GCC support to compile OpenMP 4 target constructs for Heterogeneous System Architecture

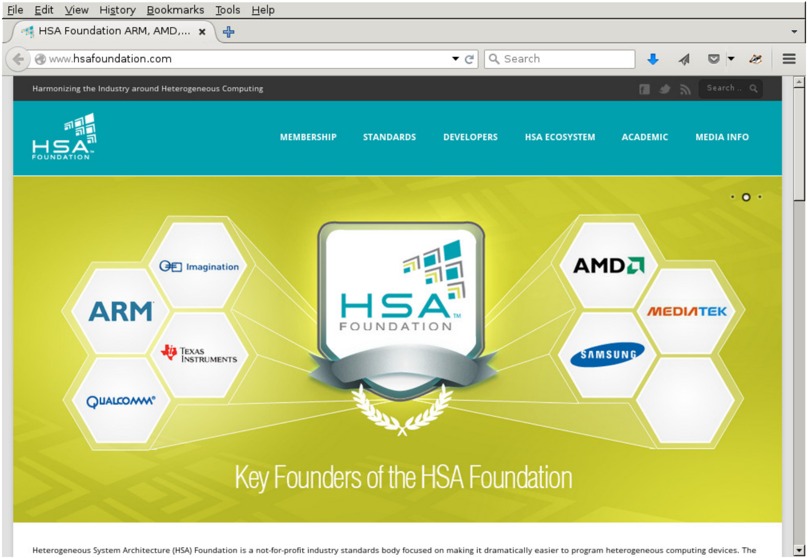
Martin Jambor

SUSE Labs

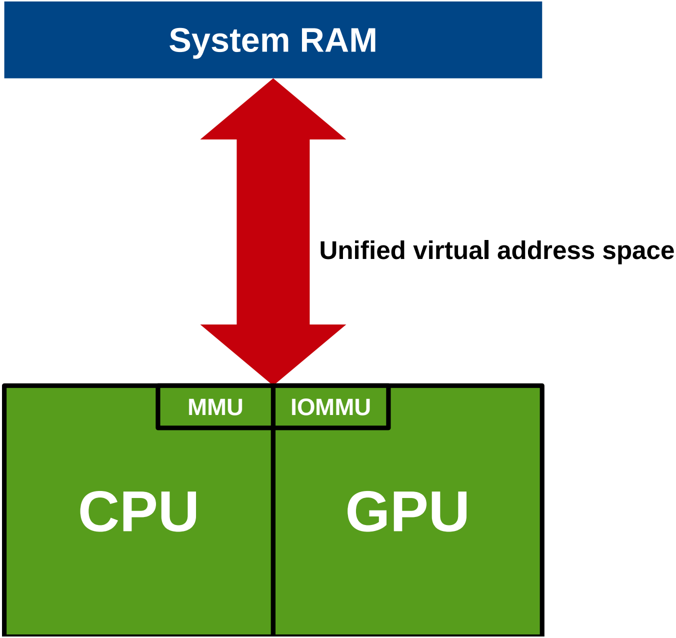
29th September 2015

Heterogeneous world

Heterogeneous Systems Architecture



Unified view of memory in HSA



HSA Intermediate Language (HSAIL)

```
prog kernel &__vector_copy_kernel(
        kernarg_u64 %a,
        kernarg_u64 %b)
{
        workitemabsid_u32 $s0, 0;
        cvt_s64_s32 $d0, $s0;
        shl_u64 $d0, $d0, 2;
        ld_kernarg_align(8)_width(all)_u64 $d1, [%b];
        add_u64 $d1, $d1, $d0;
        ld_kernarg_align(8)_width(all)_u64 $d2, [%a];
        add_u64 $d0, $d2, $d0;
        ld_global_u32 $s0, [$d0];
        st_global_u32 $s0, [$d1];
        ret;
};
```

