Sistem Operasi 11

"System I/O"

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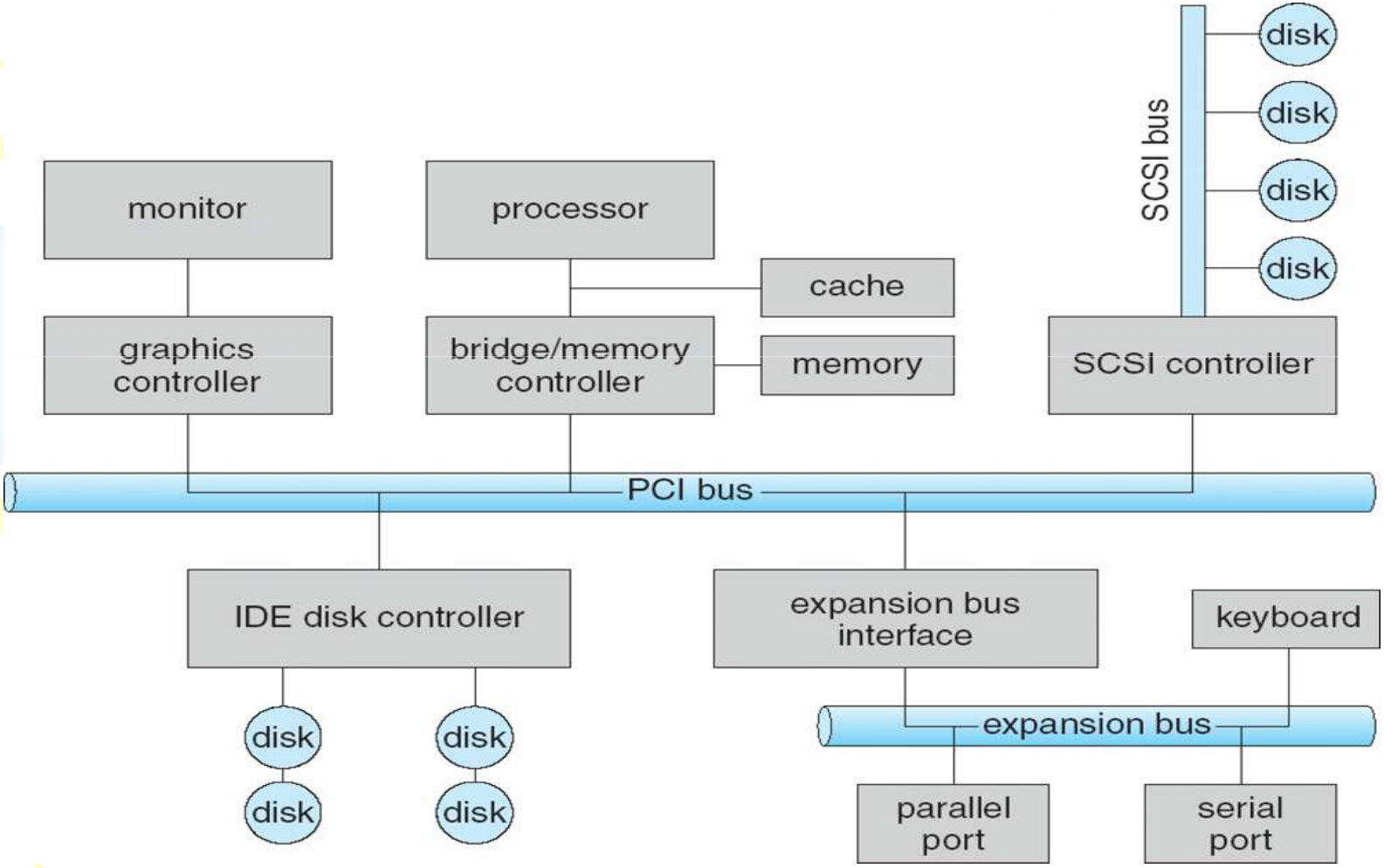
Sistem I/O

- Konsep Umum I/O :
  - Port (pintu komunikasi data)
  - Bus (jalur data - shared direct access)
  - Controller (host adapter)
- Perangkat-perangkat I/O memiliki **alamat**, digunakan untuk:
  - Menyimpan instruksi I/O secara langsung
  - Memory-mapped I/O
- Jenis perangkat keras:
  - Perangkat penyimpan data
  - Perangkat penghubung (link)
  - Perangkat antarmuka dengan user

A Typical PC Bus Structure



Device I/O Port Address Locations on PCs (sebagian)

I/O address range (hexadecimal)	device
000–00F	DMA controller
020–021	interrupt controller
040–043	timer
200–20F	game controller
2F8–2FF	serial port (secondary)
320–32F	hard-disk controller
378–37F	parallel port
3D0–3DF	graphics controller
3F0–3F7	diskette-drive controller
3F8–3FF	serial port (primary)

