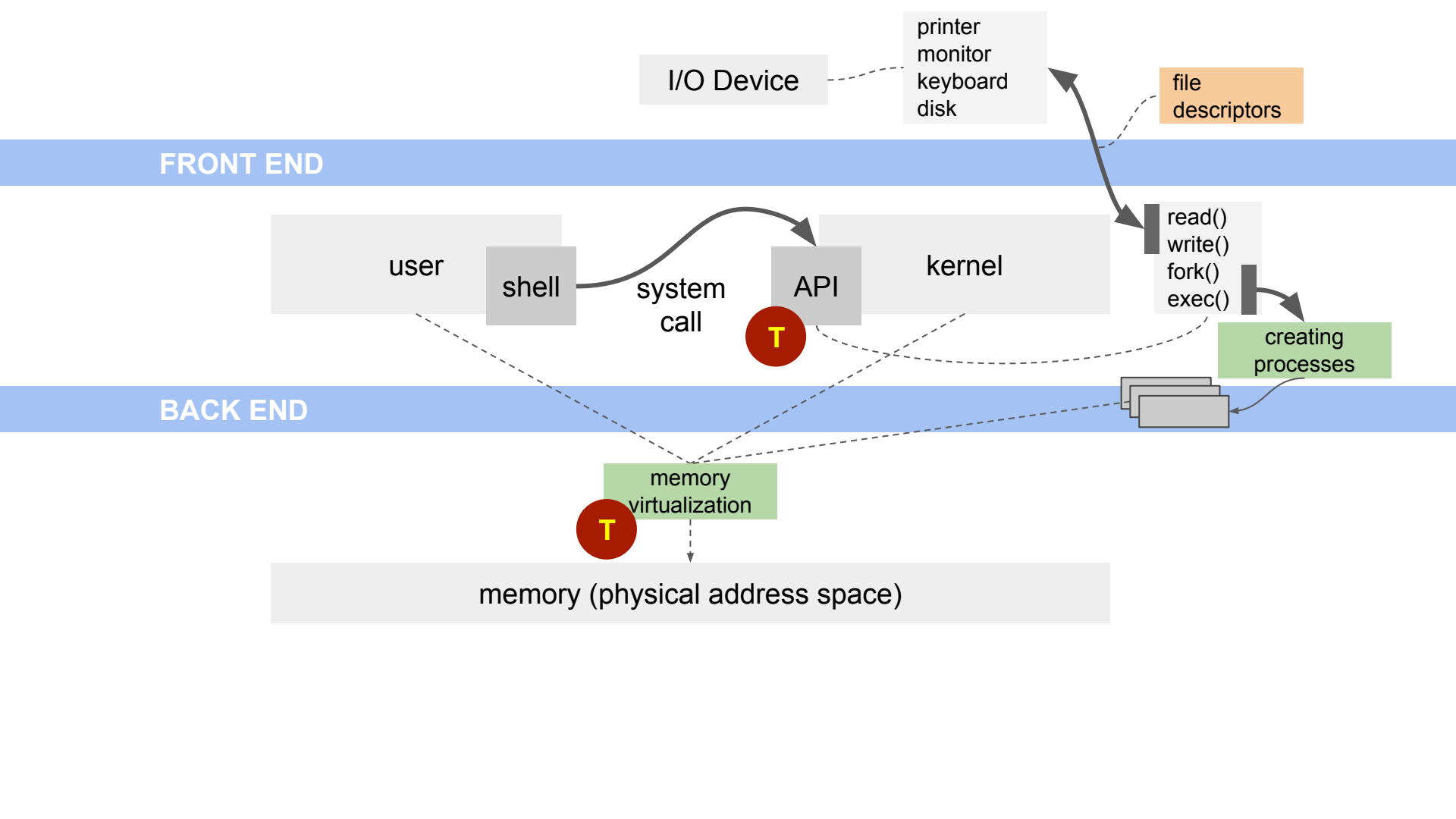
virtual address space
segmentation
paging
memory (physical address space)

