

# CELL hfn, Sci. Programming, wrappers

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16 Jan, 2008

## Status of HFN:

- ▶ Francois' write-up finished. Mauro and Jonathan's not yet. Tests and code working.
- ▶ Special issue of *Scientific Computing* dedicated to CELL B.E. processors.
- ▶ Division operation needs to be finished. Usual procedure is to use say `double` to estimate reciprocal approximation, then Newton method to HFN order. Where

$$f(x) = x^{-1} - a,$$

to compute  $x$  such that  $f(x) = 0$ , the Newton correction is

$$\begin{aligned}\Delta x &= -(f'(x_k))^{-1} f(x_k) \\ &= (x_k)^2 ((x_k)^{-1} - a) \\ &= x_k - x_k \cdot a \cdot x_k.\end{aligned}$$

or,

$$\begin{aligned}x_{k+1} &= x_k + \Delta x \\ &= 2x_k - x_k \cdot a \cdot x_k.\end{aligned}$$

Other things to be done: include `hfn` in D. Bailey's high precision functions library. This can wait.

John Shalf points out that SPUs + vectorization in effect just *enhances* vectorization. In fact, it looks a lot like Cray vectors of old.

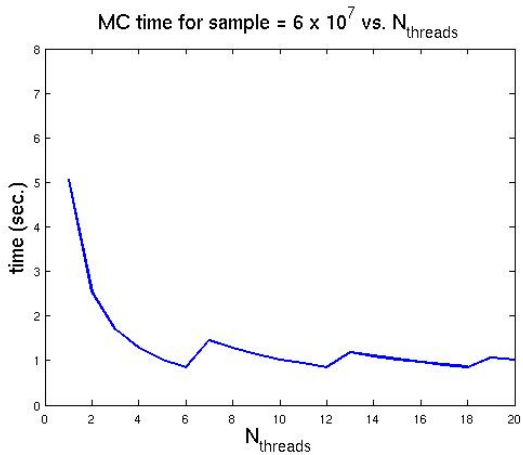


Figure: Timings vs. threads on CELL

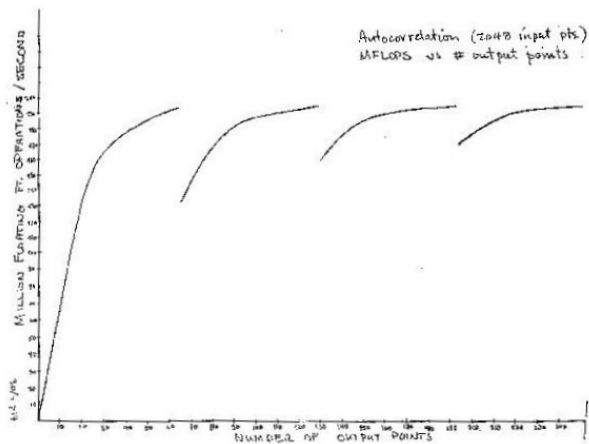


Figure: Autocorrelation on Cray X-MP vector machine, 1977.

Next item to be discussed is longer-term. Usual form of multi-tasking looks similar to OpenMP.

```
#pragma omp parallel private(outer,inner) \  
    shared(nthreads,VL)  
#pragma omp for  
    for(outer=0;outer<nthreads;outer++){  
        for(inner=0;inner<VL;inner++){  
            something[inner][outer];  
        }  
    }
```

On shared memory machines, all local CPU data are cached automatically. CELL processors require DMA access and this is controlled by the programmer.

```
void simulate_on_spe(){
    speid_t spe_ids[SPE_THREADS];
    context ctxs[SPE_THREADS] __attribute__((aligned(16)));
    char* memory[SPE_THREADS];
    int hits=0,i,status;
    for(i=0;i<SPE_THREADS;i++){
        ctxs[i].iterations = iterations/SPE_THREADS;
        ctxs[i].hits =
            (int*)malloc_aligned(16,sizeof(int),memory[i]);
        spe_ids[i] =
            spe_create_thread(0,&bench_spe,&ctxs[i],NULL,-1,0);
        if(spe_ids[i] == 0) exit(1);
    }
}
```

What we need:

- ▶ Either wrappers for DMA and thread management,
- ▶ or imbed these wrappers in a larger system:
  - \* Cactus, not very promising. <http://www.cactuscode.org/>
  - \* Trilinos, TCP/IP protocols, <http://trilinos.sandia.gov/>.
  - \* Rob Bisseling,  
<http://www.math.uu.nl/people/bisseling/>
  - \* Dongarra's people,  
<http://www.cs.utk.edu/~dongarra/cell2006/>



What has been accomplished:

- ▶ Mini-cluster of 4 PS-3s put together.
- ▶ hfn code working & tests, write-ups in progress.
- ▶ OpenMPI ported to 4 PS-3s.
- ▶ We've learned something.