

Table 1

scale Time(ms)	blas	basic	vectorized	omp-1	omp-4	omp-8
1024	526	970	627	2124	381	365
2048	334	4200	2431	2739	684	354
4096	1336	18162	12130	13642	2285	1152
8192	5454	76358	39848	11837	8148	4095
16384	217391	320218	231317	102535	307734	154084

Table 2

scale ability	blas	basic	vectorized	omp-1	omp-4	omp-8
1024	7.792	4.208	6.481	1.914	10.829	11.242
2048	12.217	2.586	4.460	3.953	15.774	30.482
4096	9.996	1.939	2.911	2.572	12.296	21.547
8192	9.789	1.858	3.558	4.795	6.997	13.939
16384	6.157	1.663	2.290	5.144	1.711	3.420

Table 3

scale utilization	blas	basic	vectorized	omp-1	omp-4	omp-8
1024	99.37%	79.50%	89.43%	91.25%	93.75%	94.69%
2048	99.27%	79.24%	89.29%	91.25%	93.60%	94.67%
4096	99.31%	79.30%	89.29%	91.28%	93.60%	94.68%
8192	99.36%	79.35%	89.32%	91.27%	93.62%	94.68%
16384	99.36%	79.35%	89.32%	91.27%	93.62%	94.68%

Answer

1. The vectorized implementation has better performance than the basic implementation at N=16384, increasing MFLOP/s by about 75%. The vectorized implementation also has better memory system utilization, improving bandwidth utilization by about 16%.
2. The OpenMP 8-way parallel implementation has better performance than the basic implementation when N=16384, increasing MFLOP/s by about 39%. However, the base implementation has better memory system utilization at about 3%.
3. When N=16384, the speedup ratio achieved by OpenMP is about 3.3 from 1 to 4 threads, and about 6.6 from 1 to 8 threads, using the data of MFLOP/s.