DDT Training
at Keeneland

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- Introduction to Allinea and DDT

- Getting started with DDT on Keeneland

- A worked example

- Getting help

SCALE TO NEW HEIGHTS

- Software tools company since 2001
  - Allinea DDT – the scalable parallel debugger
  - Allinea OPT – the optimization tool for MPI and non-MPI

  - Users at all scales – at 1 to 100,000 cores and above
  - World's only Petascale debugger!

Simplifying the challenge of multi- and many-core development
  - *Bugs at **scale** need a debugger at **scale***
    - … until recently debuggers limited to ~4,000-8,000 cores
  - Bugs **on GPUs** need a debugger **for GPUs**
    - … until recently GPU software couldn't be debugged

AMD — The future is fusion

intel

NVIDIA.

acer

BULL

CRAY — THE SUPERCOMPUTER COMPANY

FUJITSU

hp invent

IBM

NEC

sgi

Aviation and Defence
NORTHROP GRUMMAN · AIRBUS · EADS · BAE SYSTEMS · NLR · Cenaero · DASSAULT SYSTEMES · DLR

Climate and Weather
Met Office · NOAA · IRM · METEO FRANCE · ESO · Australian Government Bureau of Meteorology · Ifremer

Energy
TOTAL · ifp Innovation Energie Environnement · ffA · CGGVeritas · PGS

Electronic Design Automation
KONICA MINOLTA · cadence · SYNOPSYS · intel

Academic
Over 200 universities

SCALE TO NEW HEIGHTS

OAK RIDGE National Laboratory — Partnership to develop Petascale debugger with NVIDIA support

University of California **Lawrence Livermore National Laboratory** — Partnership to develop Petascale/ Exascale tools and standards

Argonne NATIONAL LABORATORY — Partnership on Full Scale debugging on IBM Blue Gene /P & /Q

NERSC NATIONAL ENERGY RESEARCH SCIENTIFIC COMPUTING CENTER — **Allinea DDT** is "*Debugger of Choice*" on NERSC 5 and NERSC 6 and first implementation on CRAY XE6

cea — Partnership with CEA French Atomic Energy Authority on scalable programming and CUDA

NSF — Partnership on Keeneland project to help solving software challenges introduced by mixed architectures

- Set breakpoints
  - Automatically stop on kernel launch
  - Stop at a line of CUDA code
  - Hover the mouse for more information
- Step a warp
  - Follow the logic of individual threads through the kernel
- ... or just run through to a crash
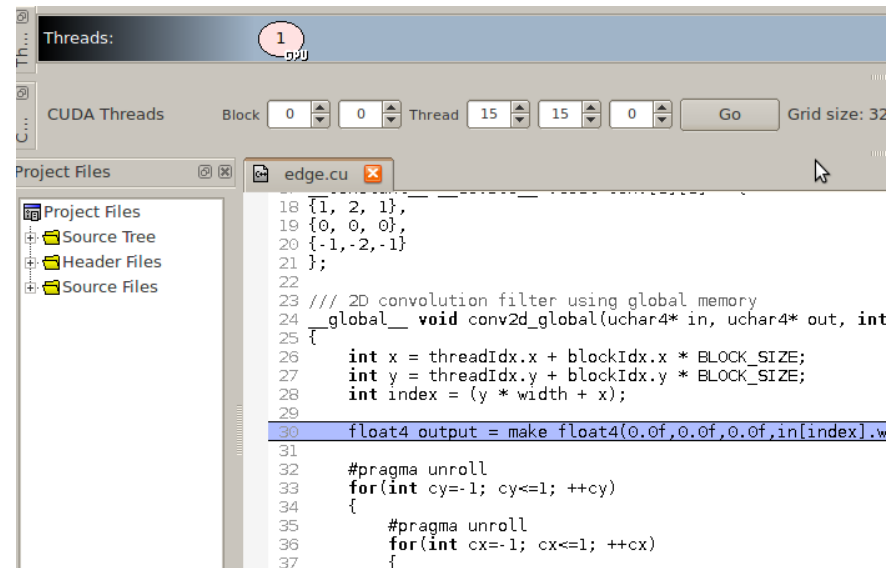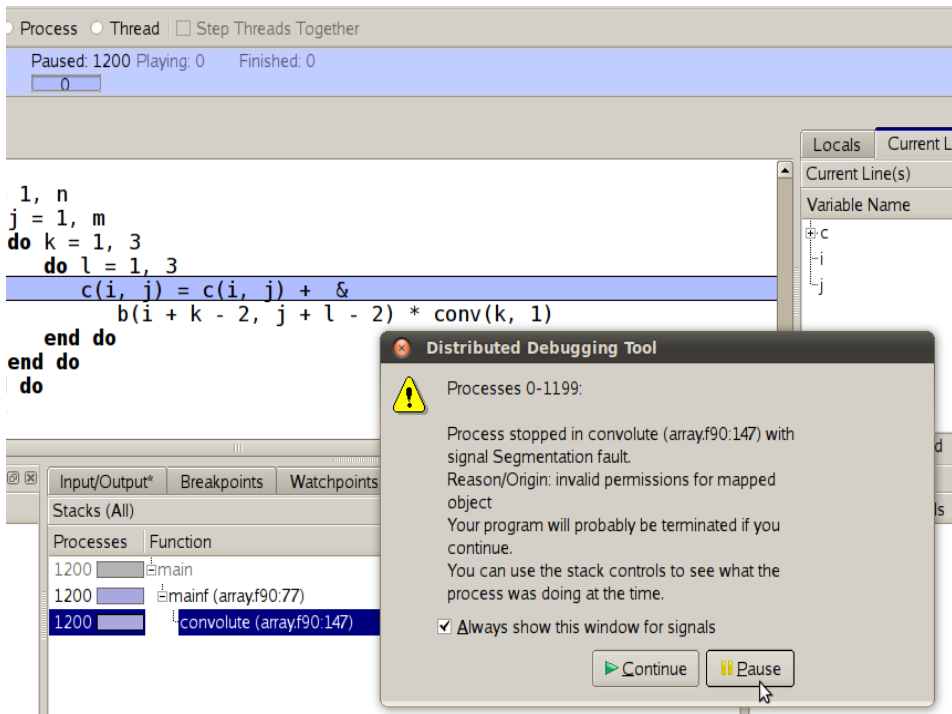
- Immediate stop on crash
  - Segmentation fault, or other memory problems
  - Abort, exit, error handlers
  - CUDA errors
- Scalable handling of error messages
- Leaps to the problem
  - Source code highlighted
  - Affected processes shown
 - Process stacks displayed clearly in parallel