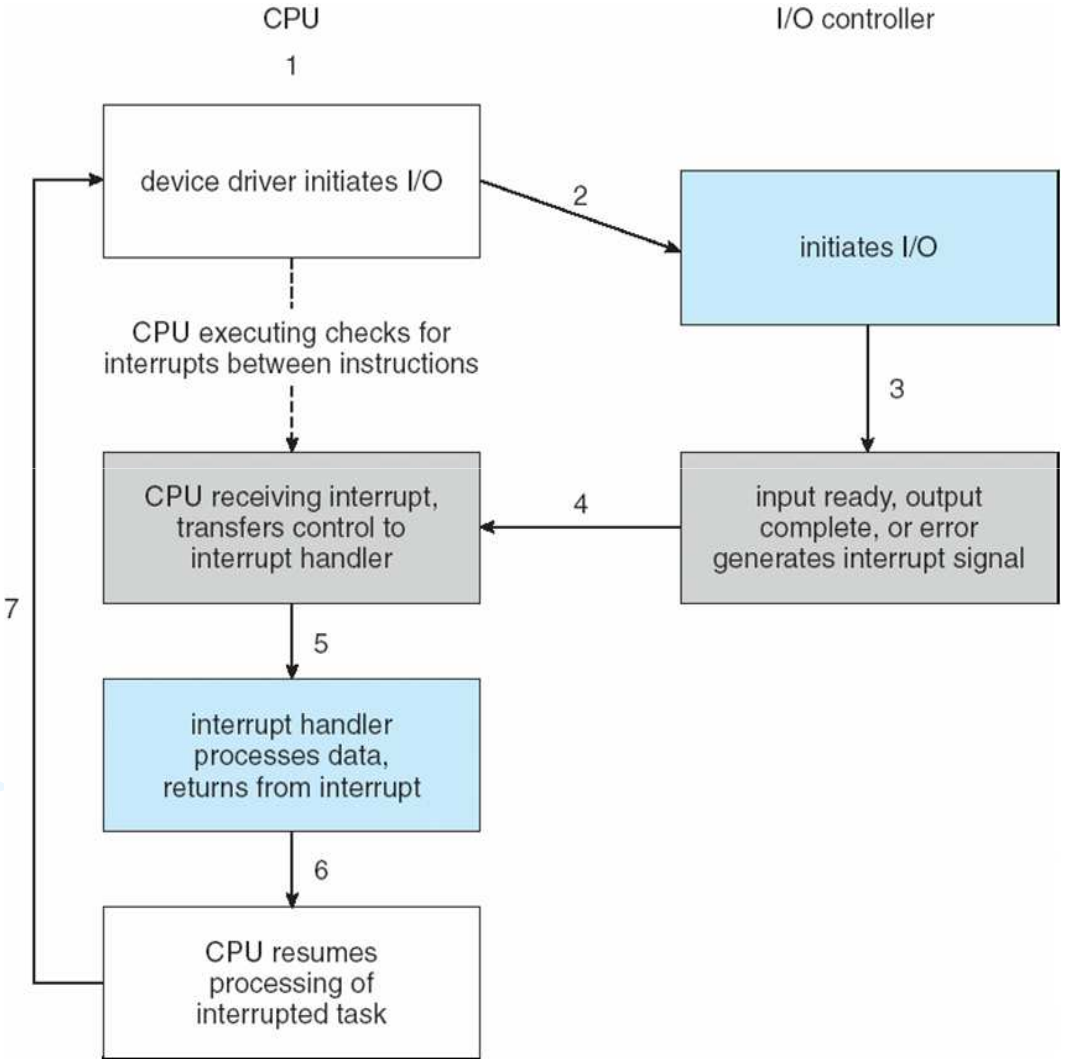
Polling I/O

- Client program determines state of device
  - command-ready
  - busy
  - error
- Client program terus membaca **busy-bit** secara berulang-ulang sampai bit tersebut **clear**
- Client program set write-bit di **command-register** dan menulis satu byte di **data-out register**
- Client program set bit **command-ready**
- Ketika controller mengetahui kalau bit **command-ready** di-set, dia men-set **busy** bit
- Controller membaca **command-register** dan melihat perintah **write**.
- Dia membaca **data-out register** untuk mendapatkan bytenya, dan melakukan **operasi I/O**
- Controller menghapus **bit command-ready**, membersihkan bit **error** di status register yang menandakan operasi I/O berhasil, dan menghapus **busy-bit** yang menandakan kalau operasi sudah selesai.
- Ex: polling a parallel printer port to check whether it is ready for another character

Mekanisme Interrupt

- Jalur interrupt dihasilkan oleh **perangkat I/O**
- Interrupt Handler menerima interrupt tersebut
- Mekanisme interrupt juga digunakan untuk penanganan **exception**

Interrupt


CPU
I/O controller
1
device driver initiates I/O
2
initiates I/O
CPU executing checks for interrupts between instructions
3
CPU receiving interrupt, transfers control to interrupt handler
4
input ready, output complete, or error generates interrupt signal
7
5
interrupt handler processes data, returns from interrupt
6
CPU resumes processing of interrupted task

Intel Pentium Processor Event-Vector Table

vector number	description
0	divide error
1	debug exception
2	null interrupt
3	breakpoint
4	INTO-detected overflow
5	bound range exception
6	invalid opcode
7	device not available
8	double fault
9	coprocessor segment overrun (reserved)
10	invalid task state segment
11	segment not present
12	stack fault
13	general protection
14	page fault
15	(Intel reserved, do not use)
16	floating-point error
17	alignment check
18	machine check
19–31	(Intel reserved, do not use)
32–255	maskable interrupts

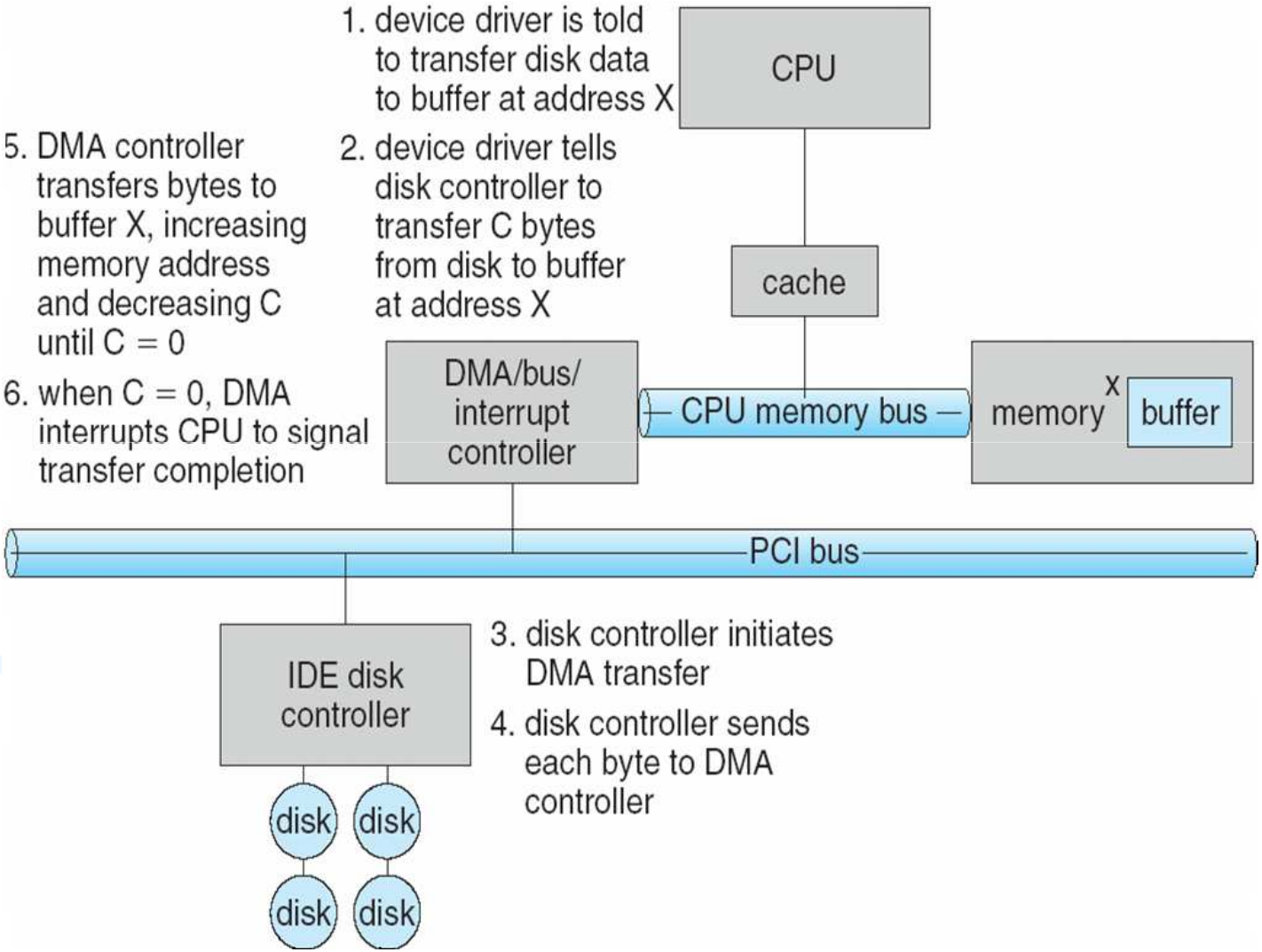
DMA

- Generasi komputer yang sangat tua
  - Controller membaca dari perangkat
  - Controller meng-interrupt OS
  - Sistem Operasi yg meminta CPU membaca data secara langsung
- Generasi komputer yang tua
  - Controller membaca dari perangkat
  - Controller meng-interrupt OS
  - Sistem Operasi dan CPU kemudian menyalin data ke **memori**
- Generasi DMA
  - Controller membaca dari perangkat
  - Controller menyalin data ke memori
  - Controller meng-interrupt OS bahwa operasi selesai

Direct Memory Access

- Used to **avoid** programmed I/O for large data movement with CPU
- Many hardware systems use DMA including disk drive controllers, graphics cards, network cards and sound cards.
- Requires **DMA controller**
- Bypasses CPU to transfer data **directly** between I/O device and memory

