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A) Service times

Name of service center	Service Time (S_k)
WebServer	**0.059996**
ApplicationServer	**0.24998**
VoucherPaymentServer	**0.3000019**

B) Simulation results

Name of service center	Utilization	Throughput
WebServer	**18.45%**	**3.0990**
ApplicationServer	**77.04%**	**3.0665**
Database	**43.20%**	**12.2967**
CardPaymentServer	**34.88%**	**1.7380**
VoucherPaymentServer	**22.37%**	**0.7492**

Average System Response Time: 30.6247 s

Average time that a user is waiting for a reply from the system

C) System upgrade

Name of service center	Minimum number of resources	Utilization	Throughput
WebServer	**2**	**0.7666**	**25.8064**
ApplicationServer	**7**	**0.9036**	**25.7591**
Database	**4**	**0.9027**	**102.4552**
CardPaymentServer	**3**	**0.9715**	**14.3460**
VoucherPaymentServer	**2**	**0.9208**	**6.1695**

Average System Response Time: 40.5655 s

Average time that a user is waiting for a reply from the system

Calculations:
A)
We know:
WEBSERVER
T = 259200 s
Vweb = 1.7361 visits
Dweb = 0.10416s
C = 466560

Vk = Ck / C
Ck = Vk*C = 1.7361*466560 = 809994.816

Dk = Vk*Sk
Sk = Dk/Vk = 0.10416/1.7361 = **0.059996** s

Xk = Ck/T = 809994.816/259200 = **3.12498**

Uk = Xk*Sk = 3.12498 * 0.059996 = **0.187468**

Application Server
We know:
Uk = **78.12** %
N = 3.565
R = 1.1408

N = X*R
X = N / R = 3.565 / 1.1408 = **3.125**

Uk = Xk * Sk
Sk = Uk/Xk = 0.7812 / 3.125 = **0.24998**

Voucher Server
Uk = 22.5%

Ck = 809994.816 *0.8*0.3 = **194398.75584**

Xk = Ck / T = 194398.75584 / 259200 = **0.7499952**

Uk = Xk*Sk
Sk = Uk / Xk = 0.225 / 0.7499952 = **0.3000019 s**