CSC506 Homework due Friday, 6/18/99 - Switch Questions

1. We have a three-stage Omega (Shuffle-exchange) network to connect eight processors numbered P0, P1, ..., P7 to eight independent memory modules numbered M0, M1, ..., M7.

   a) Draw the network.
   b) Show (highlight) the following connections through the network:
      \[
      P0 \rightarrow M2, \quad P4 \rightarrow M4, \quad P6 \rightarrow M3.
      \]
   c) Can these accesses be performed concurrently or do they conflict?
   d) Add a processor-to-memory access that is blocked (conflicts) by one of the accesses used in part b).
   e) Add a processor-to-memory access that is not blocked by one of the accesses used in part b).

   c) \[ P0 \rightarrow M2 \text{ and } P4 \rightarrow M4 \text{ are OK, but } P6 \rightarrow M3 \text{ is blocked by } P0 \rightarrow M2. \]

   d) \[ P2 \rightarrow M5 \text{ is blocked by } P4 \rightarrow M4. \] Note that I did not give credit if you showed blocking at the processor or the memory module rather than in the switch. For example, no processor can get to M2 while P0 is accessing M2, even with a full crossbar (non-blocking) switch.
2. The Omega network in question 1 needs to provide a path of 128 data lines and 32 address lines:

a) How many individual switches are required to implement the network?

- 3 stages x 4 boxes per stage x 4 individual switches per box = 48 binary switches per line. We need 128 + 32 = 160 lines, so we need a total of 48 x 160 = 7,680 individual switches.

b) If we implemented a full crossbar switch in place of the Omega network, how many individual switches would be required?

- A full crossbar requires 8 x 8 = 64 binary switches per line, for a total of 64 x 160 = 10,240 individual switches.

c) What would be the corresponding number of switches in both cases for a 16 processor, 16 memory system?

- The Omega network would need log(2) 16 = 4 stages and 16/2 = 8 boxes per stage = 32 boxes. 32 boxes x 4 individual switches per box x 160 lines = 20,480 individual switches.

- The full crossbar network needs 16 x 16 = 256 individual switches per line. 256 individual switches x 160 lines = 40,960 individual switches total.

e) P2 → M6 is OK. Several others are possible.