Large Scale Debugging

Project Meeting Report - December 2016

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The GPUOpen Initiative

GPUOpen

An initiative launched in 2015 by AMD to provide an open-source software stack to interact with graphic cards for professional use and personnal use.

Heterogeneous System Architecture (HSA) Foundation

- Provide a standardized interface for programmer
- Multiple instruction sets
- Radeon Open Compute is an implementation by AMD

AMD HSA Modification

Improvements were made on AMD's gdb version for HSA debugging.

Modifications to amd-gdb

- Usage of breakpoints instead of signals
- Outputting hsa information in machine interface format
- New command to add hsa specific breakpoint

Python interface in GDB

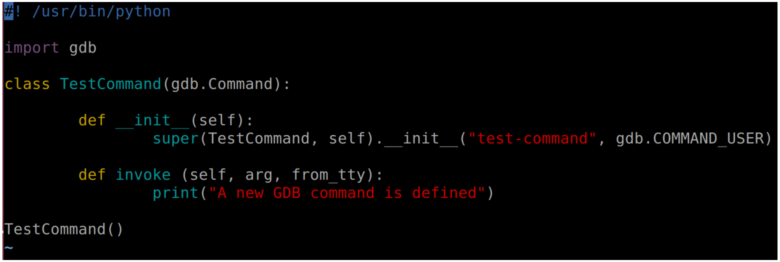
GDB allows users to easily modify its behaviour and implement new functionalities in python.

Partial feature list

- API for threads, breakpoints, inferiors, etc.
- Handling various events raised by GDB
- Customized printing
- Implementing new commands

Implementing new commands

It can be done by extending GDB Command class :



```
#! /usr/bin/python

import gdb

class TestCommand(gdb.Command):

        def __init__(self):
                super(TestCommand, self).__init__("test-command", gdb.COMMAND_USER)

        def invoke (self, arg, from_tty):
                print("A new GDB command is defined")

TestCommand()
~
```

However, this does not integrate well with an IDE

Machine Interface Commands

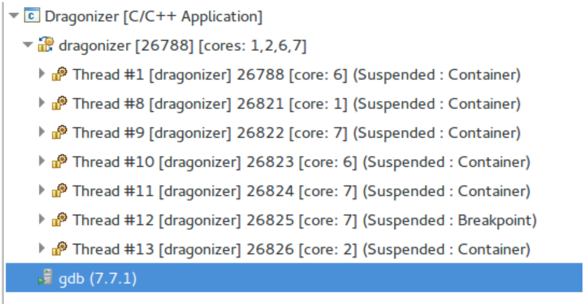
A new python module for GDB, MICommand, has been created. It facilitates interfacing python command with an IDE.

- Recognized as standard MI commands
- Uses standard Machine Interface syntax
- Access to the Python API already in place

Debug View

Standard Debug View

The debug view is the tree view to show and select the various processes, threads and stack.

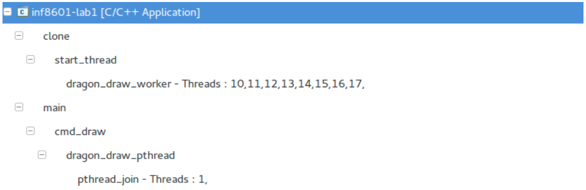


```
▼ Dragonizer [C/C++ Application]
  ▼ dragonizer [26788] [cores: 1,2,6,7]
    ▶ Thread #1 [dragonizer] 26788 [core: 6] (Suspended : Container)
    ▶ Thread #8 [dragonizer] 26821 [core: 1] (Suspended : Container)
    ▶ Thread #9 [dragonizer] 26822 [core: 7] (Suspended : Container)
    ▶ Thread #10 [dragonizer] 26823 [core: 6] (Suspended : Container)
    ▶ Thread #11 [dragonizer] 26824 [core: 7] (Suspended : Container)
    ▶ Thread #12 [dragonizer] 26825 [core: 7] (Suspended : Breakpoint)
    ▶ Thread #13 [dragonizer] 26826 [core: 2] (Suspended : Container)
    gdb (7.7.1)
```