So what exactly must be in memory?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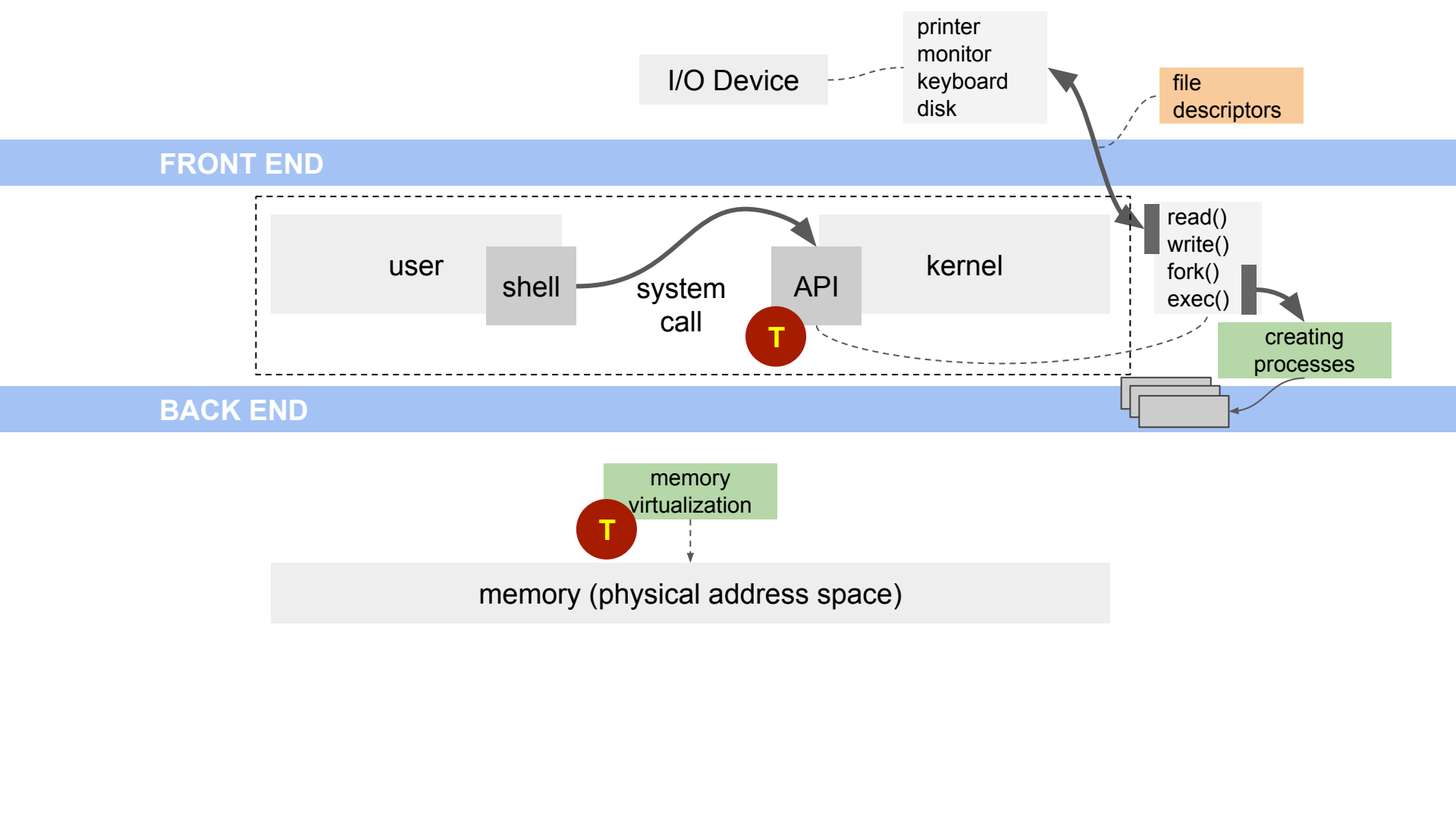
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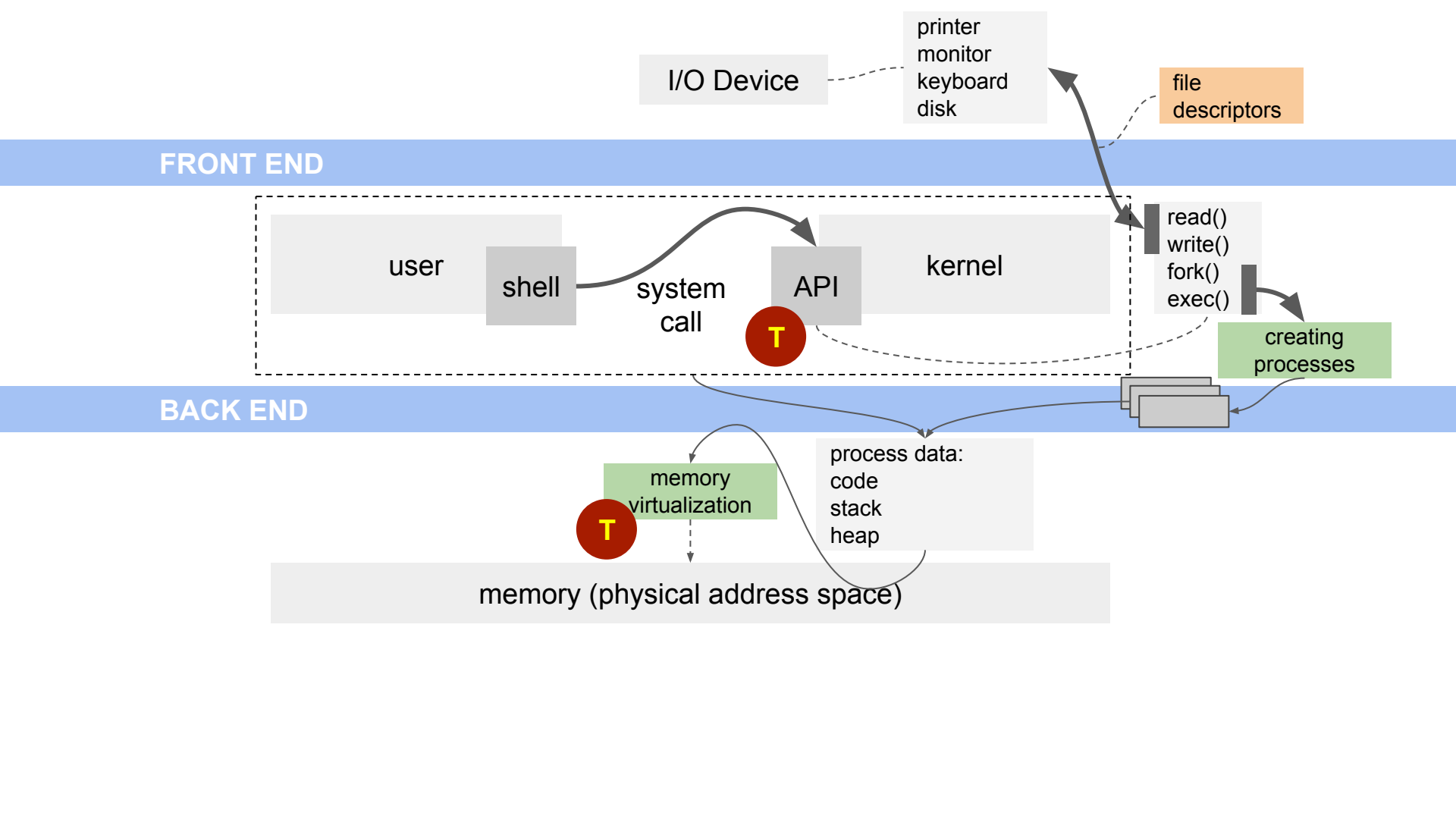
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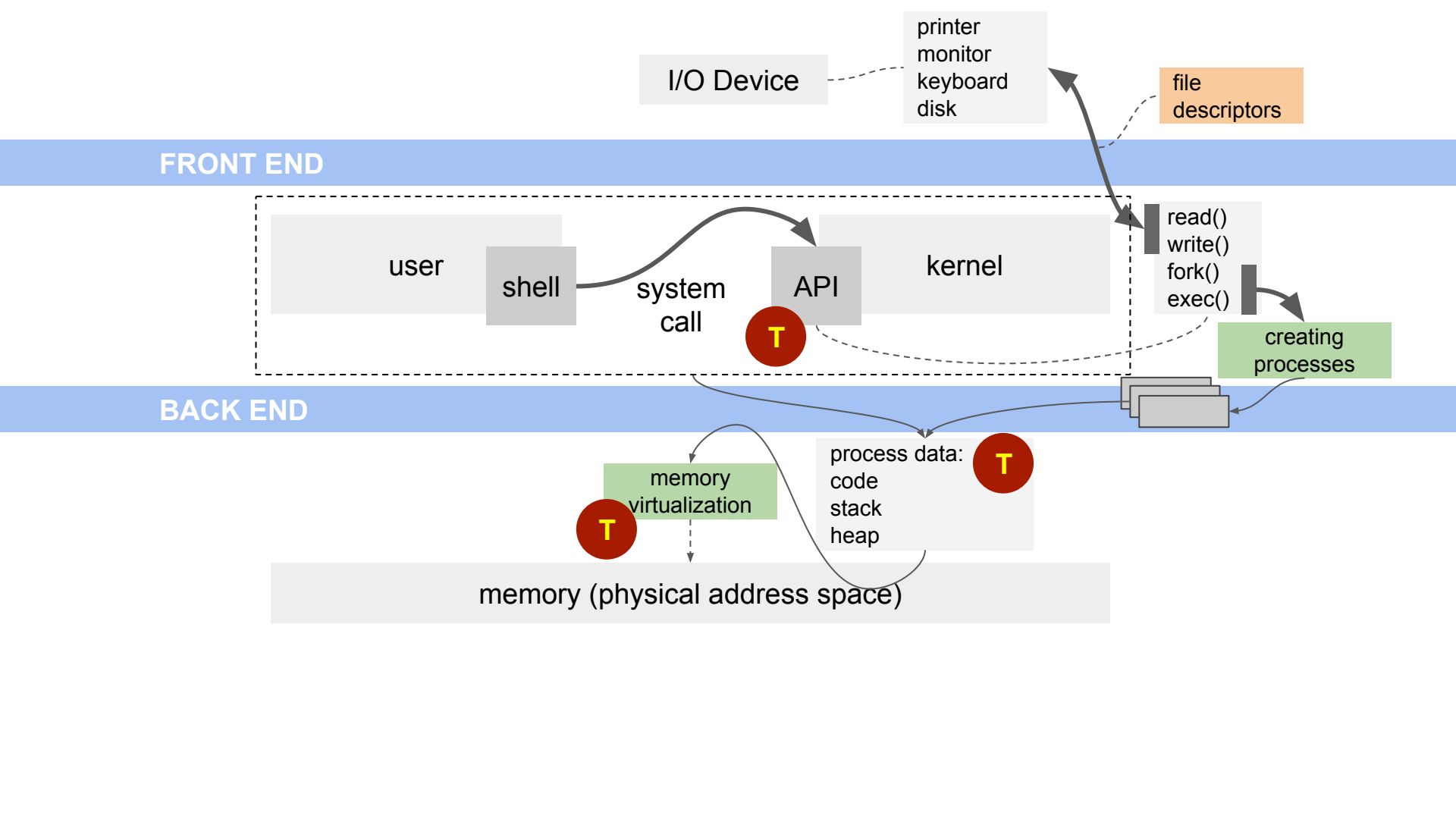
process data:
code
stack
heap
memory (physical address space)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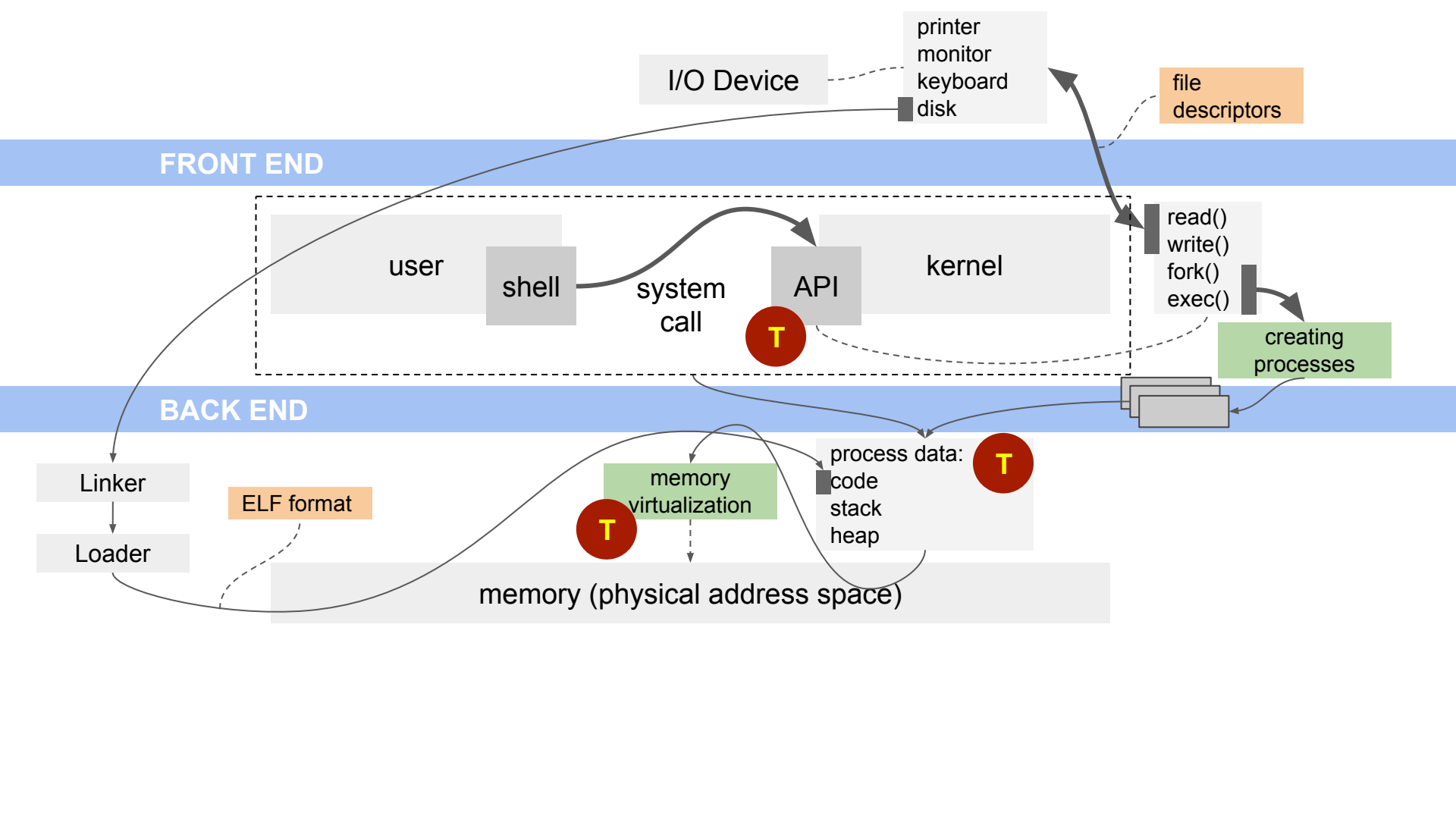
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ELF format
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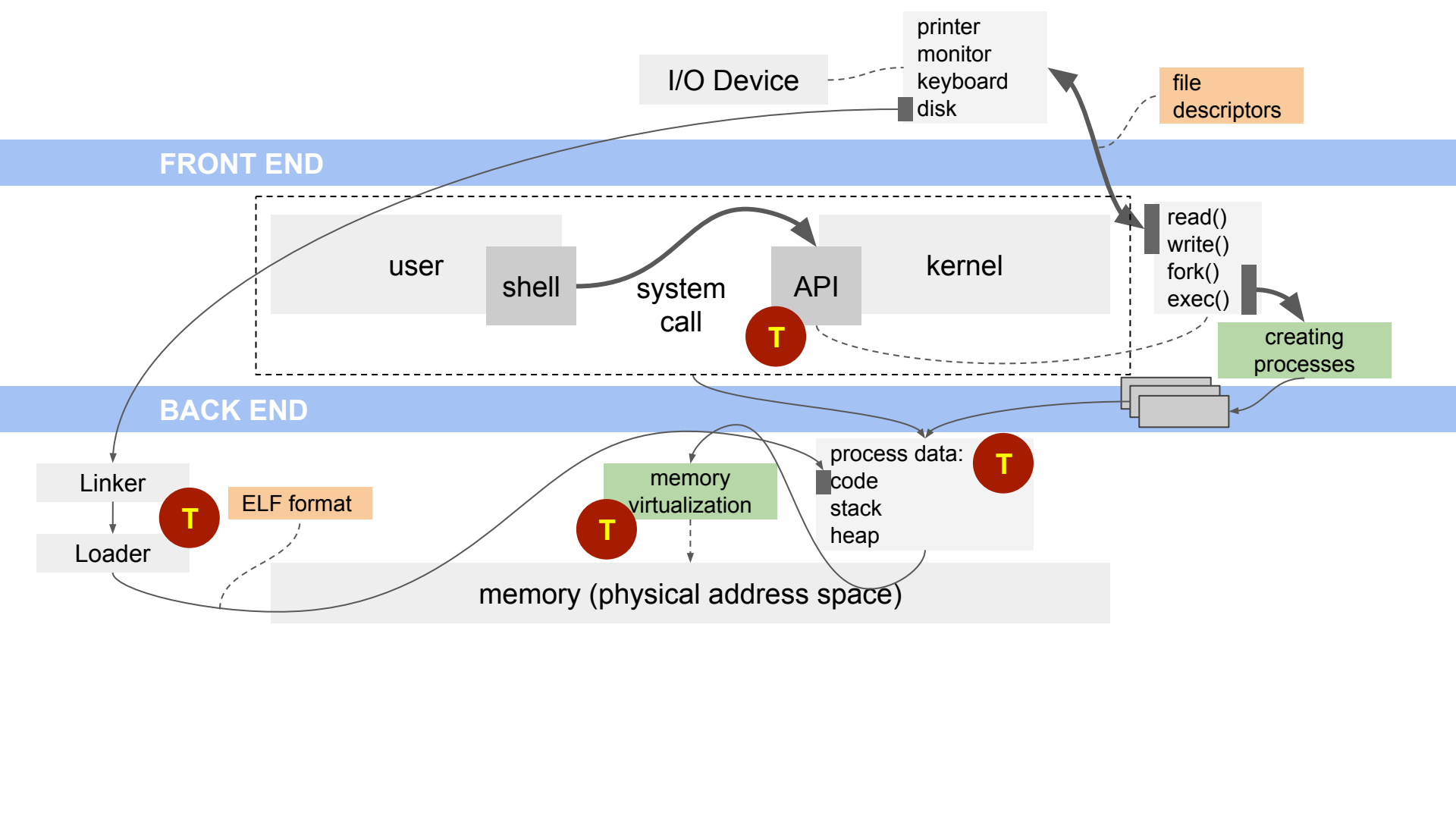
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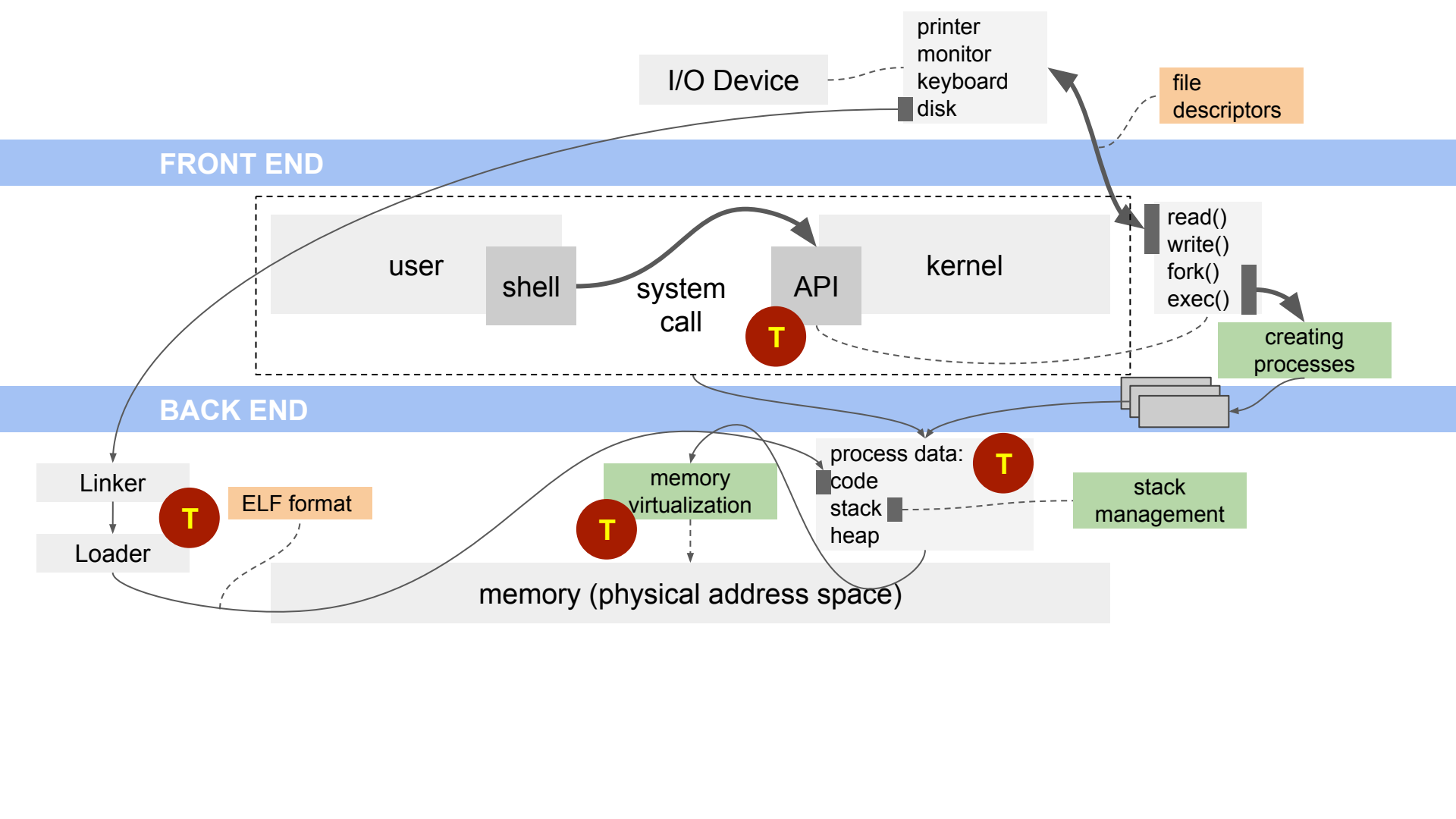
Need to handle dynamic info.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process data:
code
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management
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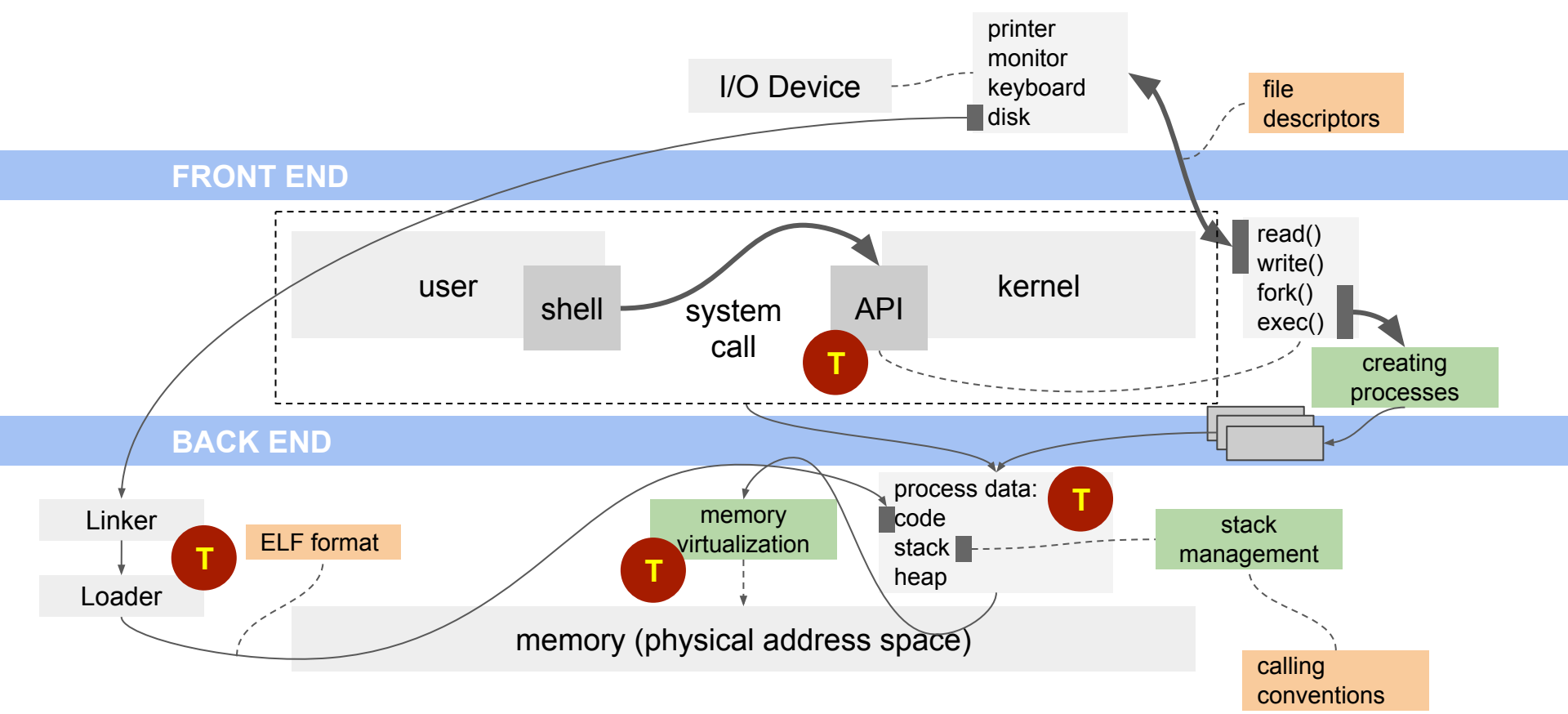
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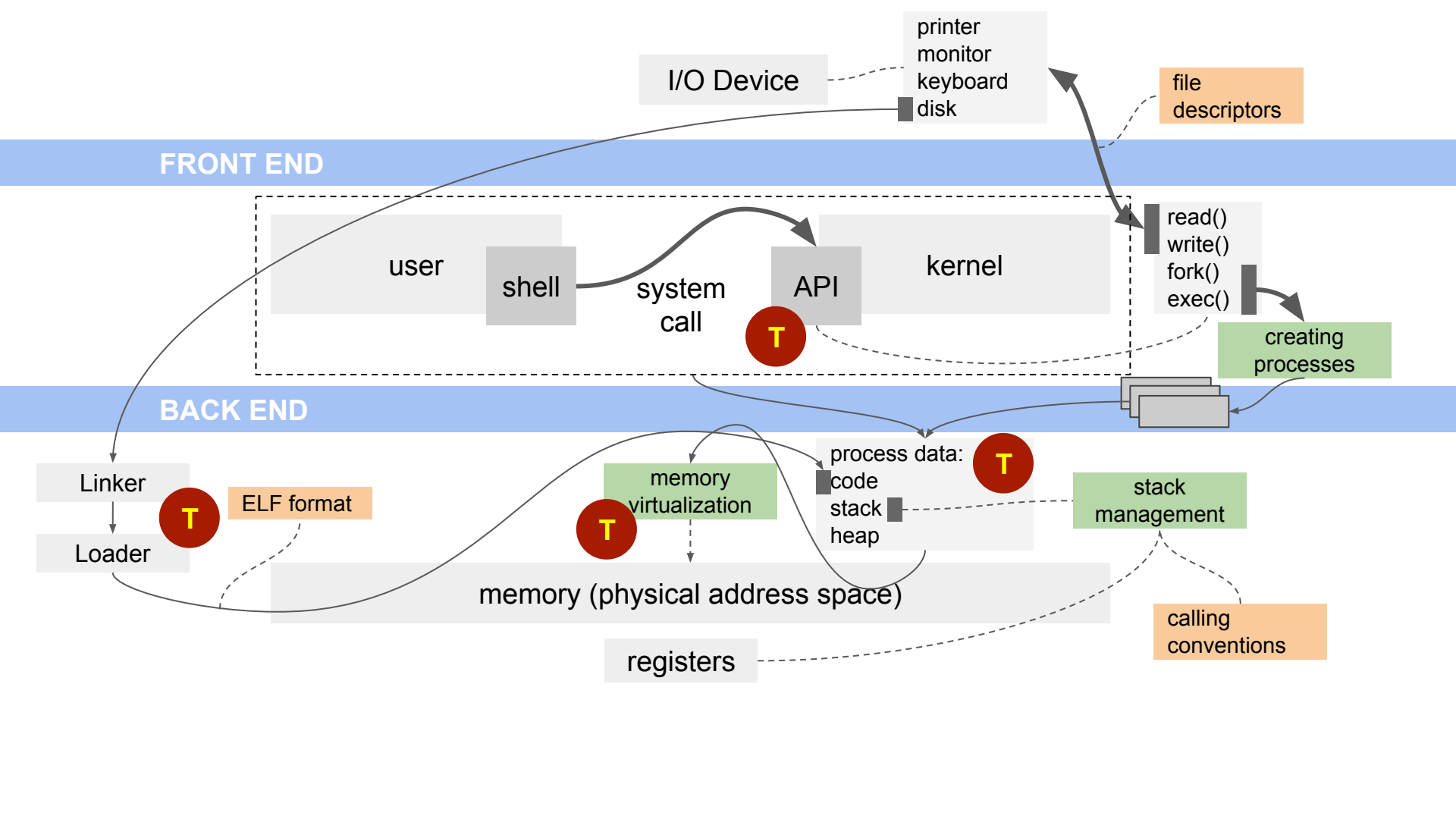
