Advanced Computer Architecture: Google 1

Jeremy Bradley

1 March 2004

1. Assume you are planning to layout a computing cluster in a cohosting site. Each rack unit PC outputs 40W of heat. Each rack requires a single switch which can output a maximum of 50W. You can fit up to 32 PCs and one switch in a rack. The air-conditioning in a hosting site can typically expel 1000W per square metre. If each rack takes 1m^2 of floor space and your proposed site is 100m^2, what is the maximum number of PCs you can locate in your site?

2. You have a cryptographic key that needs to be broken. It is 128 bits in length i.e. there are 2^{128} possible keys. You have a budget of £500,000. A standard PC costs £1000 and can perform 100,000 key tests per second today. Assuming that the average PC doubles in speed every 18 months (indefinitely), how long must you wait before you can afford to buy sufficient computing power to test all 2^{128} keys within 6 months – ignoring inflation. (If you have time, have a go at solving the harder problem of finding the shortest time to search a 128 bit key given Moore's Law)

3. You are running a disk array in a computing facility which receives 90,000 file requests every minute. In order to fulfil your SLA (service level agreement) your disk array must process each request (from arrival to service completion) within 0.01 seconds Assuming you are able to software configure the disk IO buffer, how large should you set it in order to deal with the average request load? How fast must the overall array service requests in order to meet the mean response time requirement? Answer the latter question for the different models of the disk array:

   (a) M/M/1
   (b) M/D/1

4. You are given a new model for the expected buffer length in an intranet search engine:

$$\mathbb{E}(N) = \rho + \frac{3\rho}{1-\rho}$$

   Given that the arrival rate for requests, λ, is 2 per second and the average response time is to be kept below t seconds. Find an upper bound expression for ρ in terms of t.