Homework 3

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Answer 1

a. Using the equation, $E = Z_{\alpha/2}\frac{S}{\sqrt{n}}$, we can plug in what we know
   $.4 = 2.06 * S/\sqrt{40}$
   This gives us a standard dev of 1.23

b. $E = Z_{.01/2}\frac{S}{\sqrt{n}}$
   $E = 2.58 * 1.23/\sqrt{40} = .5$
   So the new interval would be $3 \pm .5$

c. $E = Z_{\alpha/2}\frac{S}{\sqrt{n}}$
   $.1 = 2.06 * 1.23/\sqrt{n}$
   $n = 641.01$ so you would need to sample 642 people

Answer 2

Submitting late See the code in the 'src' folder

Answer 3

Converted everything from seconds to milliseconds, $\lambda = 20$, capcity $= 24000B/sec$

a. We should use M/G/1 because the arrival rate is Poisson and we know the know the normalized value of service time standard deviation. Because the packet size is unform, and the packet size is what determines the service time, we know what the mean service time is and the standard deviation.

b. $T_s = ((100 + 1500)/2)/24000 = .033ms$

c. $STD = ((1500 - 100)/24000)/\sqrt{12} = .017ms$

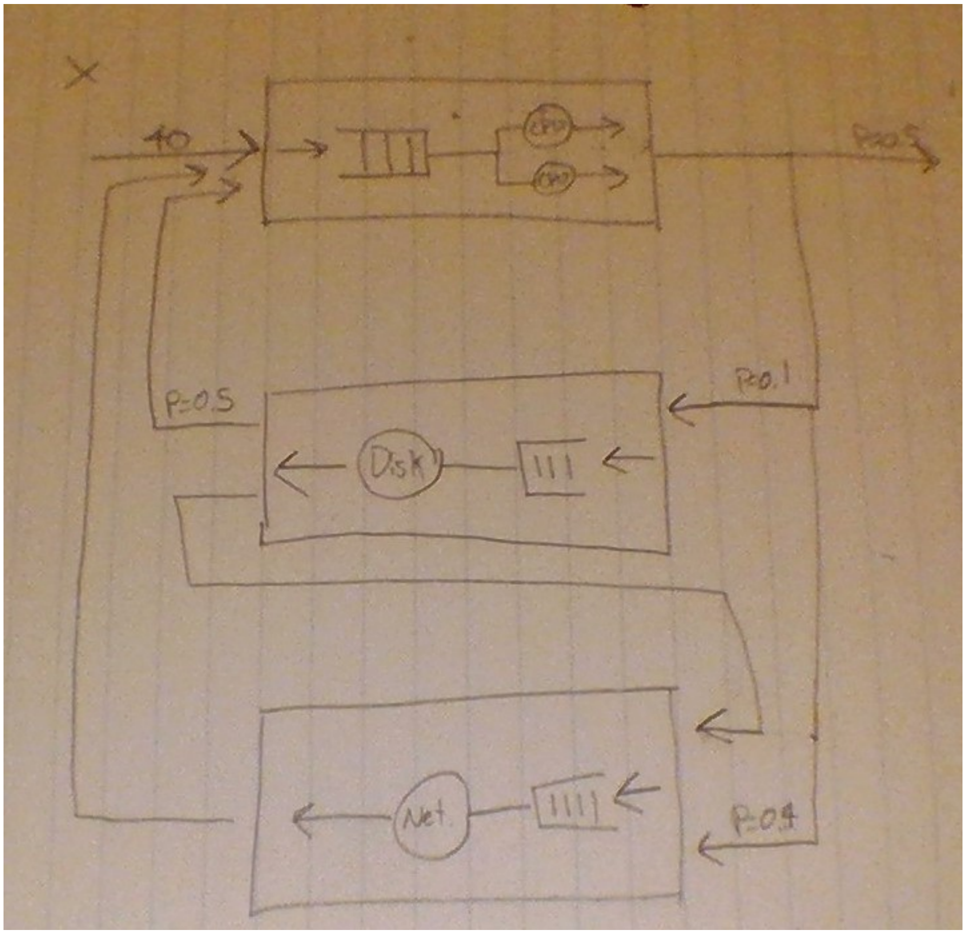
d. $A = \frac{1}{2}(1 + (\frac{.017}{.033})^2) = .63$
   $\rho = 20 * .033 = .66$
   $q = \frac{.66^2 * .63}{.34} + .66 = 1.47$

e. $w = q - \rho = .81$

f. $T_q = q/\lambda = 1.47/20 = .0735ms$

g. $\Pr[S_0] = 1 - \rho = .33$

Answer 4

a. 

b. Arrival rate to CPU system, $X = 40 + (0.1 * X) + (0.5 * 0.1 * X + 0.4 * X) = 80$
Arrival rate to Disk, $Y = 0.1 * X = 8$
Arrival rate to Network, $Z = 0.4 * X + 0.5 * Y = 36$

First, find T_q of CPU (M/M/2)
$\rho = \lambda * T_s/N = 80 * .02/2 = .8$
$C = \frac{2\rho^2}{1+\rho} = .71$
$q = C * \frac{\rho}{1-\rho} + N * \rho = .71 * \frac{.8}{.2} + 1.6 = 4.44$

Next, T_q of the Disk (M/M/1)
$\rho = \lambda * T_s = 8 * .1 = .8$
$q = \frac{\rho}{1-\rho} = .8/.2 = 4$

Next, $T_q of the network (M/M/1)$
$\rho = \lambda * T_s = 36 * .025 = .9$

$q = \frac{.9}{.1} = 9$

Total $q = 9 + 4 + 4.44 = 17.44$ Total $T_q = 17.44/80 = .218$

c. The bottleneck is the the network because it has the highest utilization and highest q

d. We need to find which processes will have $\rho > 1$ at a given arrival rate
For cpu, $\lambda = 1/.01 = 100$
disk, $\lambda = 1/.1 = 10$
network $\lambda = 1/.025 = 40$
For the arrival rate X to reach 100 at the CPU, λ to the whole system would have to be $100 - .55(100) = 45$
For the arrival rate Y to reach 10 at the Disk, $10 = .1(X), X = 100, \lambda = 45$
For the arrival rate Z to reach 40 at the Network, $40 = .45X, X = 88.88, \lambda = 88.88 - .55(88.88) = 40$

We can see that if the arrival rate to the system is over 40, then the queue in the Network queue will grow infinitely long