

Tools/likwid/example\_marker\_api\_stream

## Example: likwid Marker API in stream

- Tutorial Marker API with C/C++
- Add likwid marker API to `stream` source code

```
cp -av stream.OpenMP{,,"likwid"}.c
vim      stream.OpenMP,likwid.c
diff -u stream.OpenMP{,,"likwid"}.c

--- stream.OpenMP.c      2022-06-02 15:32:36.195137149 +0200
+++ stream.OpenMP,likwid.c      2022-06-03 11:06:44.695540812 +0200
@@ -62,6 +62,8 @@
     #error "OpenMP support required"
 #endif

+#include "likwid.h"
+
+/*-----
+ * INSTRUCTIONS:
+ *
@@ -320,6 +322,7 @@
 void static inline tuned_STREAM_Copy() {
     #pragma omp parallel default(none) shared(STREAM_ARRAY_SIZE_thread)
     {
+        likwid_markerStartRegion( "copy" );
         #ifdef __INTEL_COMPILER
             // Instructs the compiler to use non-temporal (that is, streaming) stores
             #pragma vector nontemporal
@@ -328,6 +331,7 @@
         for (long int j = 0; j < STREAM_ARRAY_SIZE_thread; j++) {
             c[j] = a[j];
         }
+        likwid_markerStopRegion( "copy" );
     }
 }
```

```

@@ -340,6 +344,7 @@
void static inline tuned_STREAM_Scale(const STREAM_TYPE scalar) {
    #pragma omp parallel default(none) shared(scalar, STREAM_ARRAY_SIZE_thread)
    {
+        likwid_markerStartRegion( "scale" );
        #ifdef __INTEL_COMPILER
            // Instructs the compiler to use non-temporal (that is, streaming) stores
            #pragma vector nontemporal
@@ -348,6 +353,7 @@
        for (long int j = 0; j < STREAM_ARRAY_SIZE_thread; j++) {
            b[j] = scalar * c[j];
        }
+        likwid_markerStopRegion( "scale" );
    }
}

@@ -360,6 +366,7 @@
void static inline tuned_STREAM_Add() {
    #pragma omp parallel default(none) shared(STREAM_ARRAY_SIZE_thread)
    {
+        likwid_markerStartRegion( "add" );
        #ifdef __INTEL_COMPILER
            // Instructs the compiler to use non-temporal (that is, streaming) stores
            #pragma vector nontemporal
@@ -368,6 +375,7 @@
        for (long int j = 0; j < STREAM_ARRAY_SIZE_thread; j++) {
            c[j] = a[j] + b[j];
        }
+        likwid_markerStopRegion( "add" );
    }
}

@@ -380,6 +388,7 @@
void static inline tuned_STREAM_Triad(const STREAM_TYPE scalar) {
    #pragma omp parallel default(none) shared(scalar, STREAM_ARRAY_SIZE_thread)
    {
+        likwid_markerStartRegion( "triad" );
        #ifdef __INTEL_COMPILER
            // Instructs the compiler to use non-temporal (that is, streaming) stores
            #pragma vector nontemporal
@@ -388,6 +397,7 @@
        for (long int j = 0; j < STREAM_ARRAY_SIZE_thread; j++) {
            a[j] = b[j] + scalar * c[j];
        }
+        likwid_markerStopRegion( "triad" );
    }
}

```

```

}

@@ -556,6 +566,17 @@
    // Explicitly turn off dynamic threads
    omp_set_dynamic(0);

+   // initialize likwid marker API
+   likwid_markerInit();
+   #pragma omp parallel
+   {
+       likwid_markerThreadInit();
+       likwid_markerRegisterRegion( "copy" );
+       likwid_markerRegisterRegion( "scale" );
+       likwid_markerRegisterRegion( "add" );
+       likwid_markerRegisterRegion( "triad" );
+   }
+
    // Number of Threads requested
    #pragma omp parallel default(none) shared(omp_num_threads_req)
    #pragma omp master
@@ -699,6 +720,9 @@
    times[TRIAD][NTIMES_count] = mysecond() - times[TRIAD][NTIMES_count];
}

+   // Close likwid marker API
+   likwid_markerClose();
+
    for (int j = 0; j < NUM_BENCHMARKS; j++) {
        // Sort times
        qsort(times[j], NTIMES, sizeof(double), double_compare);