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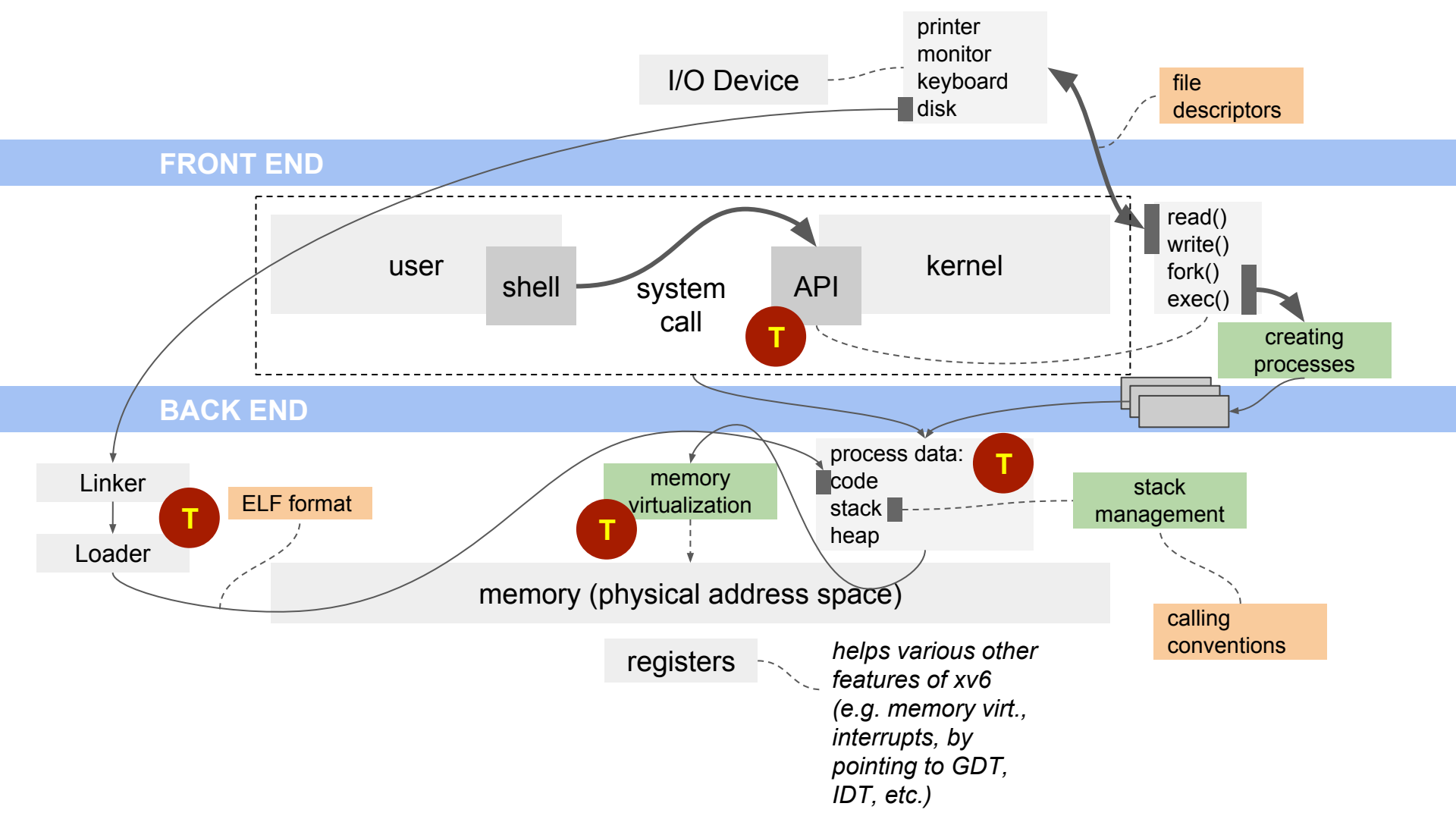
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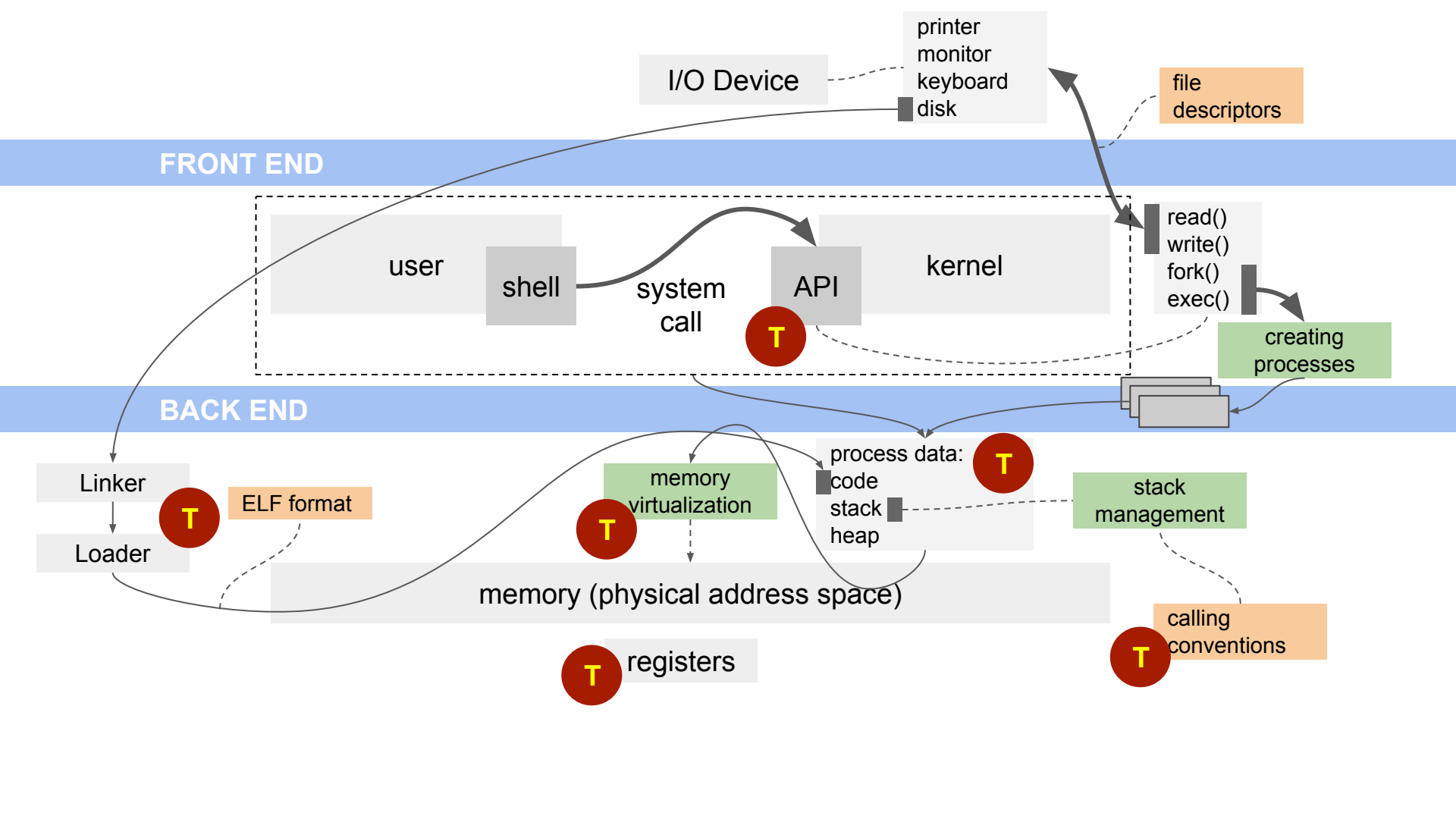
helps various other features of xv6 (e.g. memory virt., interrupts, by pointing to GDT, IDT, etc.)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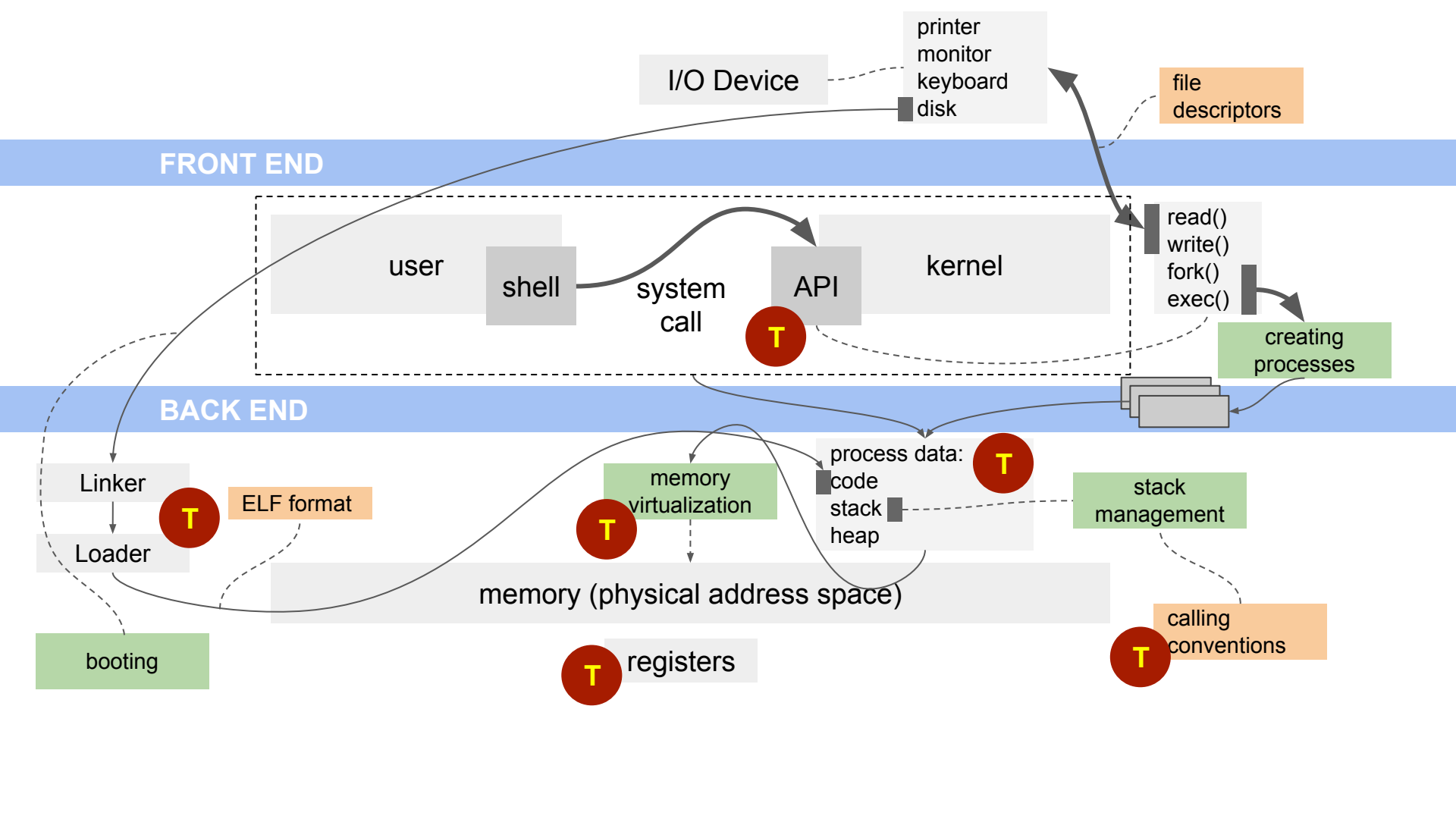
Did we forget to load the OS -- or kernel -- itself?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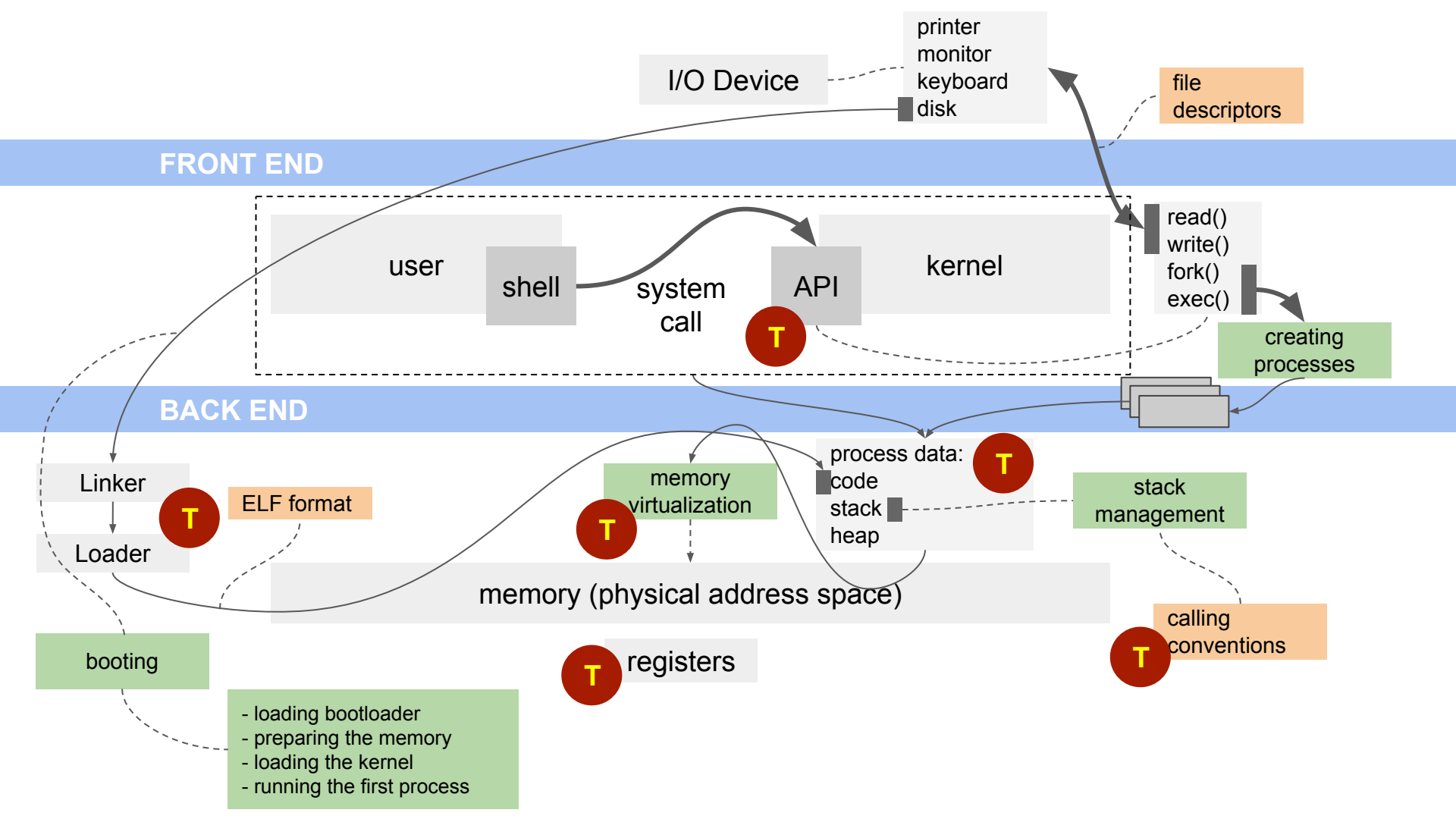
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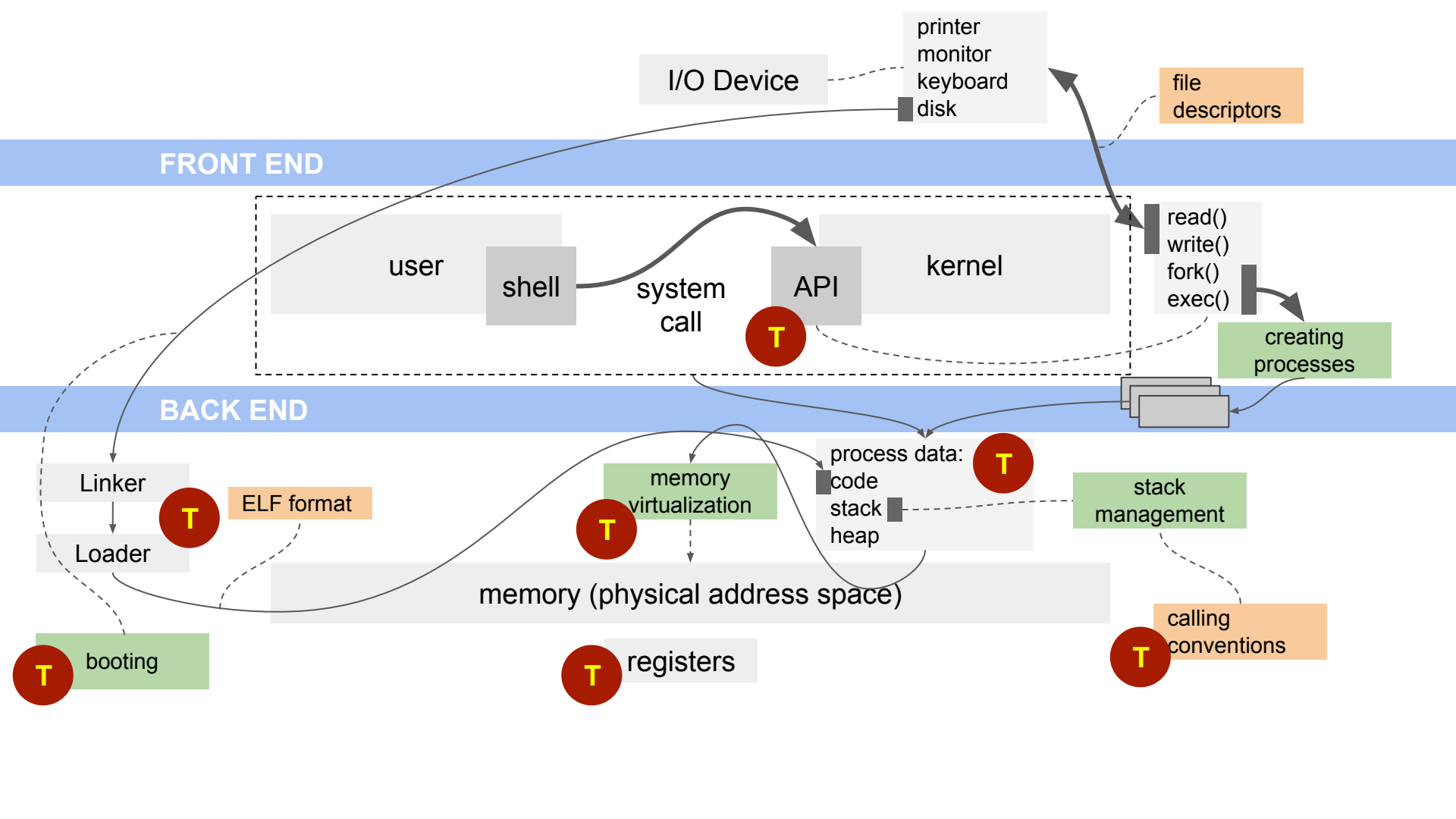
calling
conventions
- loading bootloader
- preparing the memory
- loading the kernel
- running the first process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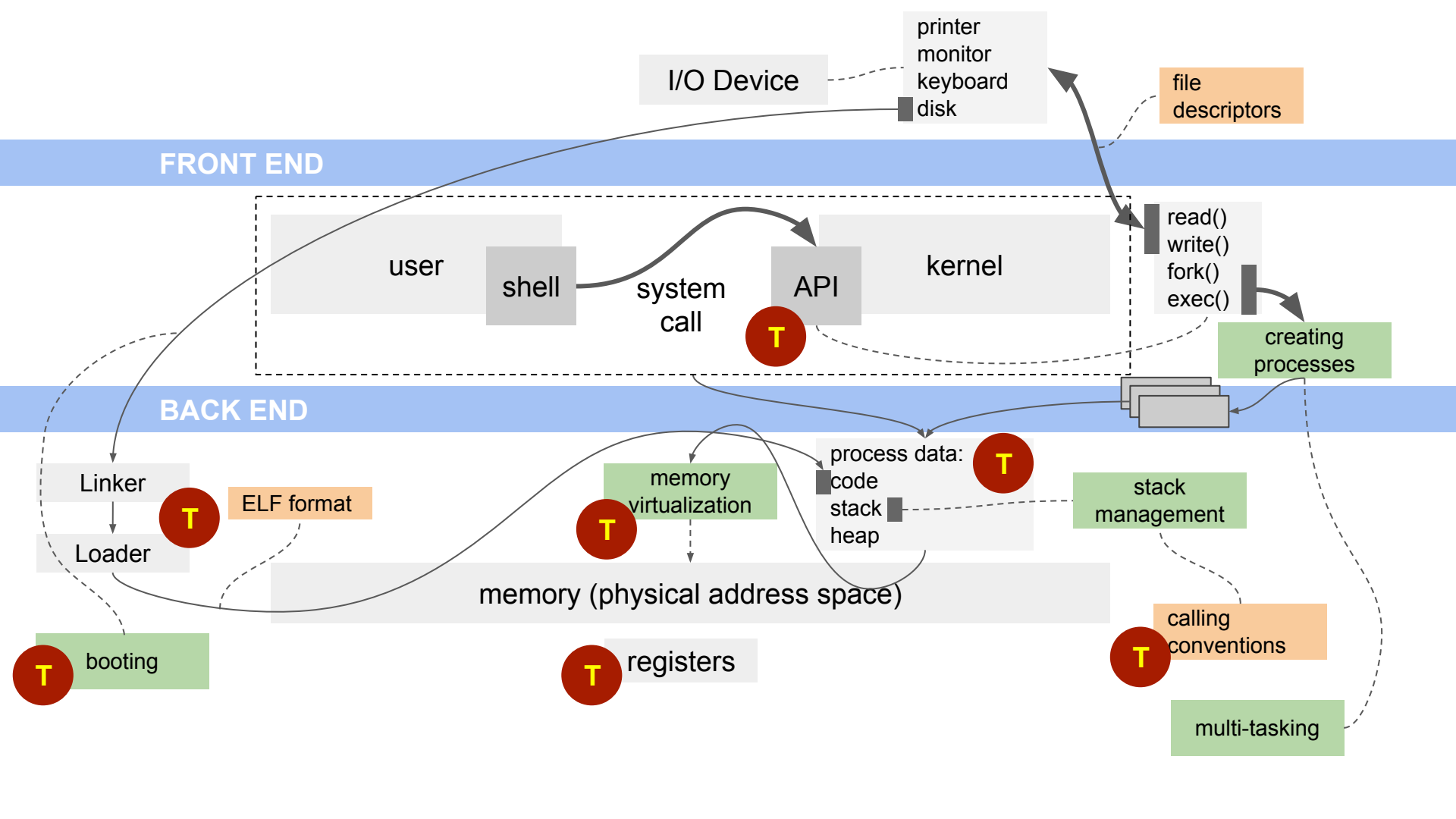
multi-tasking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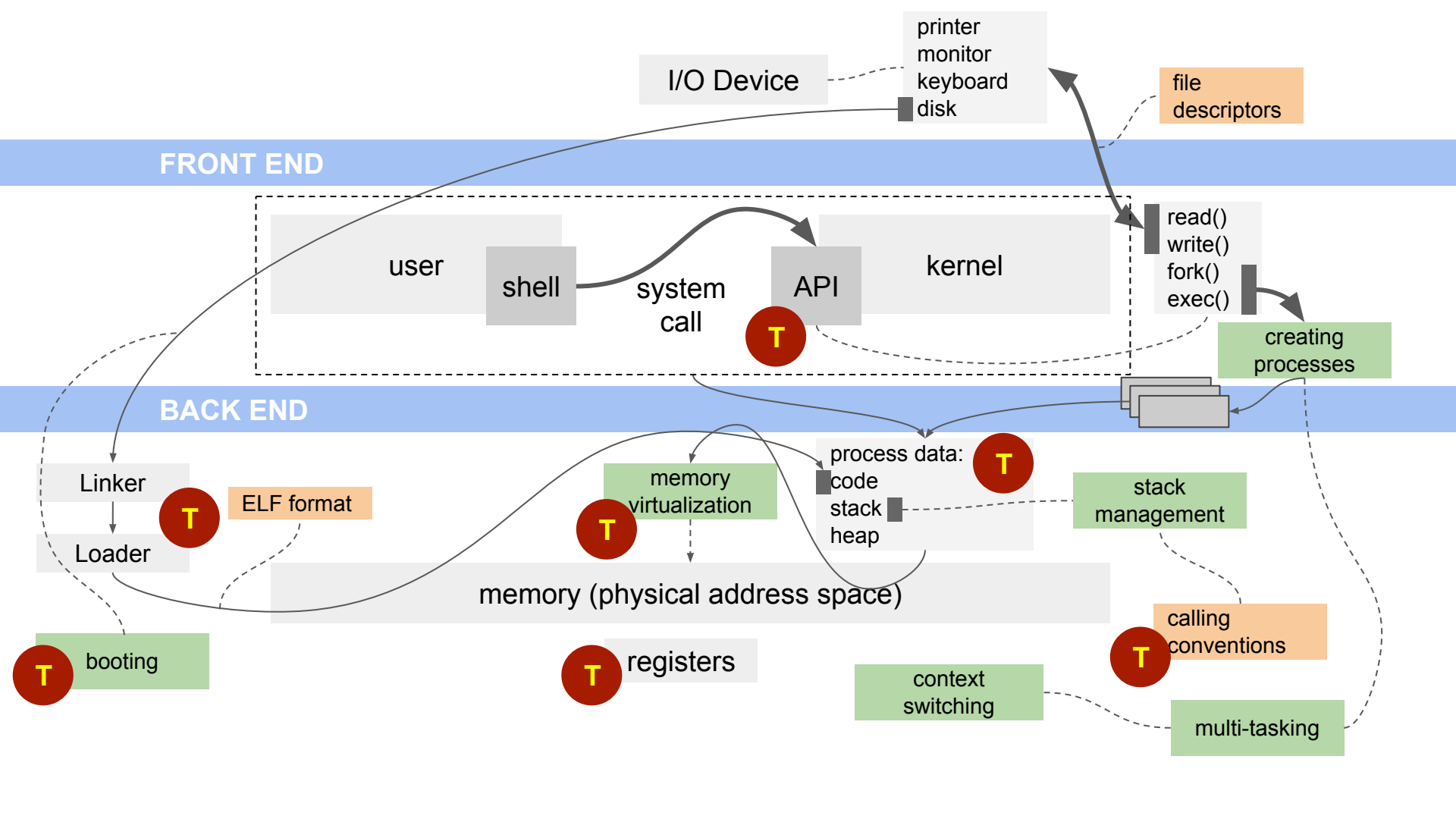
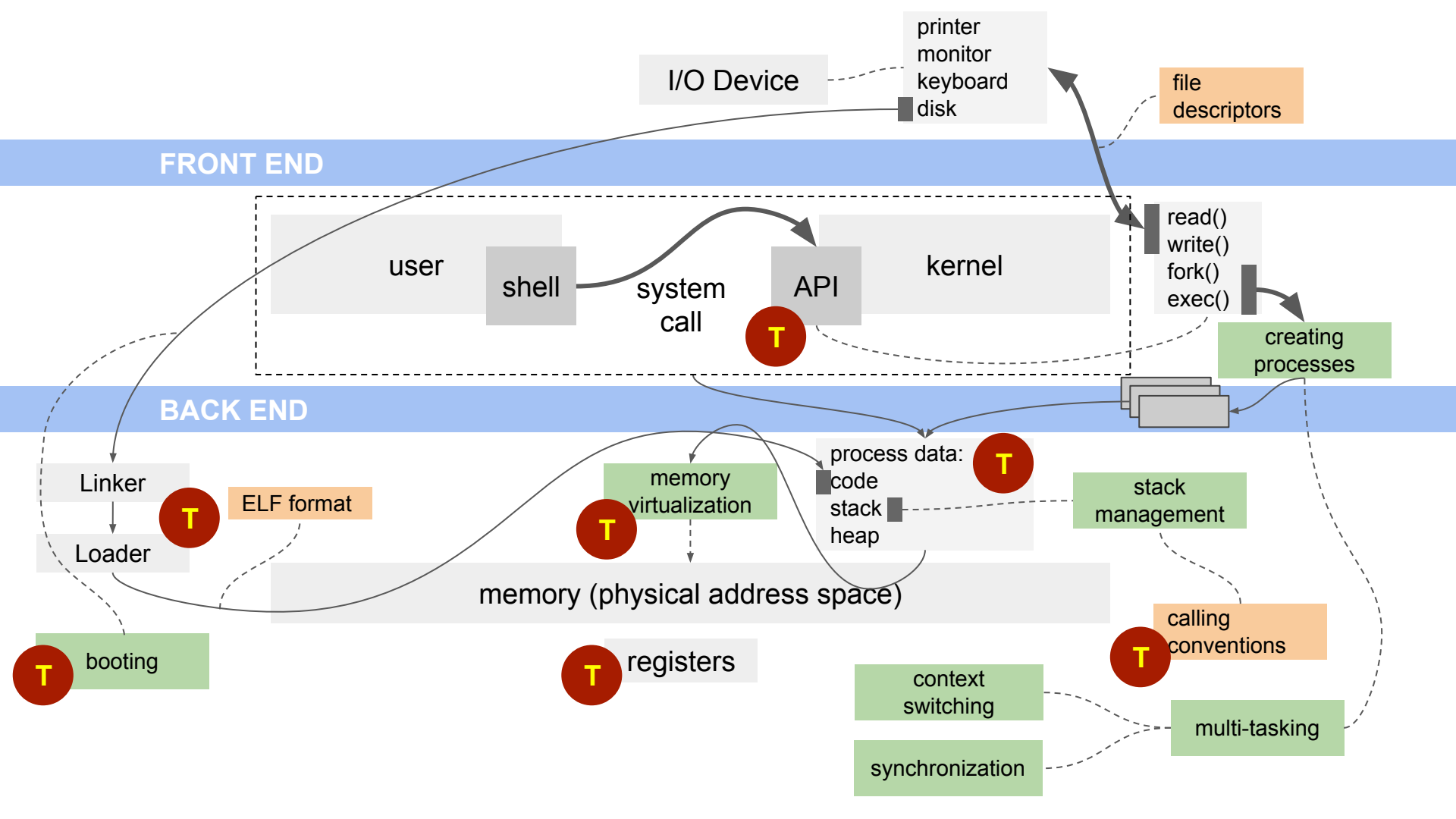
T
multi-tasking