Six Step Process to Perform DMA Transfer

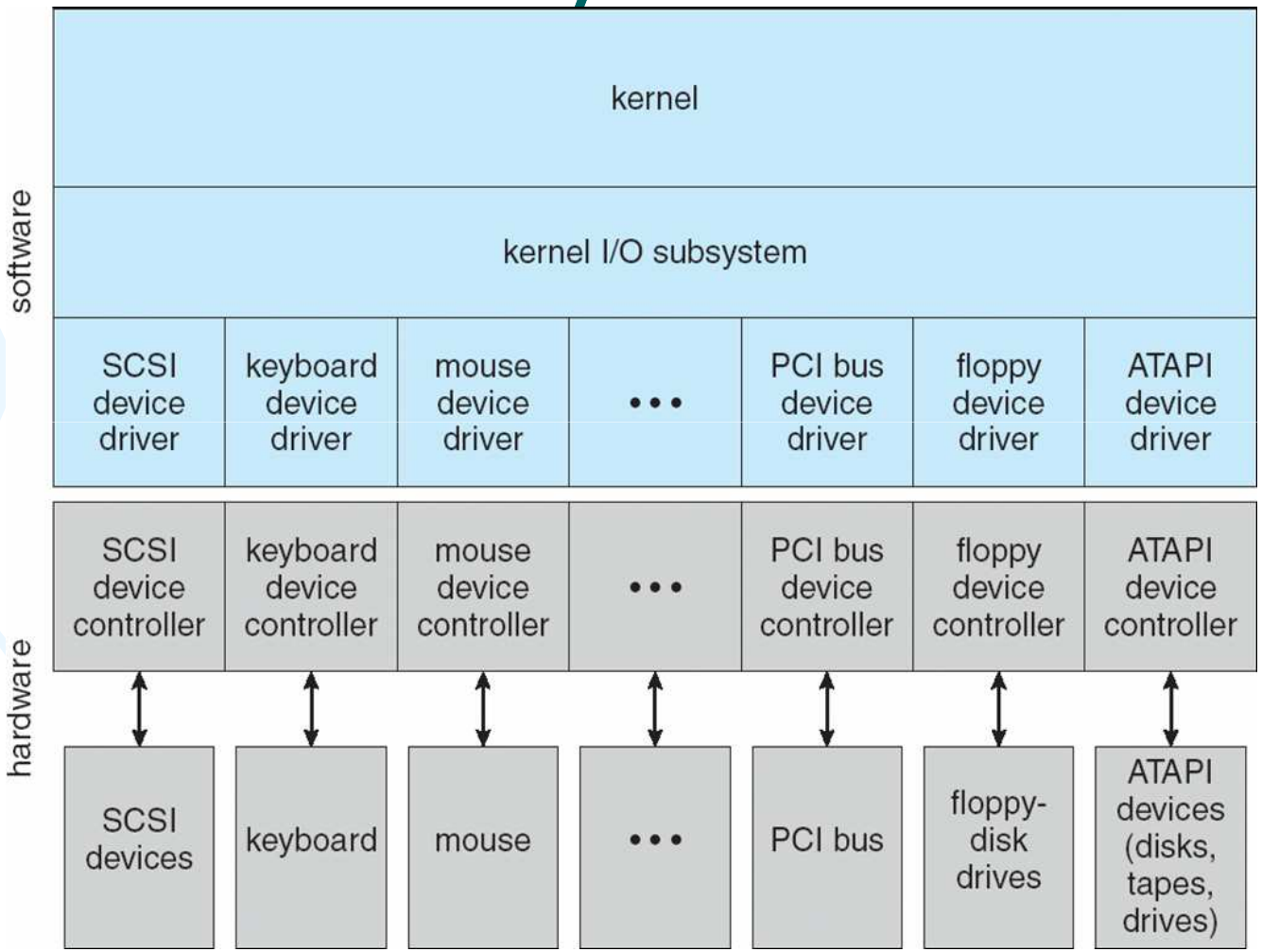


CPU dapat digunakan untuk hal lain selama sedang transfer data

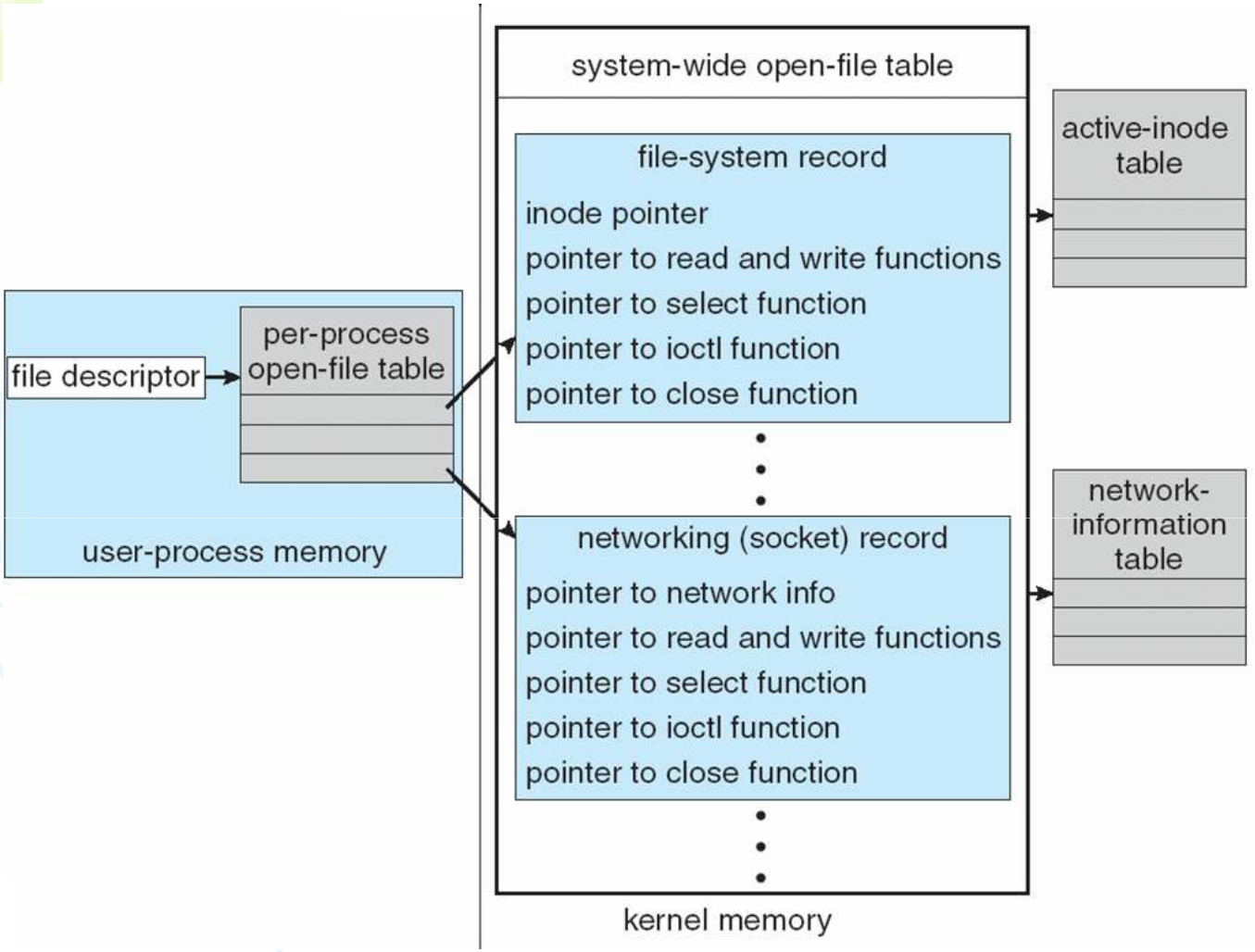
Application I/O Interface

- I/O **system calls menekapsulasi** device kemampuan secara umum dalam suatu **class**
- **Device-driver** layer **menyembunyikan** perbedaan antara I/O controllers dari kernel
- Devices memiliki dimensi yang beraneka ragam:
  - Character-stream or block
  - Sequential or random-access
  - Sharable or dedicated
  - Sifat: read-write, read only, or write only

A Kernel I/O Structure



UNIX I/O Kernel Structure



Kernel keeps state info for I/O components, including open file tables, network connections, character device state

Perangkat I/O

- Perangkat **block**:
  - Meliputi berbagai disk drive
  - Perintah baca, tulis, pencarian data
  - Dimungkinkan untuk mengakses berkas secara memory-mapped
- Perangkat **character**:
  - Contoh: keyboard, mouse
  - Perintah menulis, mengambil
  - Dapat dibuat library pengakses data per-baris
- Perangkat **jaringan**:
  - Socket: penghubung komputer dengan jaringan.
  - Komunikasi antar komputer dilakukan melalui socket.

