

HSPC 2004, Homework 1

**First Name:** Peter  
**Last Name:** Gruber

**Problem 6:** *A problem comprises two components A and B. A can be solved in 1000 seconds on computer C1 and in 5000 seconds on computer C2; B requires 4000 and 2000 seconds on C1 and C2, respectively. The two computers are connected by a 1000-km optical fiber link that can transfer data at 100MB/sec with a latency of 10msec. The two components can execute concurrently but must transfer 10MB of data 10000 times during execution. Is it cheapest (in terms of computational resources consumed) to solve the problem on computer C1, on computer C2, or on both computers together? Confirm your answer with an adequate analysis.*

If we solve the problem on computer C1, it takes  $1000 + 4000 = 5000$  seconds. Solving the problem on computer C2, we have  $5000 + 2000 = 7000$  seconds computational resources consumed.

Now, if we solve the problem on both computers together, it is evident that we shall assign component A to computer C1, and component B to computer C2. Execution time needed is thus  $\max(1000, 2000) = 2000$  seconds. (Computation is finished when both computers have found their results.)

For the time that is needed for communication, we have:

Transferring 10MB of data at 100MB/sec takes  $\frac{1}{10}$ s. The signal will travel at the speed of light, so for the first bit to arrive on the other end it takes (approximately)  $\frac{1000\text{km}}{300000\text{km/s}} = \frac{1}{300}$ s. Considering the latency, we have to add another  $10\text{ms} = \frac{1}{100}$ s, yielding  $\frac{1}{10} + \frac{1}{100} + \frac{1}{300}$  seconds that are needed for transferring one block of data.

As we have 10000 blocks of data to transfer, we finally find communication time to be equal to  $10000 \cdot (\frac{1}{10} + \frac{1}{100} + \frac{1}{300}) \approx 1133$  seconds.

Therefore, computational resources consumed in this case turn out to be  $2000 + 1133 = 3133$  seconds.

**Conclusion:** It is cheapest to solve the problem in parallel on both computers together.