I/O Device
printer
monitor
keyboard
disk
file
descriptors
FRONT END
user
shell
system
call
API
kernel
read()
write()
fork()
exec()
creating
processes
T
BACK END
Linker
Loader
T
ELF format
memory
virtualization
T
process data:
code
stack
heap
T
stack
management
memory (physical address space)
T
booting
T
registers
T
calling
conventions
context
switching
multi-tasking


I/O Device
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FRONT END
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call
API
kernel
read()
write()
fork()
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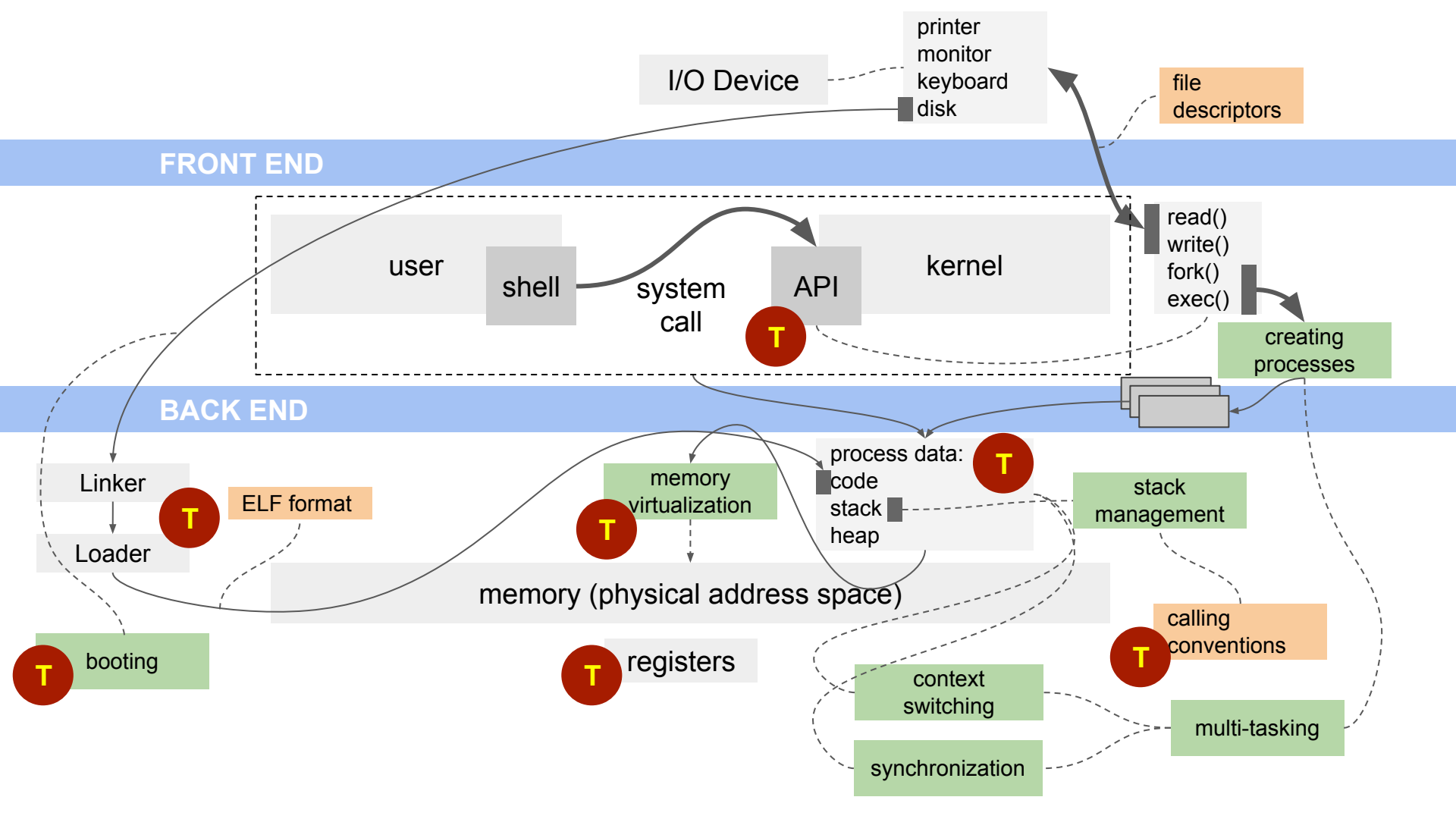
stack
heap
stack
management
memory (physical address space)
booting
registers
calling
conventions
context
switching
multi-tasking
synchronization