Characteristics of I/O Devices

aspect	variation	example
data-transfer mode	character block	terminal disk
access method	sequential random	modem CD-ROM
transfer schedule	synchronous asynchronous	tape keyboard
sharing	dedicated sharable	tape keyboard
device speed	latency seek time transfer rate delay between operations	
I/O direction	read only write only read–write	CD-ROM graphics controller disk

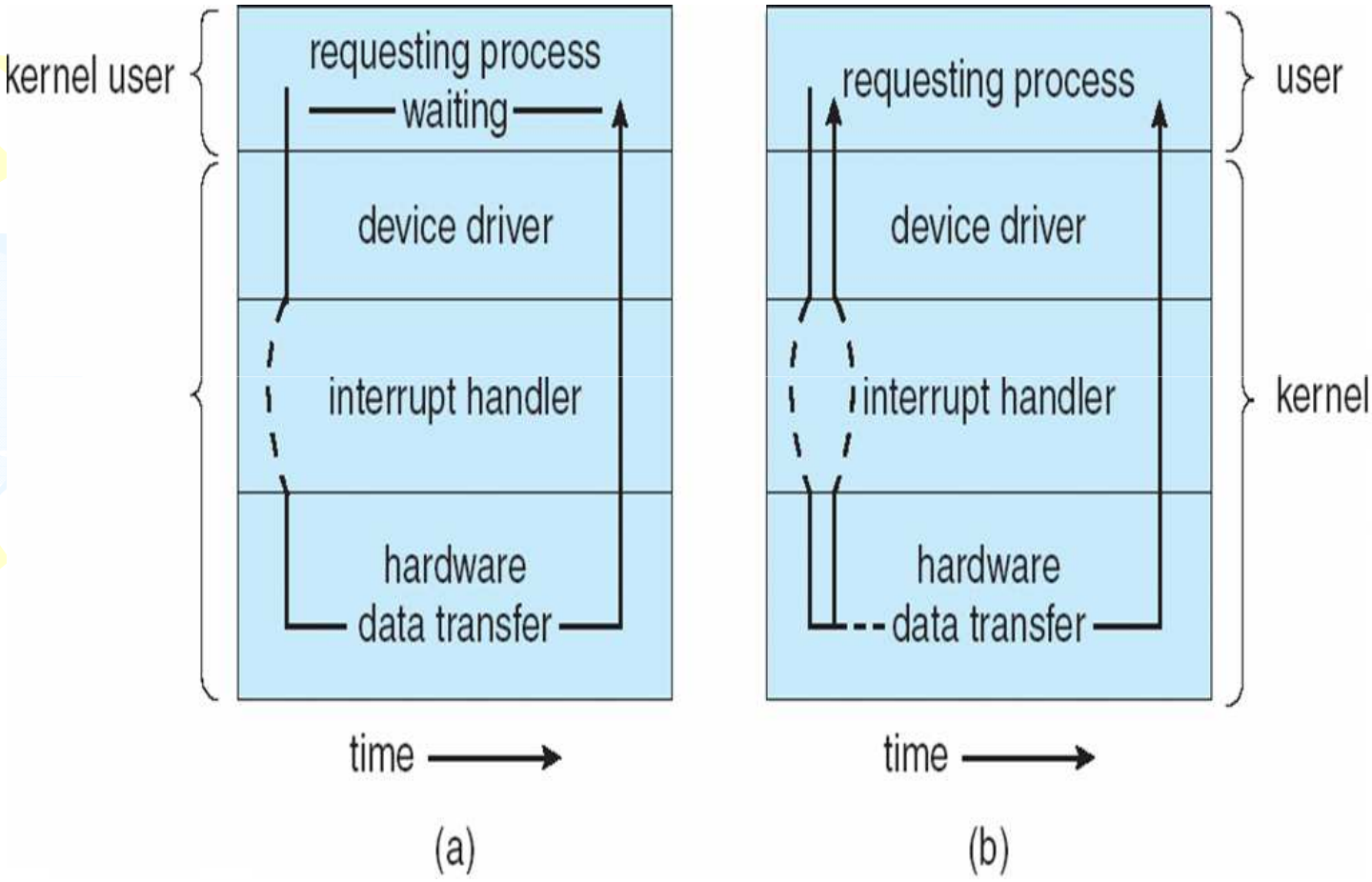
Clock dan Timer

- Fungsi clock dan timer pada hardware:
  - Mengetahui waktu saat ini
  - Lama sebuah proses telah berjalan dan idle
  - Trigger proses pada suatu waktu
- Programmable interval timer: hardware pengukur waktu dan trigger yang sudah terprogram di dalam CPU.
- Clock bukan Jam, melainkan satuan waktu CPU

Blocking and Nonblocking I/O

- Blocking - process suspended until I/O completed
  - Easy to use and understand
  - Insufficient for some needs
- Nonblocking - I/O call returns as much as available
  - User interface, data copy (buffered I/O)
  - Implemented via multi-threading
  - Returns quickly with count of bytes read or written
- Synchronous – process waits for I/O executing
  - I/O subsystem signals process when I/O completed
- Asynchronous - process runs while I/O executes
  - I/O subsystem signals process when I/O completed