HSAIL is explicitly parallel

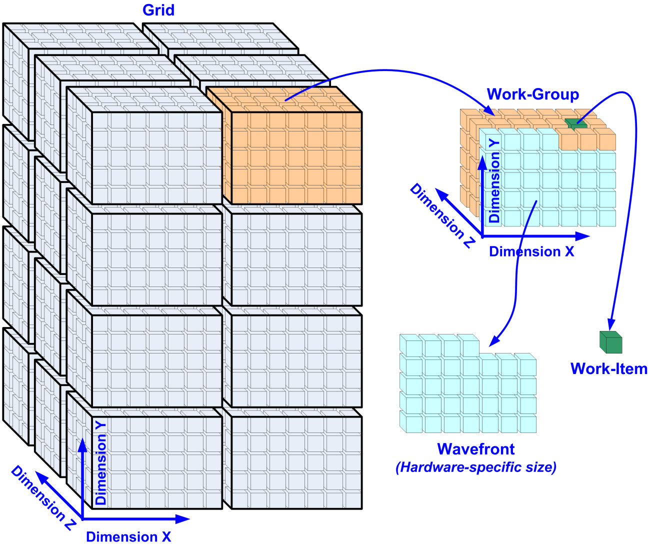


Image from www.hsafoundation.com

Getting the compiler and run time

HSA branch:

- *svn://gcc.gnu.org/svn/gcc/branches/hsa*
  (also available on the git mirror)

HSA run-time from AMD:

- *https://github.com/HSAFoundation/HSA-Runtime-AMD*

HSA kernel, firmware, KFDlib from AMD:

- *https://github.com/HSAFoundation/HSA-Drivers-Linux-AMD*

openSUSE Tumbleweed HSA kernel (at the moment):

- *https://build.opensuse.org/package/show/home:marxin:carrizo/kernel-default*

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- Compile with -fopenmp
- set `Set LD_LIBRARY_PATH` when running the compiled program
- Unlike support for other accelerators, you only need one compiler.

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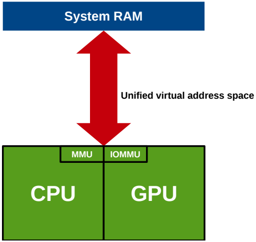

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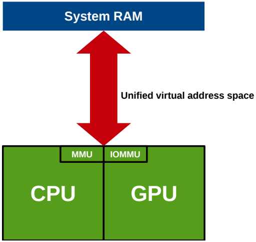

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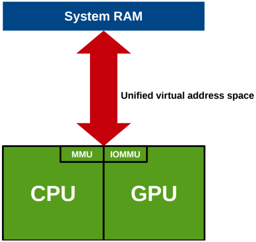

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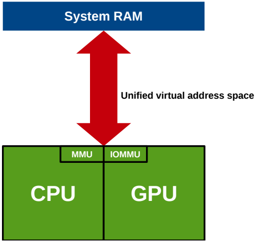


The run-time decides whether (and to which device) offload.

Offloading simple OMP parallel loops

```
/* Copy:*/
#pragma omp target
#pragma omp parallel for private(j)
   for (j=0; j<STREAM_ARRAY_SIZE; j++)
      c[j] = a[j];
```

The rest of the Stream benchmark loops

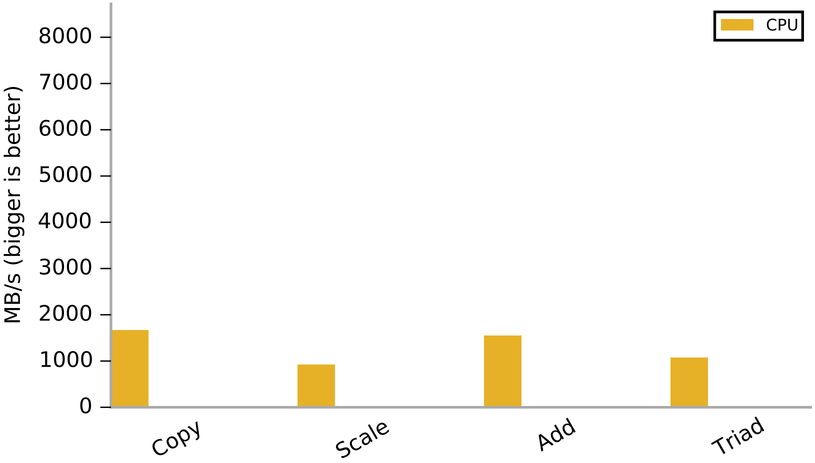
```
/* Scale: */
#pragma omp target
#pragma omp parallel for private(j)
   for (j=0; j<STREAM_ARRAY_SIZE; j++)
      b[j] = scalar *c[j];

/* Add: */
#pragma omp target
#pragma omp parallel for private(j)
   for (j=0; j<STREAM_ARRAY_SIZE; j++)
      c[j] = a[j]+b[j];

/* Triad: */
#pragma omp target
#pragma omp parallel for private(j)
   for (j=0; j<STREAM_ARRAY_SIZE; j++)
      a[j] = b[j]+scalar*c[j];
```