I/O Device
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FRONT END
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kernel
read()
write()
fork()
exec()
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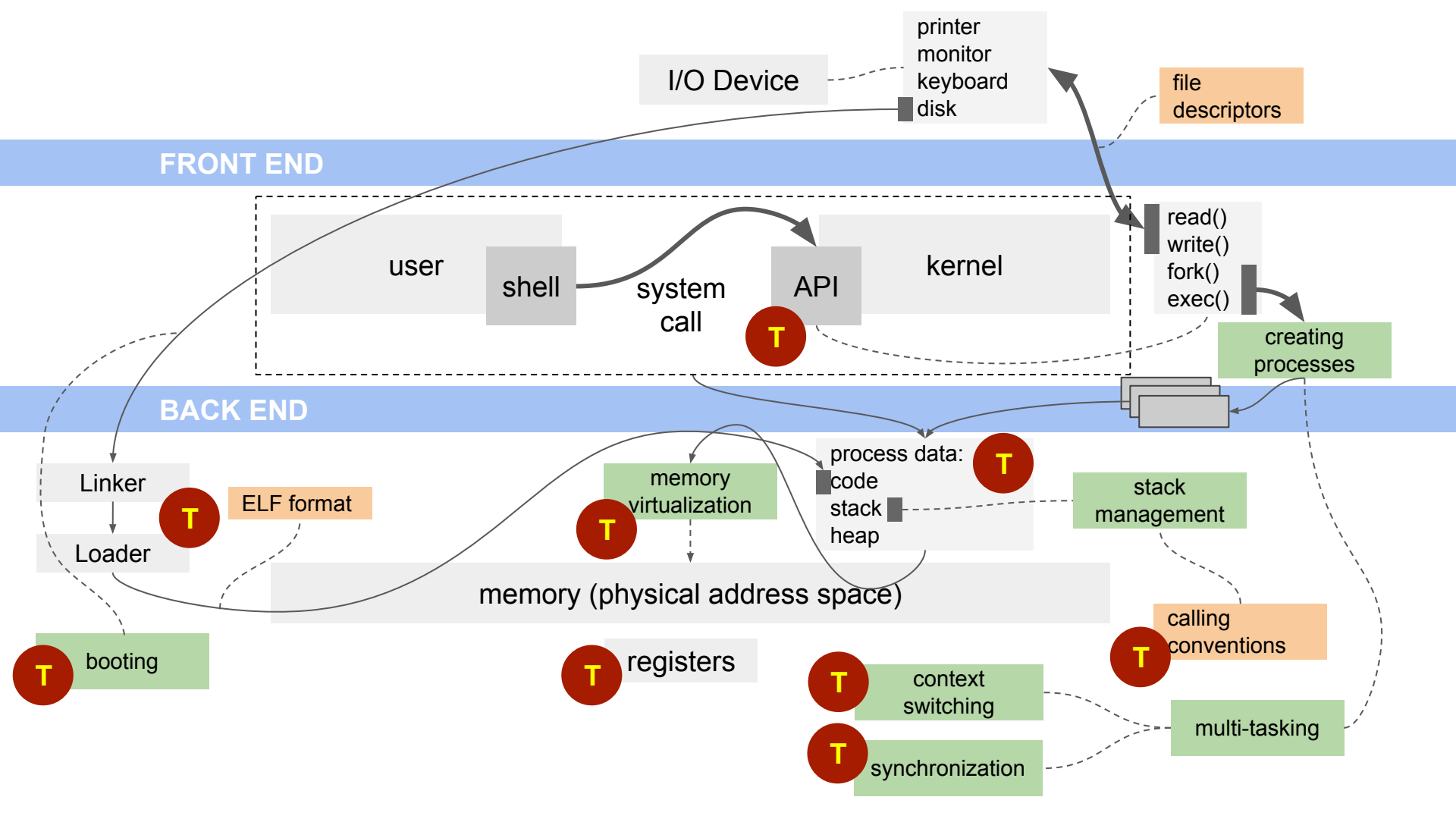
T
stack
management
memory (physical address space)
T
booting
T
registers
calling
conventions
T
context
switching
multi-tasking
synchronization