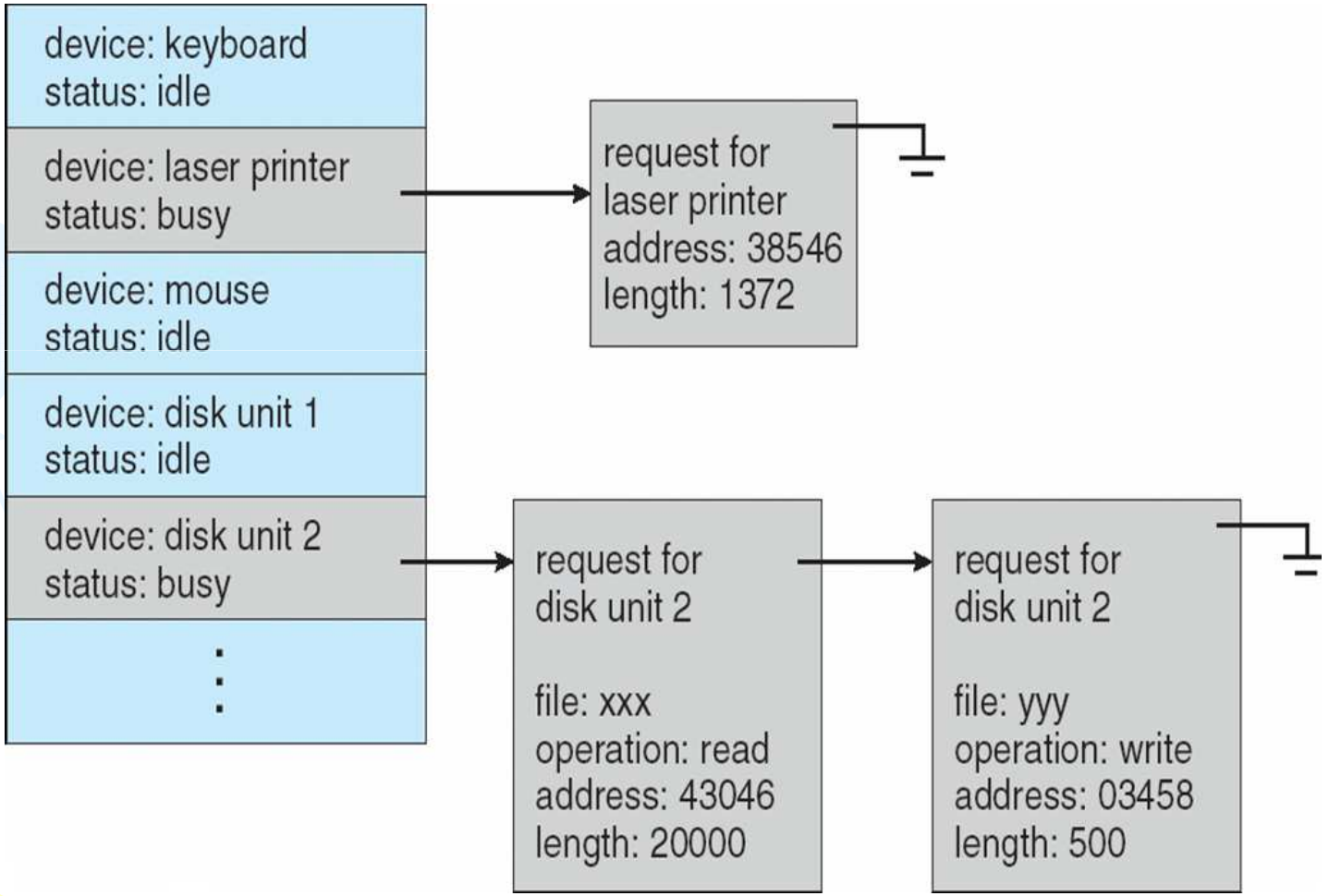
Two I/O Methods



Sinkronus/Blocking I/O

Asinkronus/Non Blocking I/O

Device-status Table



Kernel I/O Subsystem

- **Caching** – a fast memory holding **copy** of data
  - Always just a copy
  - Improve Performance
- **Buffering** - store data in memory while transferring between devices
  - To cope with device speed mismatch
  - To cope with device transfer size mismatch
- **Spooling** - **hold output** for a device for synhcronization
  - If device can serve only one request at a time
  - Wait in queue
  - i.e., Printing
- **Device reservation** - provides **exclusive** access to a device
  - System calls for allocation and deallocation
  - Device Locking
  - Watch out for deadlock

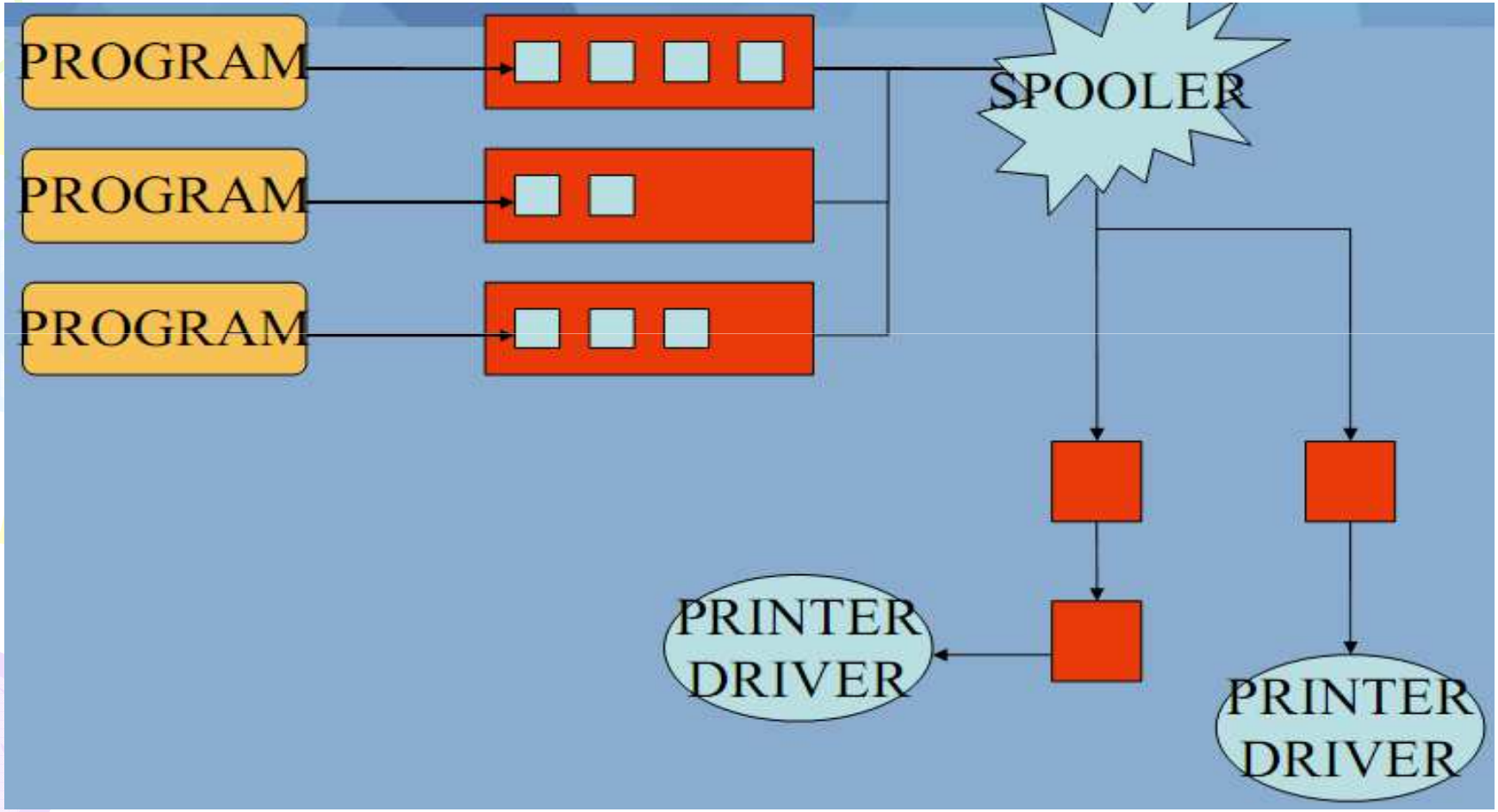
Cache vs Buffer

- **Cache** : area memori yang cepat, yang berisikan kopian-kopian data yang sering diakses
- Beda **BUFFER** dan **CACHE** :
  - Buffer menyimpan **temporary data** sebelum diberikan pada tahap berikutnya pada suatu request.
  - Cache hanya menyimpan sebuah **salinan dari data** yang **sering** diakses sehingga cepat.
- Peningkatan performa I/O, terutama untuk:
  - berkas yang digunakan secara bersama oleh beberapa aplikasi,
  - berkas yang sedang di baca/tulis secara berulang-ulang.