Stream benchmark performance (1)

Stream benchmark results for 64kB arrays (16k of floats) on a Carrizo APU:



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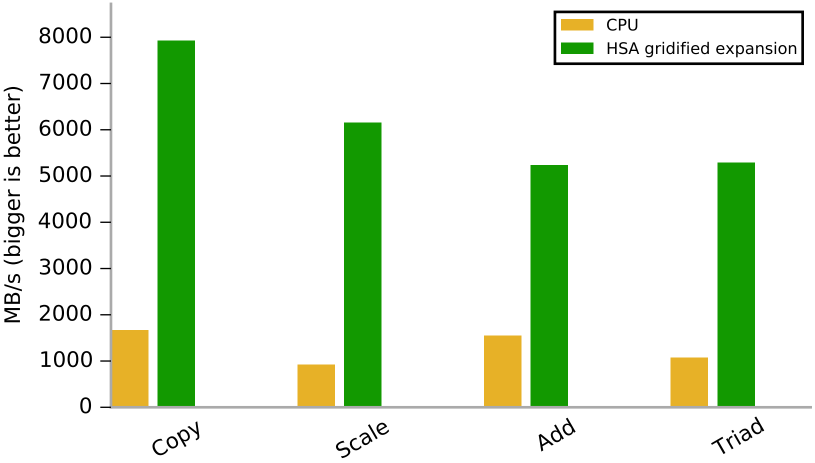

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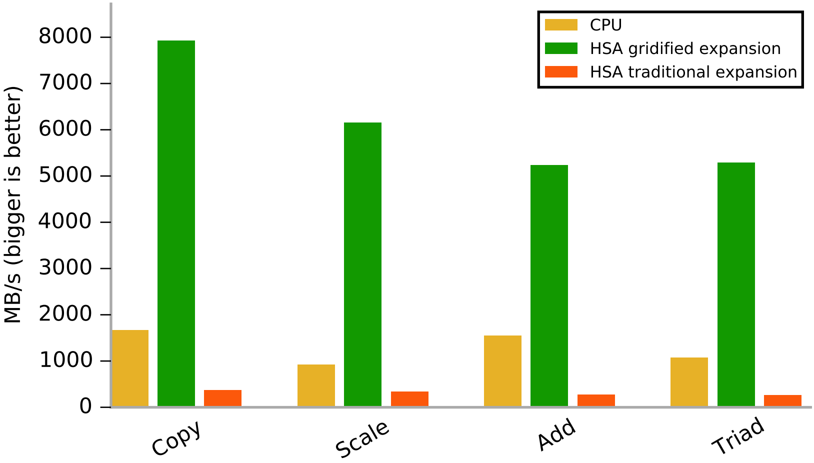
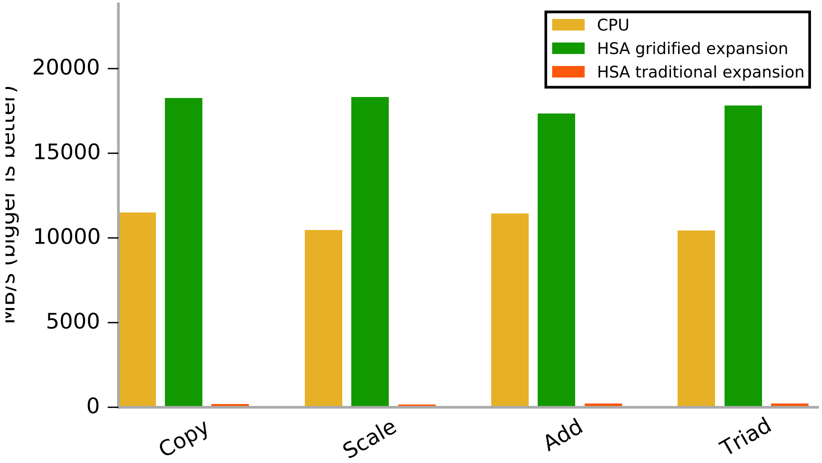


Stream benchmark performance (2)

Stream benchmark results for 128MB arrays (32M of floats) on a Carrizo APU:



Gridification

- Different way of thinking

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  - Perfect construct nesting required (at IL level, this will have to be relaxed somewhat)
  - Mechanism of notes to provide feedback to the programmer

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- Reductions through atomics almost done, we plan to support collapse(2) and collapse(3)

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…any questions?