I/O Device
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descriptors
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shell
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call
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kernel
read()
write()
fork()
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registers
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conventions
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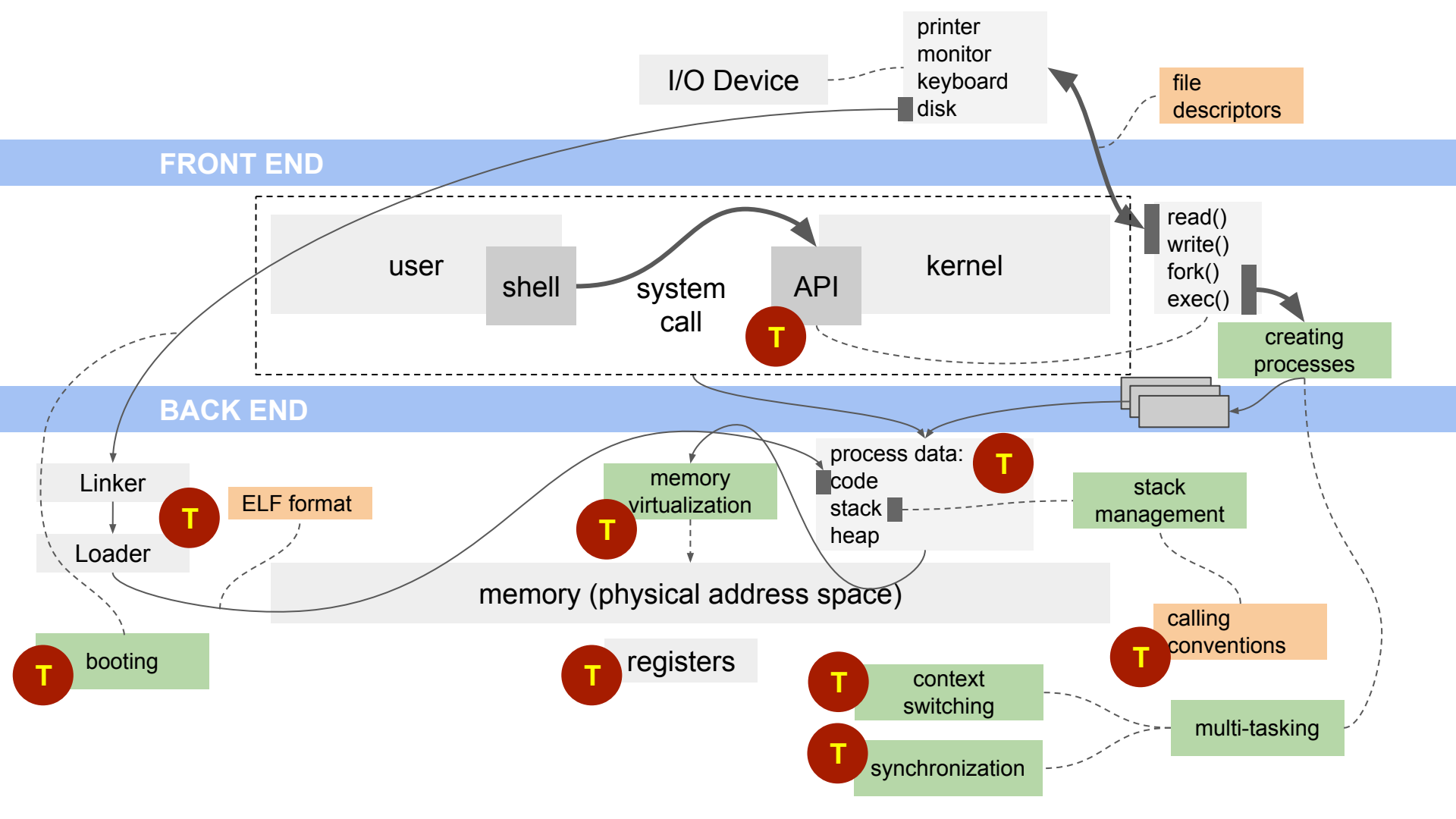
multi-tasking
synchronization


I/O Device
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kernel
read()
write()
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memory
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registers
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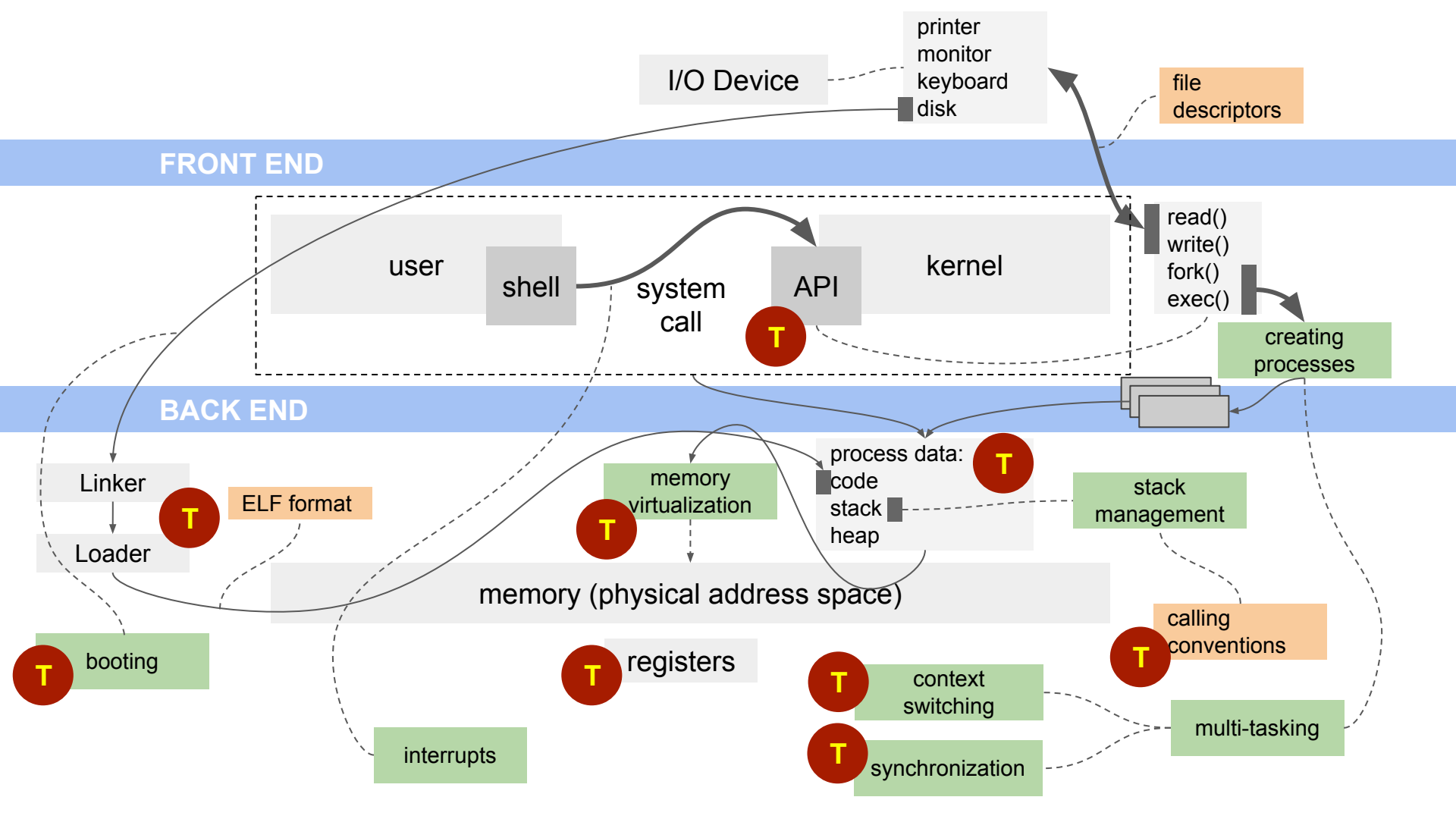
conventions
context
switching
multi-tasking
synchronization


I/O Device
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kernel
read()
write()
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heap
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conventions
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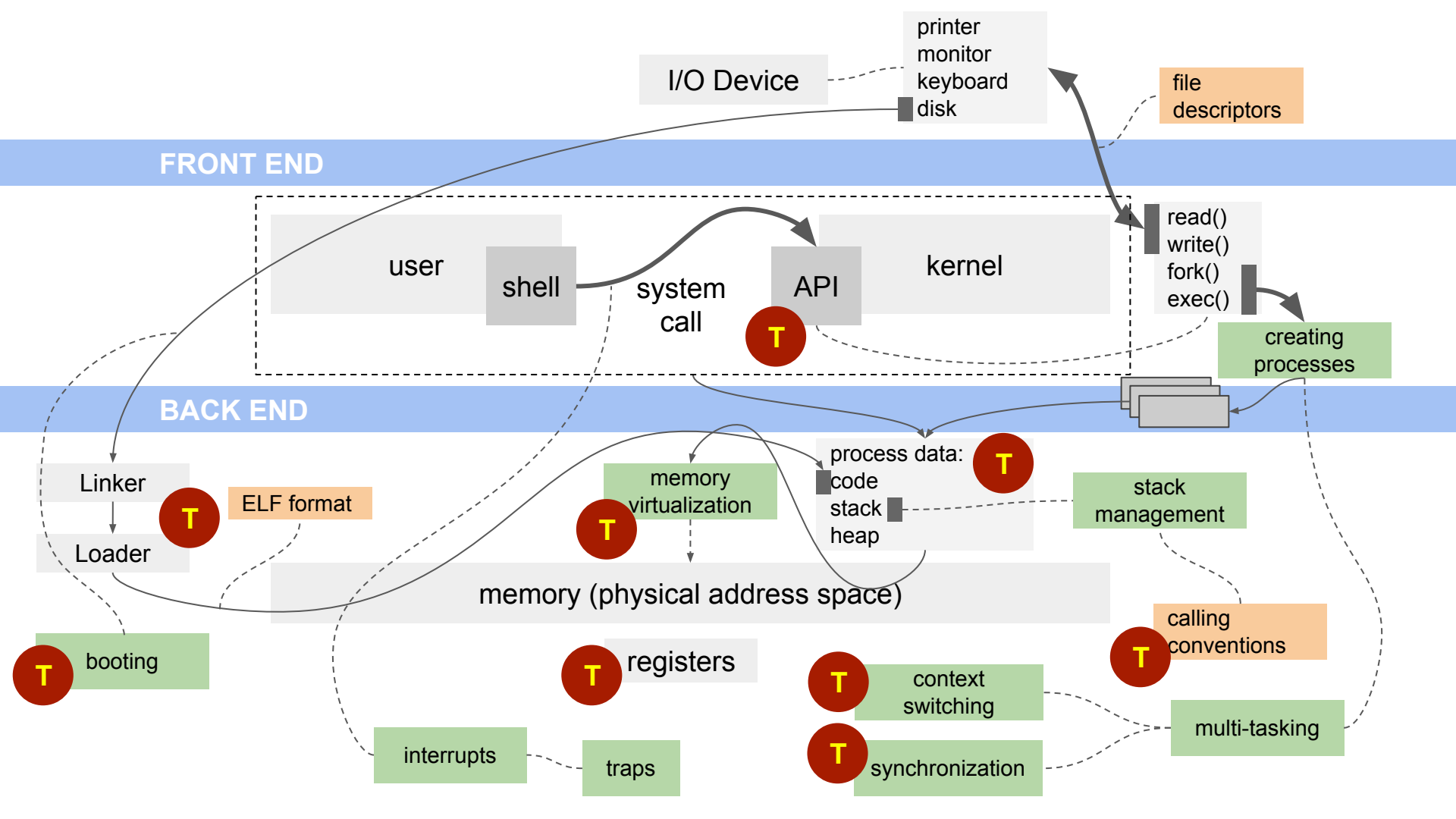
registers
context
switching
multi-tasking
interrupts
synchronization
T


I/O Device
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write()
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memory (physical address space)
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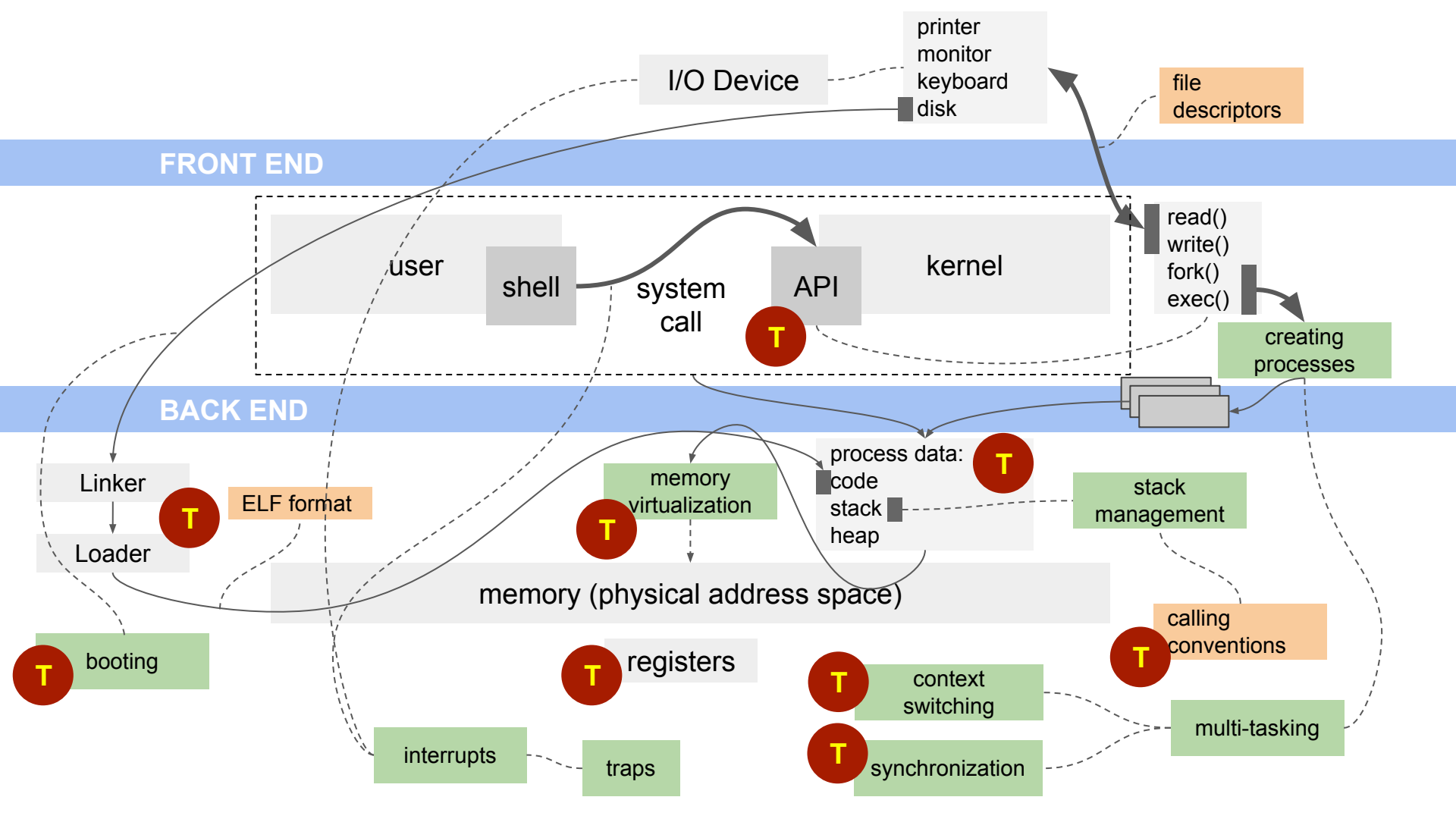
conventions
context
switching
multi-tasking
interrupts
traps
synchronization