Spooling

- **Spool** : buffer yang menyimpan queue output device
  - Tidak dapat menerima inter-leaved data stream.
- 1 device memenuhi 1 permintaan, tapi aplikasi-aplikasi bisa minta bersamaan.
- Sistem operasi meng-intercept semua output ke device.
- Masing-masing output aplikasi di-spooled ke file yang berbeda.
- Setiap Sistem Operasi menyediakan control interface yang :
  - Membuat users dan administrator sistem menampilkan antrian
- Contoh: printer

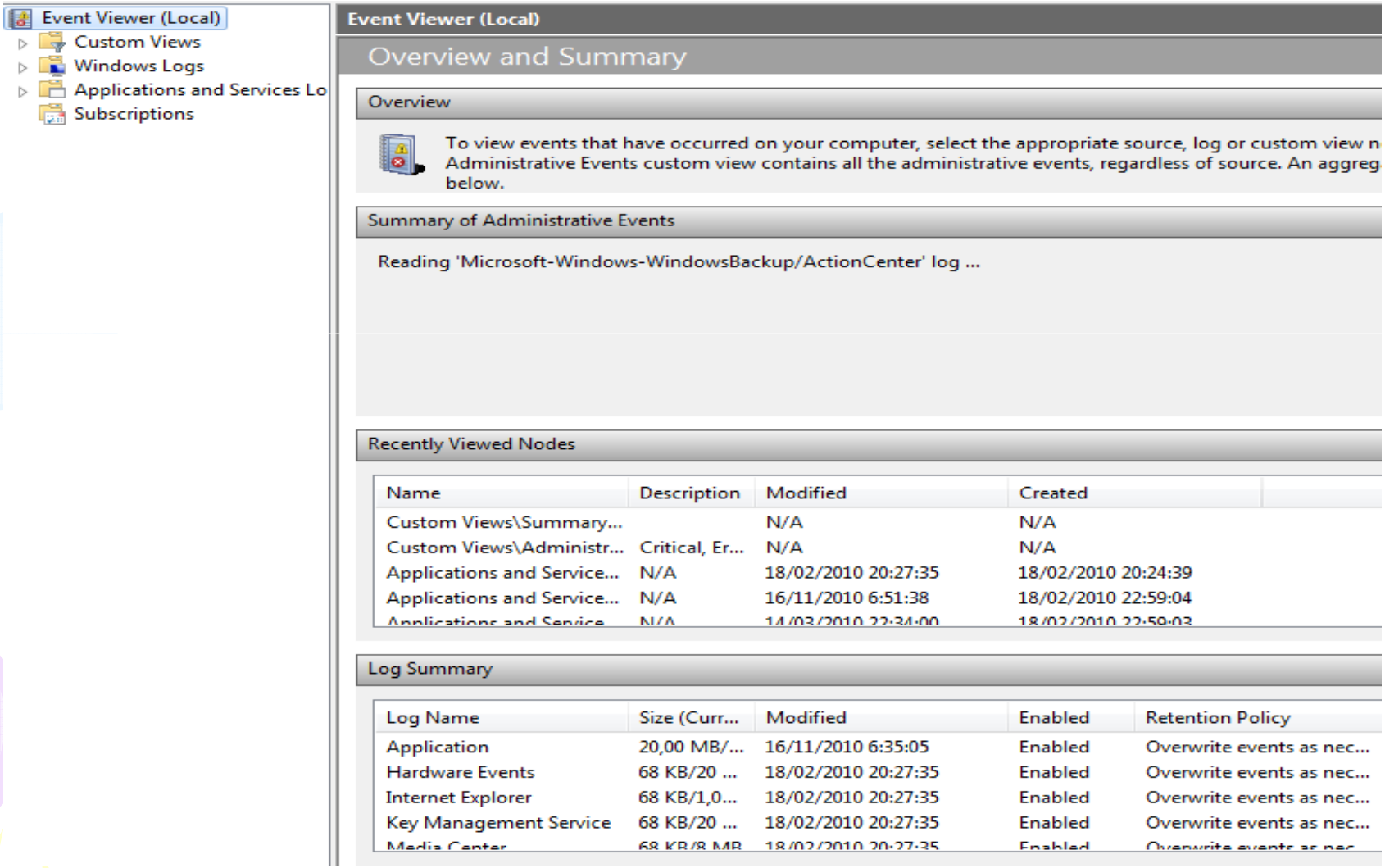
Spool


PROGRAM
PROGRAM
PROGRAM
SPOOLER
PRINTER DRIVER
PRINTER DRIVER

Error Handling

- OS can **recover** from: *disk read, device unavailable, transient write failures*
- Most return an error number or code when **I/O** request fails
  - File not found, I/O error
- System error **logs** hold problem reports
  - Ex: Events Log on Windows