```

- Prepare environment

```

module purge
module add compiler/intel/2022

```

- Build stream benchmark with likwid marker API

```

icc -std=c11 -Ofast -xHost -ipo -qopenmp \
    -DLIKWID_PERFMON \
    stream.OpenMP,likwid.c -o stream \
    -llikwid

```

- Run benchmark with 76 threads

```

# Number of threads and thread binding is handled by likwid-perfctr
unset OMP_NUM_THREADS

```

```
likwid-perfctr --marker --group MEM -C 0-75 \
./stream -n 1000000000
```

```
-----
CPU name:      Intel(R) Xeon(R) Platinum 8368 CPU @ 2.40GHz
CPU type:      Intel Icelake SP processor
CPU clock:     2.39 GHz
-----
```

```
-----
STREAM version $Revision: 5.10 $
-----
```

```
This system uses 8 bytes per array element.
-----
```

```
Array size = 999999944 (elements)
Memory per array = 7629.4 MiB (= 7.5 GiB).
Total memory required = 22888.2 MiB (= 22.4 GiB).
Each kernel will be executed 10 times.
  The *best* time for each kernel (excluding the first iteration)
  will be used to compute the reported bandwidth.
-----
```

```
OpenMP version (yyyyymm): 201611
Number of Threads requested = 76
Number of Threads counted = 76
-----
```

```
Your clock granularity appears to be 1000 ticks per microseconds.
Each test below will take on the order of 52335 microseconds.
  (= 52335268 clock ticks)
Increase the size of the arrays if this shows that
you are not getting at least 20 clock ticks per test.
-----
```

```
WARNING -- The above is only a rough guideline.
For best results, please be sure you know the
precision of your system timer.
-----
```

| Function | Best Rate MB/s | Med time | Min time | Max time |
|----------|----------------|----------|----------|----------|
| Copy:    | 315179.0       | 0.050808 | 0.050765 | 0.052163 |
| Scale:   | 313017.1       | 0.051187 | 0.051115 | 0.052063 |
| Add:     | 319321.8       | 0.075316 | 0.075159 | 0.077444 |
| Triad:   | 318246.4       | 0.075510 | 0.075413 | 0.076306 |

```
-----
Solution Validates: avg error less than 1.000000e-13 on all three arrays
-----
```

```
Region copy, Group 1: MEM
```

```
...
```

```
+-----+-----+-----+-----+
```

| Metric                                 | Sum         | Min       | Max         | A    |
|--|-------------|-----------|-------------|------|
| Runtime (RDTSC) [s] STAT               | 41.8482     | 0.5382    | 0.5564      | 0    |
| Runtime unhalted [s] STAT              | 55.4945     | 0.7139    | 0.7373      | 0    |
| Clock [MHz] STAT                       | 242600.9243 | 3190.8415 | 3192.4624   | 3192 |
| CPI STAT                               | 734.1395    | 9.4443    | 9.7546      | 9    |
| Memory read bandwidth [MBytes/s] STAT  | 161530.0713 | 0         | 80918.6365  | 2125 |
| Memory read data volume [GBytes] STAT  | 88.6124     | 0         | 44.3561     | 1    |
| Memory write bandwidth [MBytes/s] STAT | 159778.0010 | 0         | 80092.7669  | 2102 |
| Memory write data volume [GBytes] STAT | 87.6511     | 0         | 43.8465     | 1    |
| Memory bandwidth [MBytes/s] STAT       | 321308.0723 | 0         | 161011.4034 | 4227 |
| Memory data volume [GBytes] STAT       | 176.2634    | 0         | 88.2026     | 2    |

Region scale, Group 1: MEM

...

| Metric                                 | Sum         | Min       | Max         | A    |
|--|-------------|-----------|-------------|------|
| Runtime (RDTSC) [s] STAT               | 41.8878     | 0.5363    | 0.5592      | 0    |
| Runtime unhalted [s] STAT              | 53.8308     | 0.6896    | 0.7182      | 0    |
| Clock [MHz] STAT                       | 235089.3170 | 3093.0067 | 3097.8999   | 3093 |
| CPI STAT                               | 712.1258    | 9.1233    | 9.5014      | 9    |
| Memory read bandwidth [MBytes/s] STAT  | 160693.0404 | 0         | 80400.3782  | 2114 |
| Memory read data volume [GBytes] STAT  | 89.1143     | 0         | 44.6628     | 1    |
| Memory write bandwidth [MBytes/s] STAT | 158364.8350 | 0         | 79465.7938  | 2083 |
| Memory write data volume [GBytes] STAT | 87.8224     | 0         | 43.9348     | 1    |
| Memory bandwidth [MBytes/s] STAT       | 319057.8753 | 0         | 159866.1719 | 4198 |
| Memory data volume [GBytes] STAT       | 176.9365    | 0         | 88.5503     | 2    |

