Computer Architecture
CDA 4150

By: Ryan Gaskill

Dave Morrell

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Exercises for I/O

Today's lecture will consist of some example problems that will hopefully help you prepare for the final exam. Use these as practice problems or as a helpful guide when trying to determine how to solve them. Try to work them out before moving to the next slide which will show the solution to each example. Good luck!

System & Queue

- Note: The following formulas on this slide can be written on a single sheet of paper for the final exam.

$U = \lambda / \mu = \lambda * s$

$1/\mu = s$

<u>System</u>

$N = U/(1 - U)$

$R = 1/(\mu - \lambda)$ (or $R = s/(1 - U)$)

<u>Queue</u>

$Wq = R - 1/\mu = U/(\mu - \lambda)$

$Nq = \lambda * Wq = U^2/(1 - U)$

Example #1

- What your given:
  - 40 disk I/O per sec
  - Average service time of s = 20ms

1) How utilized is the disk? (U)
2) What is the average time spent in queue? (Wq)
3) What is the average response time? (R)

Example #1 Solution

- What we know:

  $\lambda = 40$ I/O request/sec

  s = 0.02 sec

Solving part 1:

U = $\lambda * s = 40 * .02 = .08$

Solving part 2:

.02 = 1/ μ so $\mu = 50$

Wq = U/($\mu - \lambda$) = $.8/(50 - 40) = 80$ms

Solving part 3:

R = 1/($\mu - \lambda$) = $1/10 = 100$ms

Example #2

- The time spent between request to a web sever is 8ms.

  s = 5ms

a) What is the average response time (R) observed b the users making requests on this server?

b) How much faster must the sever process requests to halve this average responsive time?

Example #2 Solution

- Solution to part a)

  $\lambda = 1/8$ms = .125 requests per sec.

  s = 5ms so $\mu = 1/s$ = .2 request per ms

  R = $1/(\mu - \lambda) = 1/(.2 - .125) = 13.33$ms

Therefore the average response time (R) observed by the users making requests on this server is 13.33ms

Example #2 Solution

- Solution to part b)

  R = 13.33/2 = 6.67ms

Substitute this new value back into R and determine what λ is.

$R = 6.67 = 1/(\mu - .125)$

$\mu = .275$ IORB per ms

Example #3

- The I/O device has a service time of 7.8ms. What is the response time for the following numbers of IORB per second

  64,72,80,96,104,112,120,124,126,128,129

  Given that s = 7.8ms and λ from above, we can compute the response time (R) by determining U. Answers are given as a table and chart on the next two slides. This example can be found in the textbook on page 748.

Example #3 Solution

λ (Given)	U	R
64	50%	15.6 ms
72	56%	17.8 ms
80	62%	20.7 ms
96	75%	31.0 ms
104	81%	41.3 ms
112	87%	61.7 ms
120	94%	121.8 ms
124	97%	238.5 ms
126	98%	452.9 ms
128	99.8%	4761 ms
129	> 100%	→ infinity

Example #3 Solution