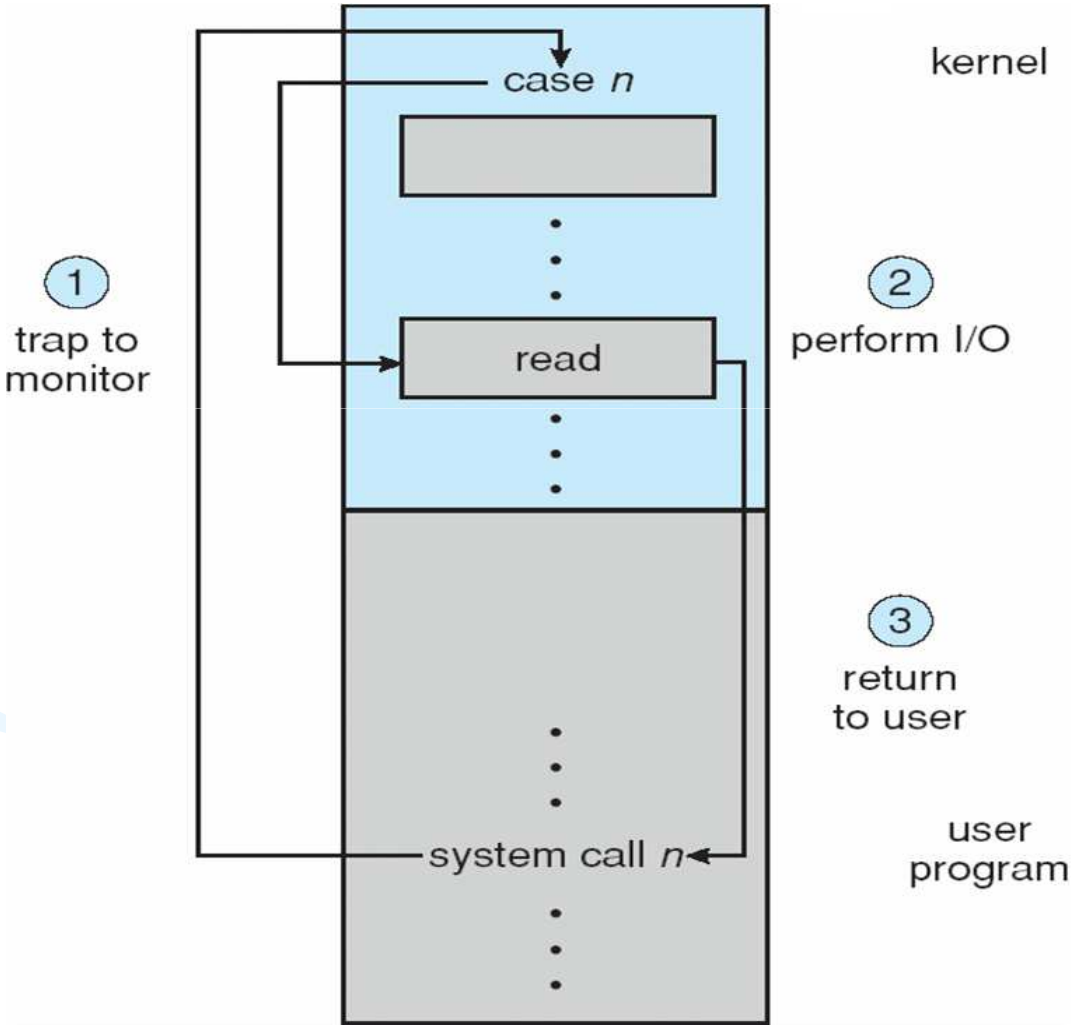
Event Log


Event Viewer (Local)
Custom Views
Windows Logs
Applications and Services Lo
Subscriptions
Event Viewer (Local)
Overview and Summary
Overview
To view events that have occurred on your computer, select the appropriate source, log or custom view n
Administrative Events custom view contains all the administrative events, regardless of source. An aggreg
below.
Summary of Administrative Events
Reading 'Microsoft-Windows-WindowsBackup/ActionCenter' log ...
Recently Viewed Nodes
Name Description Modified Created
Custom Views\Summary... N/A N/A
Custom Views\Administr... Critical, Er... N/A N/A
Applications and Service... N/A 18/02/2010 20:27:35 18/02/2010 20:24:39
Applications and Service... N/A 16/11/2010 6:51:38 18/02/2010 22:59:04
Log Summary
Log Name Size (Curr... Modified Enabled Retention Policy
Application 20,00 MB/... 16/11/2010 6:35:05 Enabled Overwrite events as nec...
Hardware Events 68 KB/20 ... 18/02/2010 20:27:35 Enabled Overwrite events as nec...
Internet Explorer 68 KB/1,0... 18/02/2010 20:27:35 Enabled Overwrite events as nec...
Key Management Service 68 KB/20 ... 18/02/2010 20:27:35 Enabled Overwrite events as nec...

I/O Protection

- User process may accidentally or purposefully attempt to **disrupt** (mengganggu) normal operation via **illegal I/O** instructions
  - So all I/O instructions defined to be **privileged**
  - And I/O must be performed **via system calls**
    - Memory-mapped and I/O port memory locations must be **protected** too