Stack Aggregation View

Proposed view

This debug view merge the call stack of each thread to display useful information when there is a large number of threads.



```
inf8601-lab1 [C/C++ Application]
  clone
    start_thread
      dragon_draw_worker - Threads : 10,11,12,13,14,15,16,17,
  main
    cmd_draw
      dragon_draw_pthread
        pthread_join - Threads : 1,
```

Integrating HSA to the debug view

Waves

The wave concept can be related to a thread : each wave has a program counter and executes the same instructions on a data group, which is similar to a CPU thread using vector instructions.

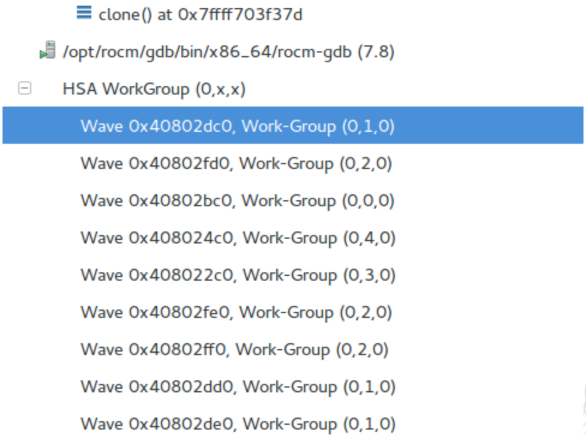
Challenge

A single GPU can support an enormous amount of waves executing at the same time. The AMD R9 Nano used for the test can support up to a maximum of 2560 waves.

Debug View

Adapted debug view

First iteration of the HSA debug view : grouping by work-group.



```
clone() at 0x7ffff703f37d
/opt/rocm/gdb/bin/x86_64/rocm-gdb (7.8)
HSA WorkGroup (0,x,x)
  Wave 0x40802dc0, Work-Group (0,1,0)
  Wave 0x40802fd0, Work-Group (0,2,0)
  Wave 0x40802bc0, Work-Group (0,0,0)
  Wave 0x408024c0, Work-Group (0,4,0)
  Wave 0x408022c0, Work-Group (0,3,0)
  Wave 0x40802fe0, Work-Group (0,2,0)
  Wave 0x40802ff0, Work-Group (0,2,0)
  Wave 0x40802dd0, Work-Group (0,1,0)
  Wave 0x40802de0, Work-Group (0,1,0)
```

GPU Visualizer

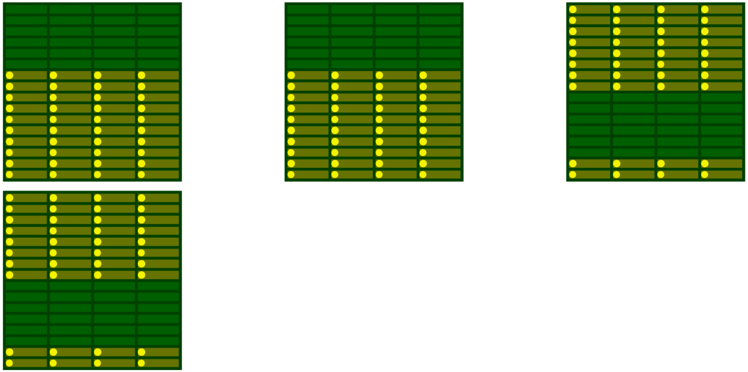
Visualizer

Apdaptation of the multicore visualizer available in Eclipse CDT to display GPU structure and waves.

Java FX

The visualizer has been modified to use the new version of the Graphical Eclipse Framework based on Java FX.

GPU Visualizer



Future Work

- Optimize the various views
- Integrate the HSA views together
- Add a focus (Work-group, compute-unit, etc) to HSA debugging
- Submit work to GDB, CDT

Any Questions ?

Contact

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