Exercises Sheet
Sizing and Probabilities

Systems Configuration and Management
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1. A router handles 100 packets per second and the processing time of each packet is 2ms. What is the router utilization?

2. A new VoIP system is composed of multiple IP-PBX devices. IP-PBX can have at most 4 pending requests and the average delay of each request is 50ms. How many IP-PBX devices will be required to handle 500 calls per second?

3. Consider a cache placed in front of an web server. The system receives 60 requests/s. The cache is able to reply on average to 80% of the requests.

   (a) How many requests are handled by the cache and how many are handled by the web server?

   (b) Assume instead that a load balancer equally distributes the load to 3 replicas of the cache. How many requests are handled by each component?

   (c) Finally assume that only a cache exists and the load balancer is placed between the cache and 3 replicas of the web server. How many requests are handled by each component in this case?

4. A company is planning a web site that must be able to cope with 100 requests/s and a variance of more or less 30 requests/s. Which hardware option is cheaper?

   (a) A load balancer that can handle 500 requests/s (cost 2000) and small servers that can handle 50 requests/s each (cost of each: 2000);

   (b) A unique server (cost 8000);

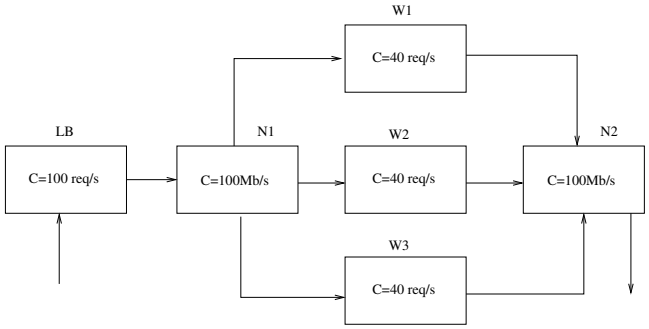

Figure 1:

5. Consider the system depicted in Fig. 1 and assume that 60 requests/s are received. Each request uses a 1Kb packet and replies have on average 100Kb. Finally, assume that the system's flow can be modeled using M/M/1 queues.

   (a) What is the average delay of each request?

   (b) How many requests will be at the Load Balancer and Web Server?

   (c) Repeat your calculations considering that replies are routed through N1 and LB.

6. Assuming that the probability of failure of the components in the network of Fig. 1 is 10^{-4} for the web servers, 10^{-6} for network components and 10^{-5} for the load balancer, determine:

   (a) the probability of the system being correct

   (b) discuss the scenarios in which the system will operate in degraded mode

   (c) discuss approaches to increase system reliability. Would a combination of 2 LB and 2 WS increase or decrease system reliability?

Formulas

Queues M/M/1 For an arrival rate λ and service rate μ:

utilization $\rho = \frac{\lambda}{\mu}$

average delay $\frac{1}{\mu(1-\rho)}, \rho < 1$

requests in system $\frac{\rho}{1-\rho}, \rho < 1$