I/O Device
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keyboard
disk
file
descriptors
FRONT END
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read()
write()
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memory (physical address space)
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registers
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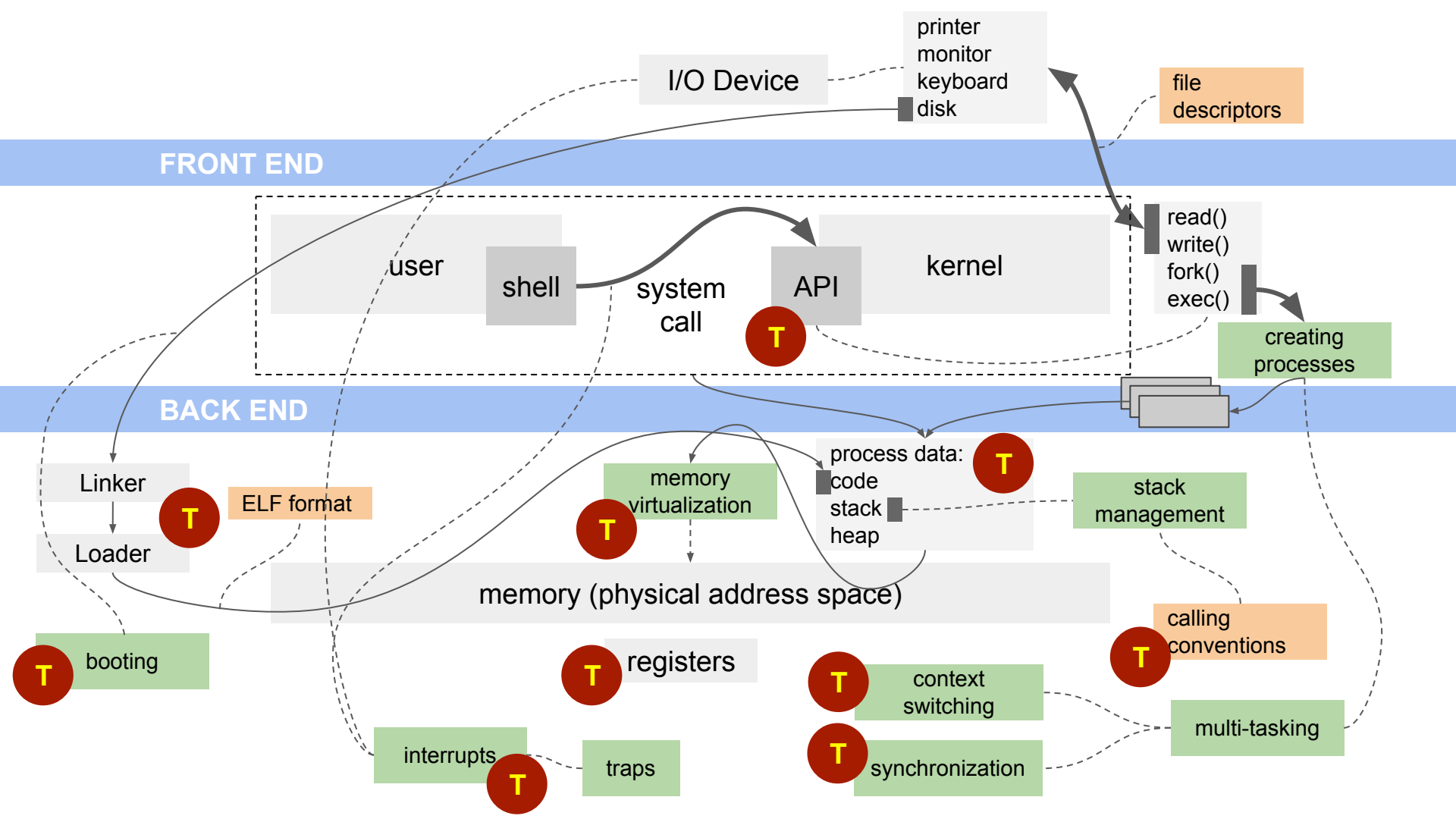
conventions
context
switching
multi-tasking
interrupts
traps
synchronization


I/O Device
printer
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keyboard
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descriptors
FRONT END
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shell
system
call
API
kernel
read()
write()
fork()
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BACK END
Linker
ELF format
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code
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heap
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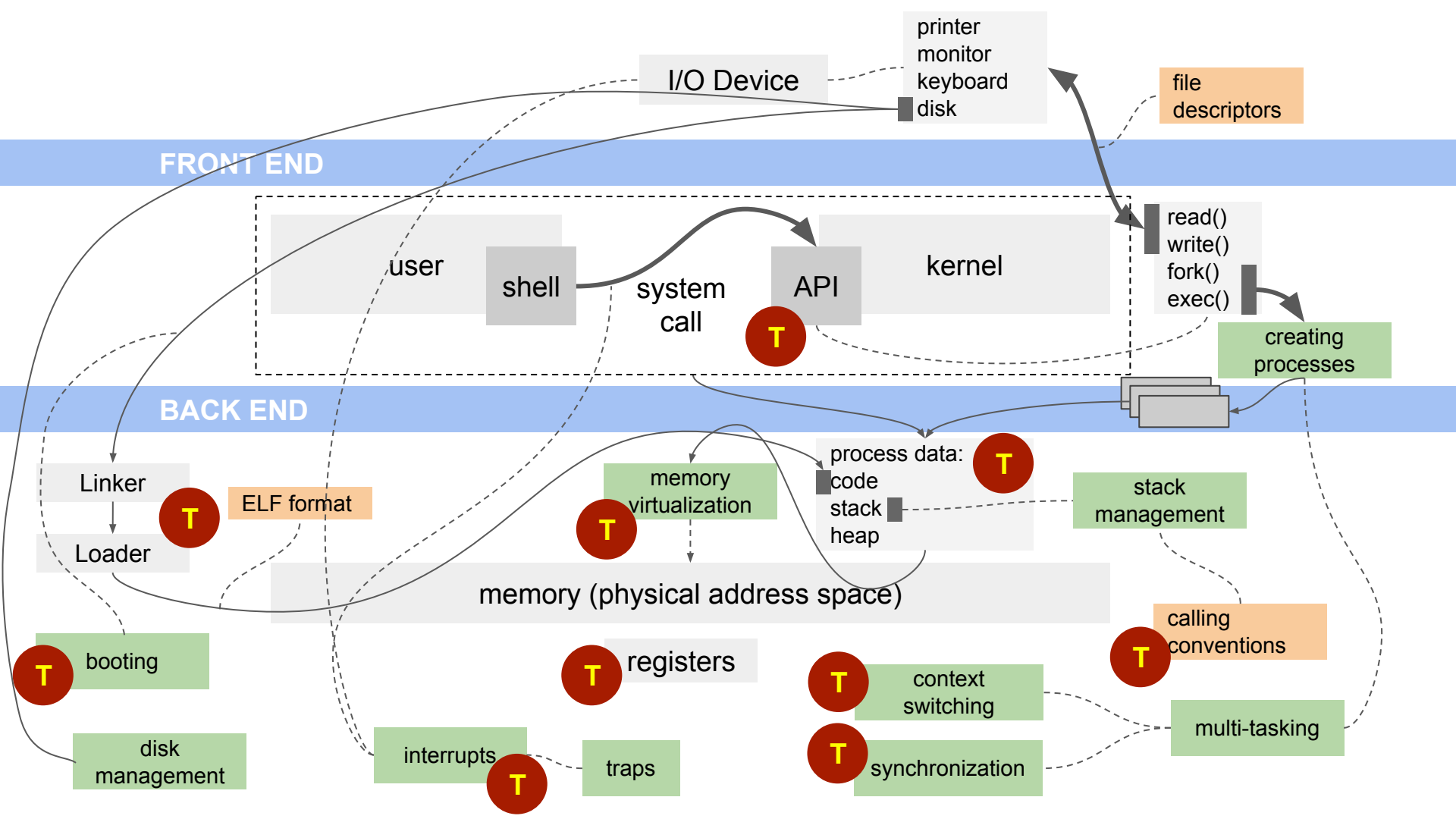
management
memory (physical address space)
booting
registers
calling
conventions
context
switching
multi-tasking
interrupts
traps
synchronization
T


printer
monitor
keyboard
disk
I/O Device
file
descriptors
FRONT END
user
shell
system
call
API
kernel
read()
write()
fork()
exec()
creating
processes
BACK END
Linker
ELF format
Loader
memory
virtualization
process data:
code
stack
heap
stack
management
memory (physical address space)
calling
conventions
booting
registers
context
switching
multi-tasking
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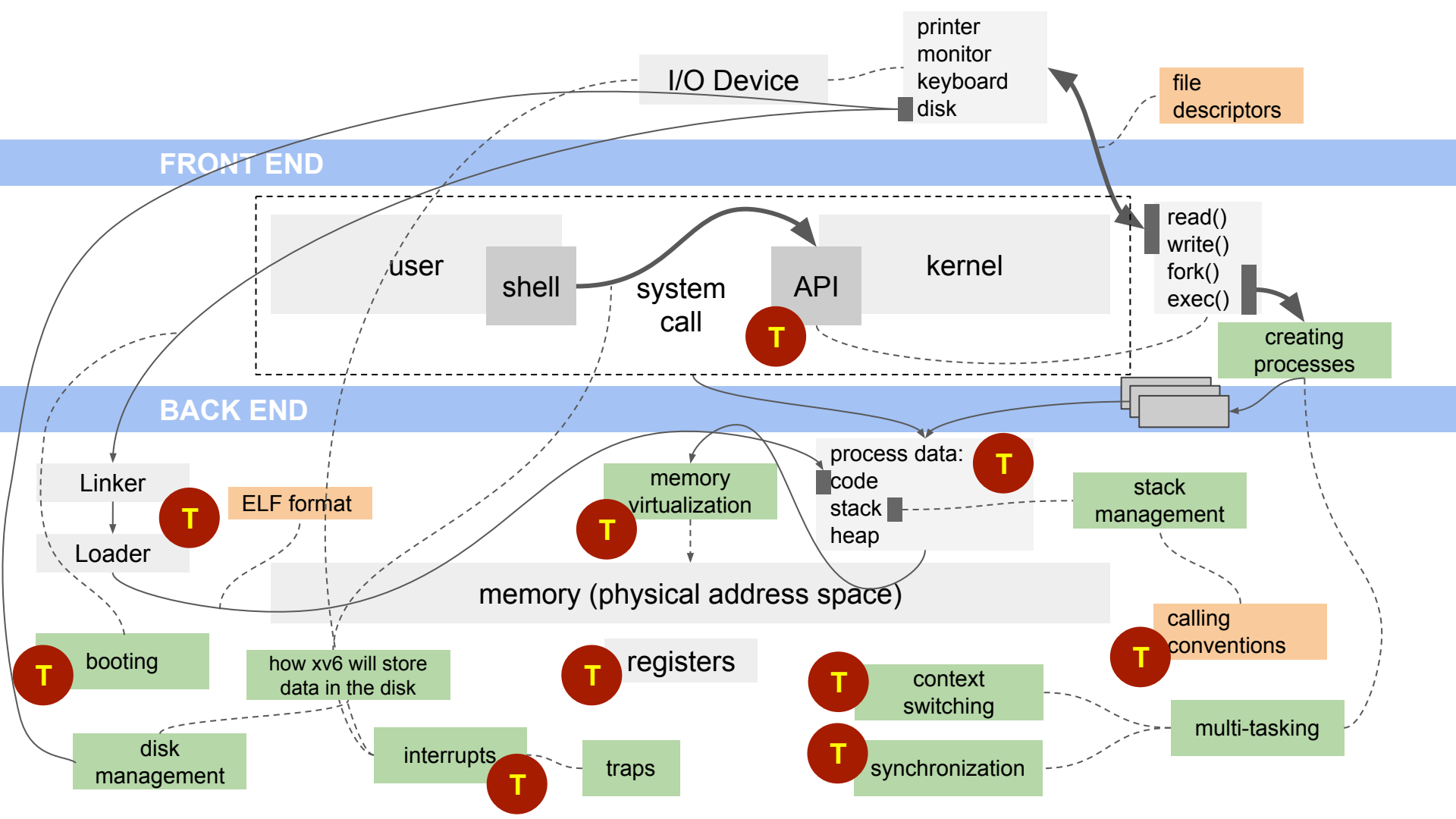
management
interrupts
traps
synchronization
T


I/O Device
printer
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disk
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descriptors
FRONT END
user
shell
system
call
API
kernel
read()
write()
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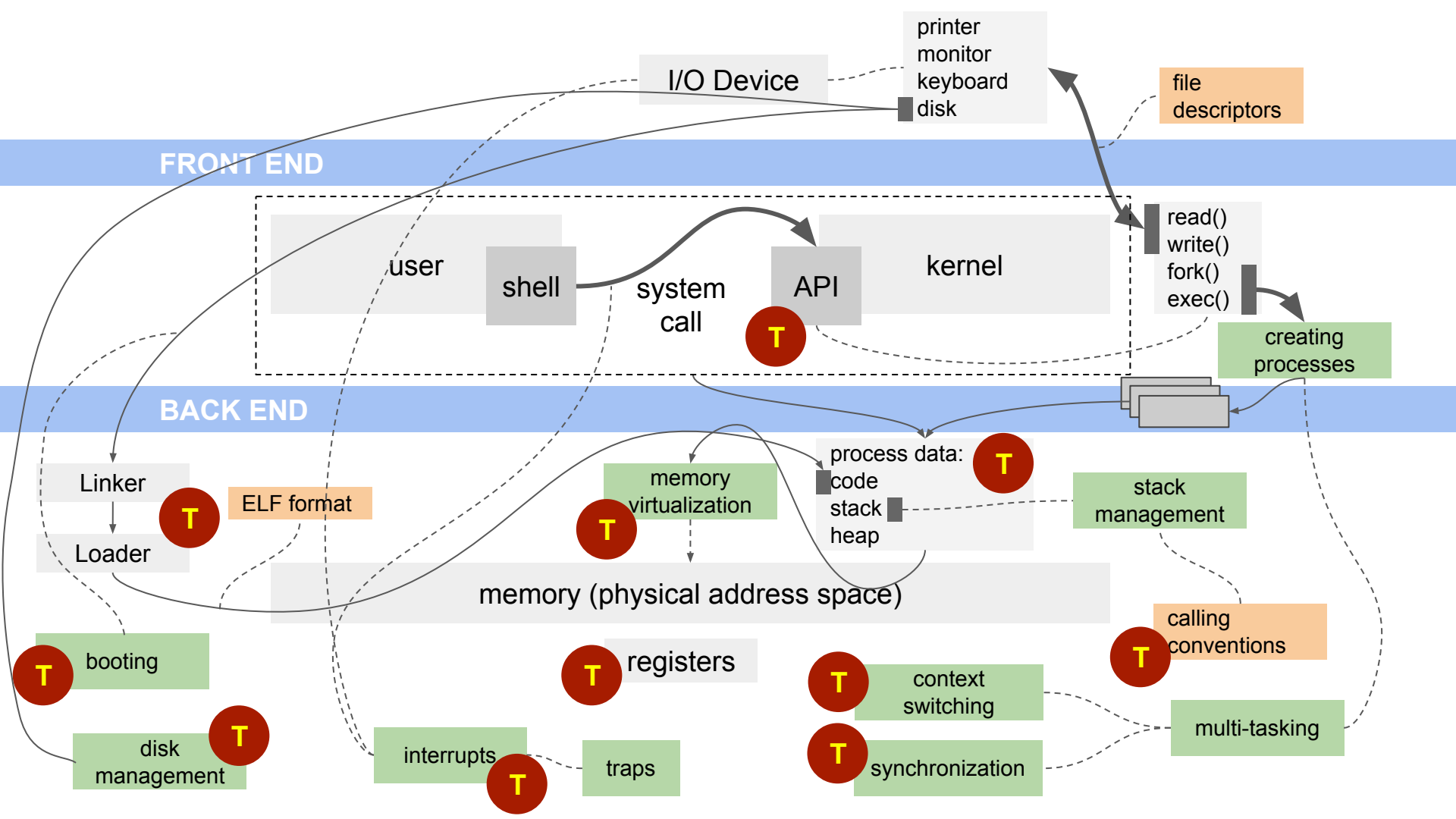
exec()
creating
processes
BACK END
Linker
ELF format
Loader
memory
virtualization
process data:
code
stack
heap
stack
management
memory (physical address space)
calling
conventions
booting
how xv6 will store
data in the disk
registers
context
switching
multi-tasking
disk
management
interrupts
traps
synchronization
T


