Solutions for Chapter 1 Exercises

1.1 5, CPU

1.2 1, abstraction

1.3 3, bit

1.4 8, computer family

1.5 19, memory

1.6 10, datapath

1.7 9, control

1.8 11, desktop (personal computer)

1.9 15, embedded system

1.10 22, server

1.11 18, LAN

1.12 27, WAN

1.13 23, supercomputer

1.14 14, DRAM

1.15 13, defect

1.16 6, chip

1.17 24, transistor

1.18 12, DVD

1.19 28, yield

1.20 2, assembler

1.21 20, operating system

1.22 7, compiler

1.23 25, VLSI

1.24 16, instruction

1.25 4, cache

1.26 17, instruction set architecture

1.27 21, semiconductor

1.28 26, wafer

1.29 i

1.30 b

1.31 e

1.32 i

1.33 h

1.34 d

1.35 f

1.36 b

1.37 c

1.38 f

1.39 d

1.40 a

1.41 c

1.42 i

1.43 e

1.44 g

1.45 a

1.46 Magnetic disk:

Time for 1/2 revolution = 1/2 rev × 1/7200 minutes/rev × 60 seconds/minutes = 4.17 ms

Time for 1/2 revolution = 1/2 rev × 1/10,000 minutes/rev × 60 seconds/minutes = 3 ms

1.47 (DVD):

Bytes on center circle = 1.35 MB/seconds × 1/1600 minutes/rev × 60 seconds/minutes = 50.6 KB

Bytes on outside circle = 1.35 MB/seconds × 1/570 minutes/rev × 60 seconds/minutes = 142.1 KB

1.48 Total requests bandwidth = 30 requests/sec × 512 Kbit/request = 15,360 Kbit/sec < 100 Mbit/sec. Therefore, a 100 Mbit Ethernet link will be sufficient.

1.49 Possible solutions:

Ethernet, IEEE 802.3, twisted pair cable, 10/100 Mbit

Wireless Ethernet, IEEE 802.11b, no medium, 11 Mbit

Dialup, phone lines, 56 Kbps

ADSL, phone lines, 1.5 Mbps

Cable modem, cable, 2 Mbps

1.50

a. Propagation delay = m/s sec

Transmission time = L/R sec

End-to-end delay = $m/s + L/R$

b. End-to-end delay = $m/s + L/R + t$

c. End-to-end delay = $m/s + 2L/\mathrm{R} + t/2$

1.51 Cost per die = Cost per wafer/(Dies per wafer × Yield) = 6000/(1500 × 50%) = 8

Cost per chip = (Cost per die + Cost_packaging + Cost_testing)/Test yield = (8 + 10)/90% = 20

Price = Cost per chip × (1 + 40%) = 28

If we need to sell n chips, then $500{,}000 + 20n = 28n$, $n = 62{,}500$.

1.52 CISC time = $P \times 8T = 8\ PT$ ns

RISC time = $2P \times 2T = 4\ PT$ ns

RISC time = CISC time/2, so the RISC architecture has better performance.

1.53 Using a Hub:

Bandwidth that the other four computers consume = 2 Mbps × 4 = 8 Mbps

Bandwidth left for you = 10 – 8 = 2 Mbps

Time needed = (10 MB × 8 bits/byte) / 2 Mbps = 40 seconds

Using a Switch:

Bandwidth that the other four computers consume = 2 Mbps × 4 = 8 Mbps

Bandwidth left for you = 10 Mbps. The communication between the other computers will not disturb you!

Time needed = (10 MB × 8 bits/byte)/10 Mbps = 8 seconds

1.54 To calculate $d = a \times b - a \times c$, the CPU will perform 2 multiplications and 1 subtraction.

Time needed = $10 \times 2 + 1 \times 1 = 21$ nanoseconds.

We can simply rewrite the equation as $d = a \times b - a \times c = a \times (b-c)$. Then 1 multiplication and 1 subtraction will be performed.

Time needed = 10 x 1 + $1 \times 1 = 11$ nanoseconds.

1.55 No solution provided.

1.56 No solution provided.

1.57 No solution provided.

1.58 Performance characteristics:

Network address

Bandwidth (how fast can data be transferred?)

Latency (time between a request/response pair)

Max transmission unit (the maximum number of data that can be transmitted in one shot)

Functions the interface provides:

Send data

Receive data

Status report (whether the cable is connected, etc.?)

1.59 We can write Dies per wafer = $f((\text{Die area})^{-1})$ and Yield = $f((\text{Die area})^{-2})$ and thus Cost per die = $f((\text{Die area})^{3})$.

1.60 No solution provided.

1.61 From the caption in Figure 1.15, we have 165 dies at 100% yield. If the defect density is 1 per square centimeter, then the yield is approximated by

$$\frac{1}{\left[1+\left(\frac{\frac{1}{100\text{mm}^2}\times 250\text{mm}^2}{2}\right)\right]^2} = .198.$$

Thus, $165 \times .198 = 32$ dies with a cost of \$1000/32 = \$31.25 per die.

1.62 Defects per area.

1.63 $$\text{Yield} = \frac{1}{(1 + \text{Defects per area} \times \text{Die area}/2)^2}$$

$$\text{Defects per area} = \frac{2}{\text{Die area}}\left(\frac{1}{\sqrt{\text{Yield}}} - 1\right)$$

1.64

1980	Die area	0.16
	Yield	0.48
	Defect density	5.54
1992	Die area	0.97
	Yield	0.48
	Defect density	0.91
1992 + 1980	Improvement	6.09