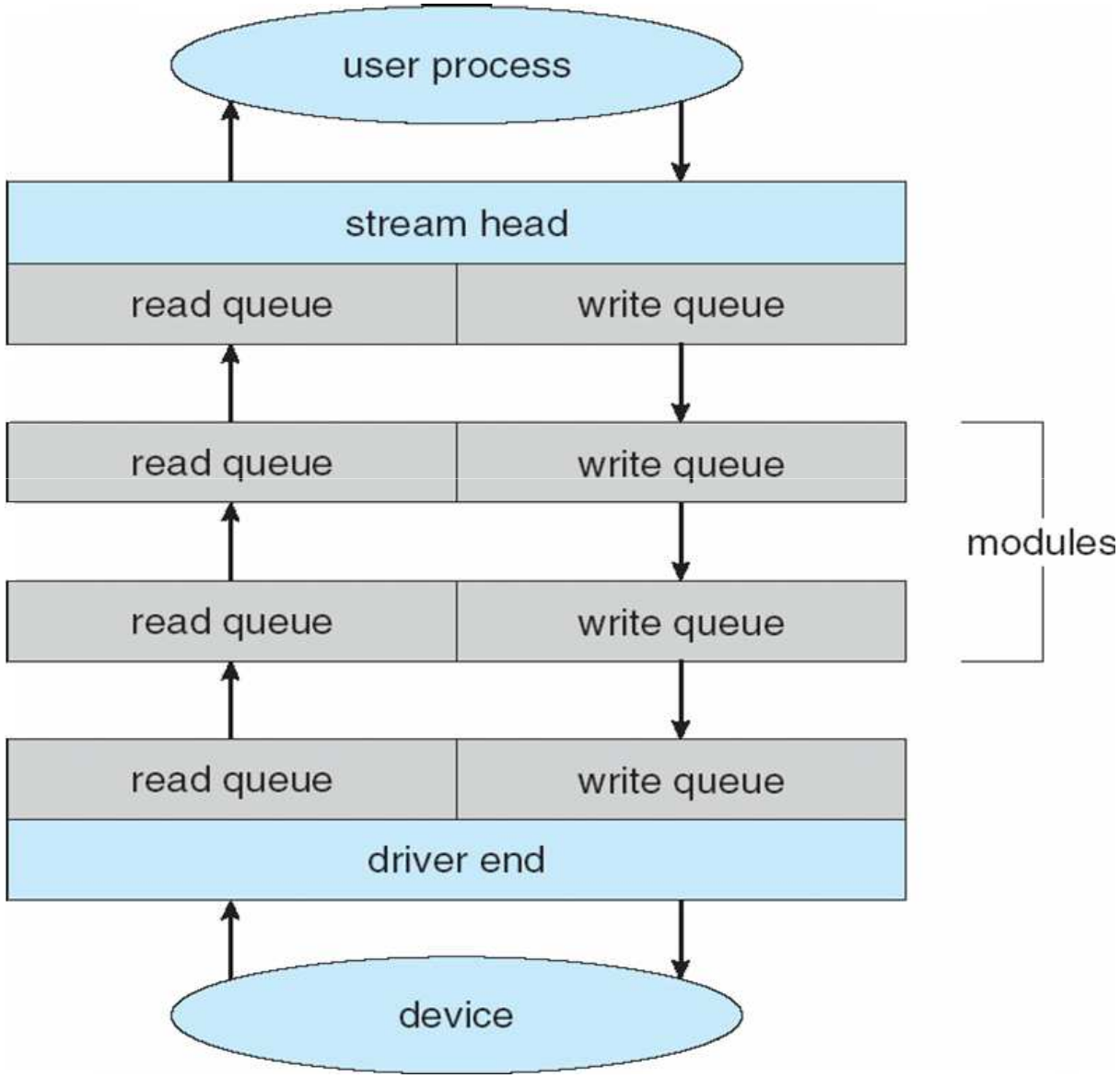
Use of a System Call to Perform I/O



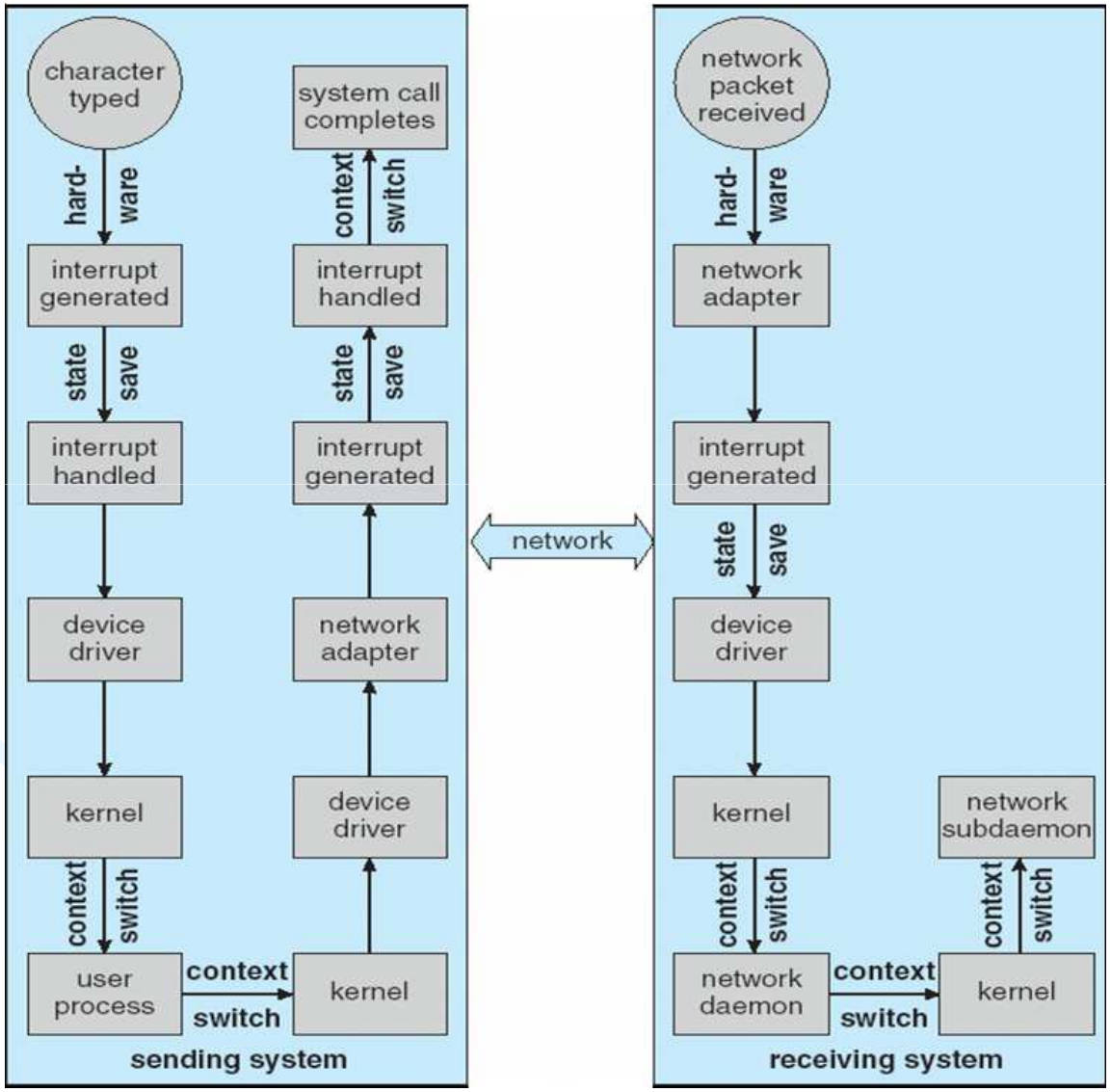
I/O Streams

- I/O stream adalah suatu mekanisme pengiriman data secara **bertahap dan terus menerus** melalui suatu aliran data (duplex)
- Biasa digunakan dalam **network protocol**
- Bersifat **Asynchronous**
- Menggunakan **message passing** dalam men-transfer data
- Untuk memasukkan ke dalam stream digunakan IO control system call
  - Atau pemrograman **Socket**
- Untuk menuliskan data ke device digunakan write / **putmsg** system call
- Untuk membaca data dari device digunakan read / **getmsg** system call

The STREAMS Structure



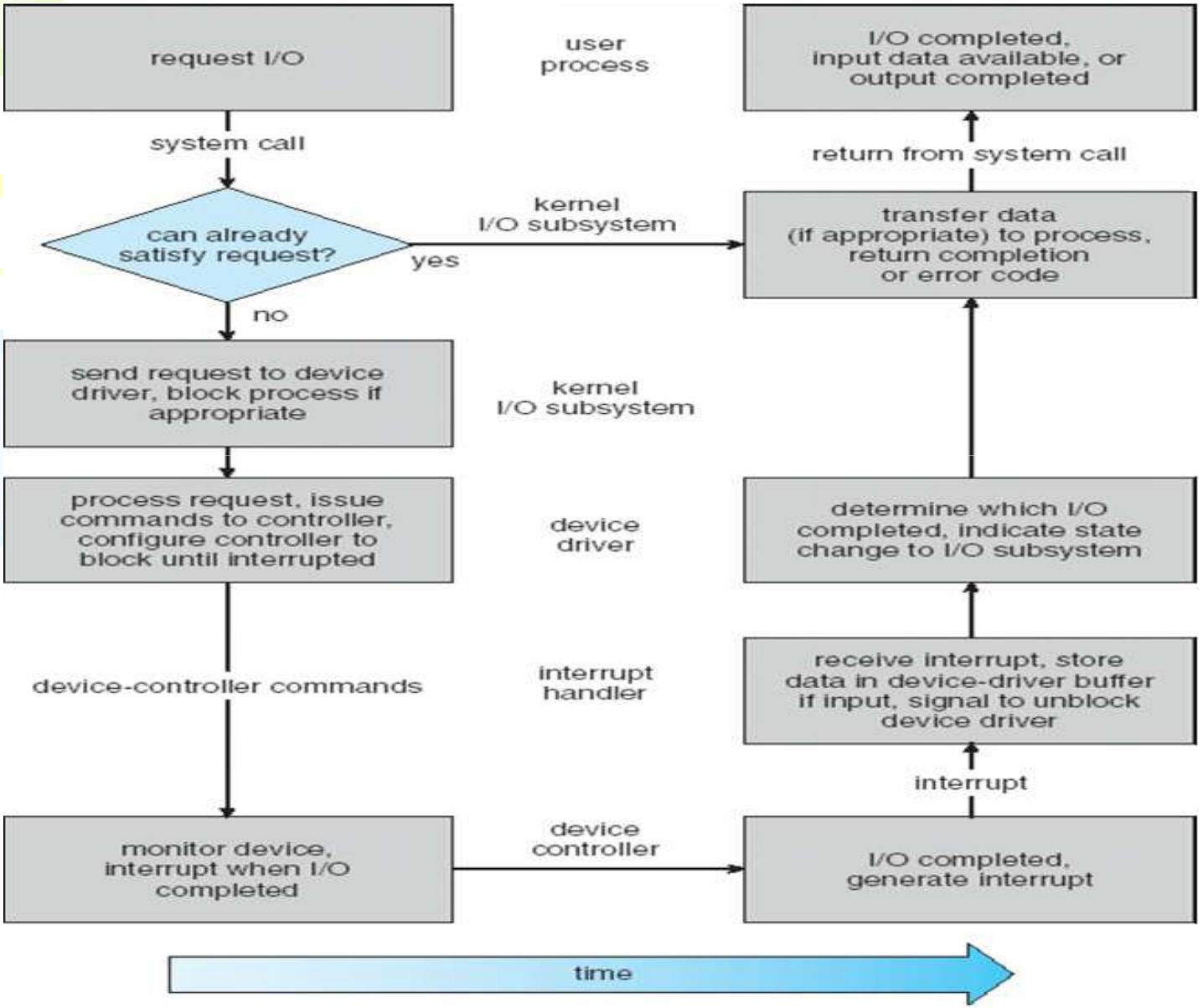
Intercomputer Communications



I/O Requests to Hardware Operations

- Consider reading a file from disk for a process:
  - **Determine** device holding file
  - **Translate** name to device representation
  - **Physically read** data from disk into buffer
  - **Make sure** data available to requesting process
  - **Return** control to process

Life Cycle of An I/O Request



Performance

- I/O is a major factor in system performance:
  - **Demands CPU** to execute device driver, kernel I/O code
  - **Context switches** due to interrupts
  - Data **copying**
  - **Network traffic** especially stressful

Meningkatkan Kinerja I/O

- Memperkecil jumlah context switch
- Memperkecil jumlah penyalinan data yang dilakukan sewaktu pengoperan data antara device dan aplikasi
- Memperkecil jumlah interrupt dengan menggunakan transfer secara besar-besaran, smart controllers dan polling (jika busy-waiting bisa diminimalisir)
- Menambah kongruensi dengan menggunakan DMA controllers
- Memindahkan proses-proses primitif ke perangkat keras
- Menyeimbangkan kemampuan CPU, memory subsystem, bus, dan I/O performance, karena kelebihan di salah satu area akan membuat keterlambatan pada yang lain

Next

- Implementasi Sistem Operasi
  - DOS dan Windows