Region add, Group 1: MEM

...

| Metric                                 | Sum         | Min       | Max         | A    |
|--|-------------|-----------|-------------|------|
| Runtime (RDTSC) [s] STAT               | 62.0432     | 0.8066    | 0.8242      | 0    |
| Runtime unhalted [s] STAT              | 81.1006     | 1.0548    | 1.0785      | 1    |
| Clock [MHz] STAT                       | 239109.9365 | 3140.5410 | 3150.6727   | 3146 |
| CPI STAT                               | 894.1243    | 11.6297   | 11.8899     | 11   |
| Memory read bandwidth [MBytes/s] STAT  | 215032.0937 | 0         | 107714.6641 | 2829 |
| Memory read data volume [GBytes] STAT  | 176.1806    | 0         | 88.2026     | 2    |
| Memory write bandwidth [MBytes/s] STAT | 107543.0152 | 0         | 53933.9665  | 1415 |
| Memory write data volume [GBytes] STAT | 88.1121     | 0         | 44.0605     | 1    |
| Memory bandwidth [MBytes/s] STAT       | 322575.1088 | 0         | 161648.6306 | 4244 |
| Memory data volume [GBytes] STAT       | 264.2928    | 0         | 132.2631    | 3    |

|                                 |  |  |             |  |           |  |             |  |      |
|---------------------------------|--|--|-------------|--|-----------|--|-------------|--|------|
| +-----+-----+-----+-----+-----+ |  |  |             |  |           |  |             |  |      |
| Region triad, Group 1: MEM      |  |  |             |  |           |  |             |  |      |
| ...                             |  |  |             |  |           |  |             |  |      |
| +-----+-----+-----+-----+-----+ |  |  |             |  |           |  |             |  |      |
|                                 | Metric                                 |  | Sum         |  | Min       |  | Max         |  | A    |
| +-----+-----+-----+-----+-----+ |  |  |             |  |           |  |             |  |      |
|                                 | Runtime (RDTSC) [s] STAT               |  | 62.0811     |  | 0.8065    |  | 0.8268      |  | 0    |
|                                 | Runtime unhalted [s] STAT              |  | 81.1337     |  | 1.0546    |  | 1.0801      |  | 1    |
|                                 | Clock [MHz] STAT                       |  | 239105.4407 |  | 3139.8575 |  | 3151.7754   |  | 3146 |
|                                 | CPI STAT                               |  | 894.4848    |  | 11.6269   |  | 11.9085     |  | 11   |
|                                 | Memory read bandwidth [MBytes/s] STAT  |  | 214584.7874 |  | 0         |  | 107525.1345 |  | 2823 |
|                                 | Memory read data volume [GBytes] STAT  |  | 176.3537    |  | 0         |  | 88.2335     |  | 2    |
|                                 | Memory write bandwidth [MBytes/s] STAT |  | 107024.2402 |  | 0         |  | 53675.3900  |  | 1408 |
|                                 | Memory write data volume [GBytes] STAT |  | 87.9563     |  | 0         |  | 43.9887     |  | 1    |
|                                 | Memory bandwidth [MBytes/s] STAT       |  | 321609.0276 |  | 0         |  | 161200.5245 |  | 4231 |
|                                 | Memory data volume [GBytes] STAT       |  | 264.3099    |  | 0         |  | 132.2010    |  | 3    |
| +-----+-----+-----+-----+-----+ |  |  |             |  |           |  |             |  |      |

|       | Memory read data volume | Memory write data volume | Factor | # Load Ops. | # Store Ops. | Fa |
|-------|-------------------------|--------------------------|--------|-------------|--------------|----|
| copy  | 88.6                    | 87.6                     | 1.01   | 1           | 1            |    |
| scale | 89.1                    | 87.8                     | 1.01   | 1           | 1            |    |
| add   | 176.2                   | 88.1                     | 2.00   | 2           | 1            |    |
| triad | 176.3                   | 88.0                     | 2.00   | 2           | 1            |    |