I/O Device
printer
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keyboard
disk
file
descriptors
FRONT END
user
shell
system
call
API
kernel
read()
write()
fork()
exec()
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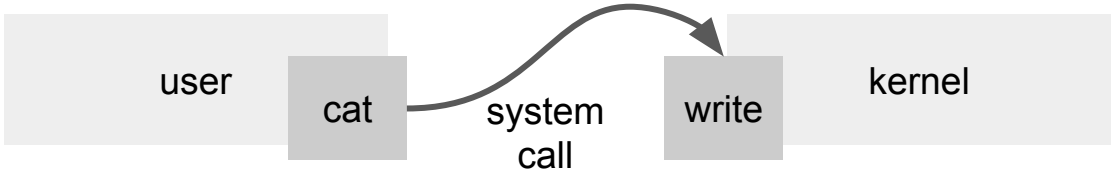
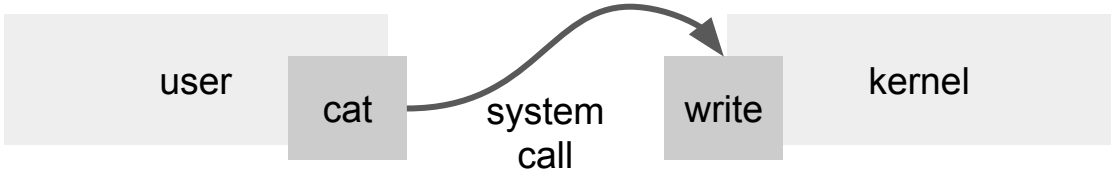
processes
BACK END
Linker
ELF format
Loader
memory
virtualization
process data:
code
stack
heap
stack
management
memory (physical address space)
calling
conventions
booting
registers
context
switching
multi-tasking
disk
management
interrupts
traps
synchronization
T

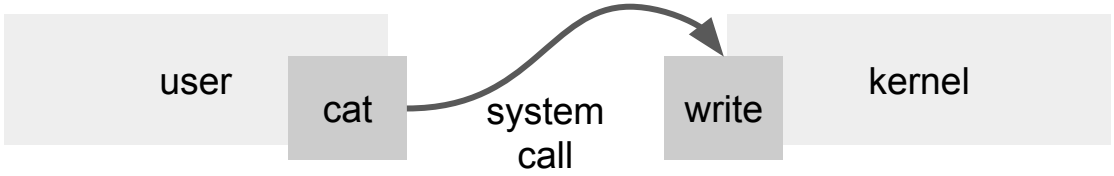
Now ... System Call Demo


user
cat
system
call
write
kernel



cat.c

```
if (write(1, buf, n) != n)
```



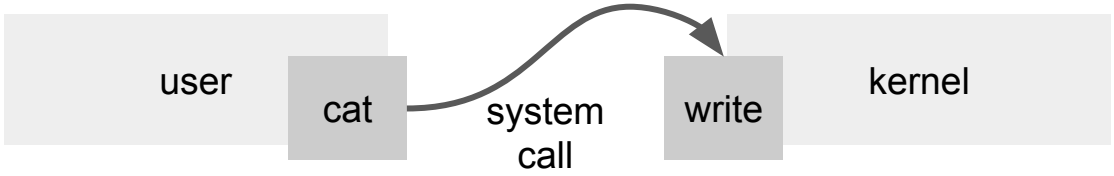
cat.c

```
if (write(1, buf, n) != n)
```

defined here

usys.S

```
SYSCALL(write)
```



cat.c

```
if (write(1, buf, n) != n)
```

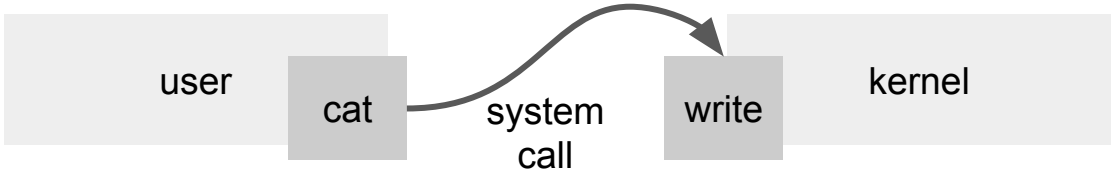
defined here

usys.S

```
SYSCALL(write)
```

expanded to

```
#define SYSCALL(name) \
  .globl name; \
  name: \
    movl $SYS_ ## name, %eax; \
    int $T_SYSCALL; \
    ret
```



cat.c

```
if (write(1, buf, n) != n)
```

defined here

usys.S

```
SYSCALL(write)
```

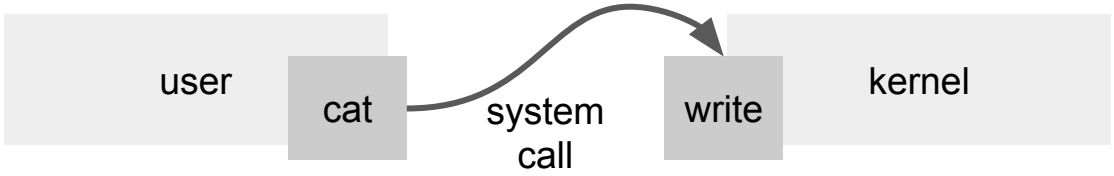
expanded to

```
#define SYSCALL(name) \
  .globl name; \
  name: \
    movl $SYS_ ## name, %eax; \
    int $T_SYSCALL; \
    ret
```

expansion provided here

syscall.h

```
#define SYS_write  16
```



cat.c

```
if (write(1, buf, n) != n)
```

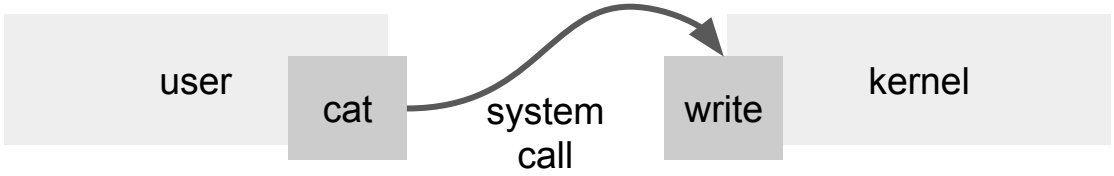
defined here

usys.S

```
SYSCALL(write)
```

expanded to

```
#define SYSCALL(name) \
  .globl name; \
  name: \
    movl $SYS_ ## name, %eax; \
    int $T_SYSCALL; \
    ret
```



cat.c

```
if (write(1, buf, n) != n)
```

defined here

usys.S

```
SYSCALL(write)
```

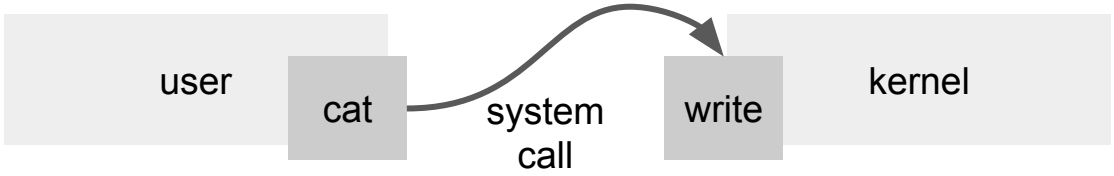
expanded to

```
#define SYSCALL(name) \
  .globl name; \
  name: \
    movl $SYS_ ## name, %eax; \
    int $T_SYSCALL; \
    ret
```

actual assembly
code generated here

usys.o

```
00000028 <write>:
  28:b8 10 00 00 00    mov    $0x10,%eax
  2d:cd 40             int    $0x40
  2f:c3                ret
```



cat.c

```
if (write(1, buf, n) != n)
```

defined here

usys.S

```
SYSCALL(write)
```

expanded to

```
#define SYSCALL(name) \
  .globl name; \
  name: \
    movl $SYS_ ## name, %eax; \
    int $T_SYSCALL; \
    ret
```

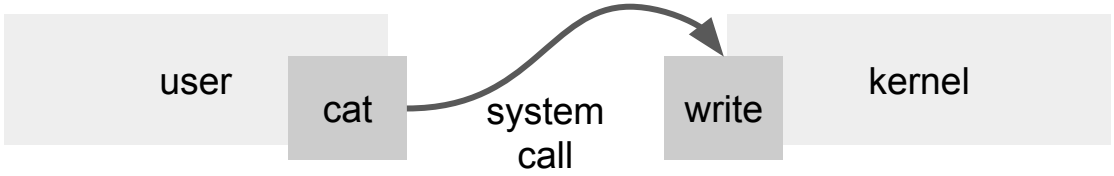
actual assembly code generated here

usys.o

```
00000028 <write>:
  28:b8 10 00 00 00    mov    $0x10,%eax
  2d:cd 40             int    $0x40
  2f:c3                ret
```

EAX

10



cat.c

```
if (write(1, buf, n) != n)
```

defined here

usys.S

```
SYSCALL(write)
```

expanded to

```
#define SYSCALL(name) \
  .globl name; \
  name: \
    movl $SYS_ ## name, %eax; \
    int $T_SYSCALL; \
    ret
```

actual assembly
code generated here

usys.o

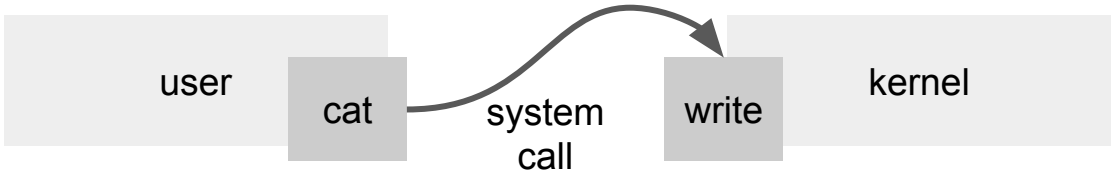
```
00000028 <write>:
  28:b8 10 00 00 00    mov    $0x10,%eax
  2d:cd 40             int    $0x40
  2f:c3                ret
```

EAX

10

vectors.S

```
jmp alltraps
```



cat.c

```
if (write(1, buf, n) != n)
```

defined here

usys.S

```
SYSCALL(write)
```

expanded to

```
#define SYSCALL(name) \
  .globl name; \
  name: \
    movl $SYS_ ## name, %eax; \
    int $T_SYSCALL; \
    ret
```

actual assembly
code generated here

usys.o

```
00000028 <write>:
  28:b8 10 00 00 00     mov     $0x10,%eax
  2d:cd 40              int     $0x40
  2f:c3                 ret
```

EAX

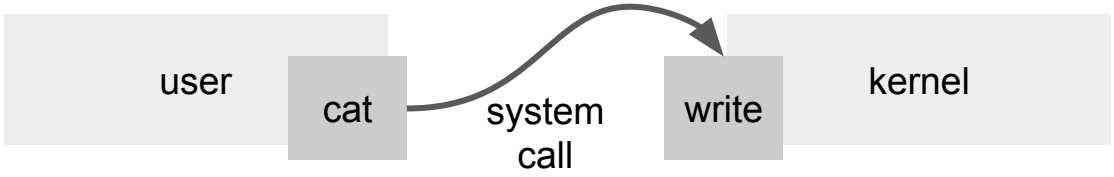
10

[trapasm.S](#)

defined in

vectors.S

```
jmp alltraps
```



cat.c

```
if (write(1, buf, n) != n)
```

defined here

usys.S

```
SYSCALL(write)
```

expanded to

```
#define SYSCALL(name) \
  .globl name; \
  name: \
    movl $SYS_ ## name, %eax; \
    int $T_SYSCALL; \
    ret
```

actual assembly code generated here

usys.o

```
00000028 <write>:
  28:b8 10 00 00 00     mov     $0x10,%eax
  2d:cd 40              int     $0x40
  2f:c3                 ret
```

EAX

10

trap.c

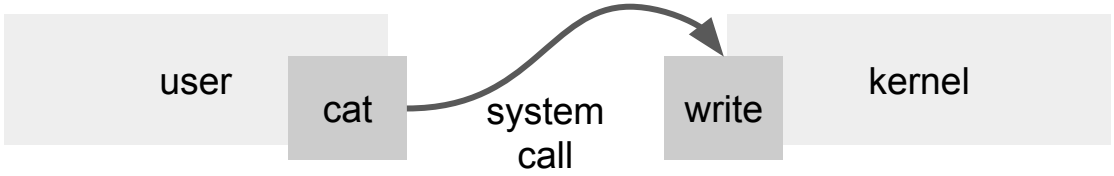
calls traps()

trapasm.S

defined in

vectors.S

```
jmp alltraps
```



cat.c

```
if (write(1, buf, n) != n)
```

defined here

usys.S

```
SYSCALL(write)
```

expanded to

```
#define SYSCALL(name) \
  .globl name; \
  name: \
    movl $SYS_ ## name, %eax; \
    int $T_SYSCALL; \
    ret
```

actual assembly code generated here

usys.o

```
00000028 <write>:
  28:b8 10 00 00 00     mov     $0x10,%eax
  2d:cd 40              int     $0x40
  2f:c3                 ret
```

EAX

10

syscall.c

calls syscall()

trap.c

calls traps()

trapasm.S

defined in

vectors.S

```
jmp alltraps
```

Thank you!