

CSE160 Quiz #1

10/13/2006

NAME: _____ LOGIN: _____

1. Parallelization

- (a) Identify the loop carried dependencies in the following code segment.

```
for(i=0; i < N; i++) // Initialization
    a[i] = 3*i + 5*i*i;

for(t=1; t < NT; t++) // Iterative computation
    for(i=1; i < N-1; i++)
        a[i] = a[i-1] + a[i+1];
```

A) The iterative computation has a loop carried dependency. The value $a[i]$ needs $a[i-1]$, which is updated at previous loop.

- (b) Parallelize the loop on a CREW PRAM, introducing `forall` loops where appropriate, that utilize $O(N)$ processors.

A) The idea is having another array that has the same size with array **A** and copying back and forth.

```
forall(i=0; i < N; i++) // Initialization
    a[i] = 3*i + 5*i*i;

for(t=1; t < NT; t++){ // Iterative computation
    forall(i=1; i < N-1; i++)
        if(t%2 == 0)
            b[i] = a[i-1] + a[i+1];
        else
            a[i] = b[i-1] + b[i+1];
}
```

2. Interconnect

- (a) What is the diameter and bisection bandwidth of an $N \times N \times N$ toroidal mesh interconnect?

A) Diameter: $3N/2$

bisection bandwidth: $2N^2$

- (b) Give an efficient broadcast algorithm for the 3D toroidal mesh. What is the running time of your algorithm?

A) Brief description:

- Broadcast to a one row
- Each node that has the value broadcasts to a orthogonal row
- The plane that has the value broadcasts to other planes.

Let assume Node (0,0,0) broadcast a value.

```
broadcastOneRow((0, 0, 0), (N-1, 0, 0));  
forall(i = 0; i < N; i++)  
    broadcastOneRow((i, 0, 0), (i, N-1, 0));  
  
forall(i = 0; i < N; i++)  
    forall(j = 0; j < N; j++)  
        broadcastOneRow((i, j, 0), (i, j, N-1));
```

Each `broadcastOneRow()` takes $N/2$ time steps because propagating to both right and left direction saves $N/2$ steps. Therefore, the total running time of the algorithm is $3N/2$, which is $O(N)$.