- View all threads in parallel stack view

  - At one glance, see all GPU and CPU threads together

  - Links with thread selection

  - Pick a tree node to select one of the CUDA threads at that location

- Full MPI support

  - See GPU and CPU threads from multiple nodes
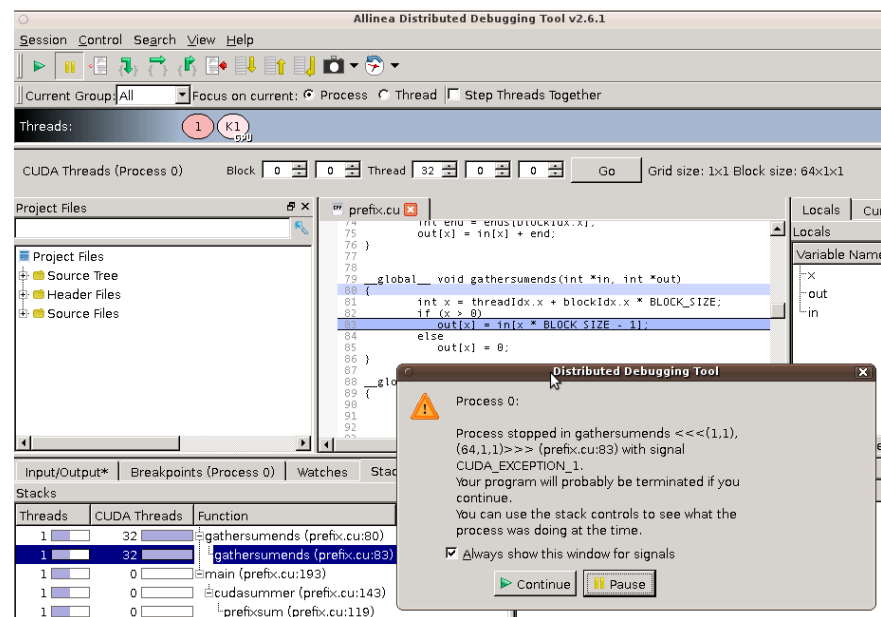
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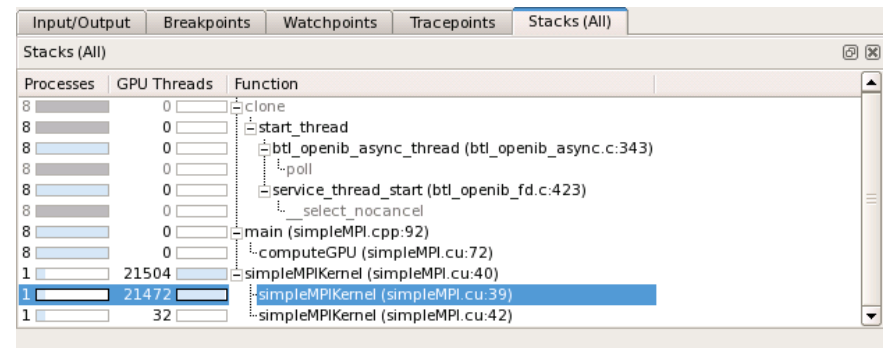
- Full data browsing
  - Local and current line(s) variables
    - Show variables relevant to current position
    - Drag in the source code for more
    - C, C++, F90
    - Shows memory type for CUDA
      - register, shared, ...

- Smart Highlighting
  - Scalable and fast automatic comparison and change detection
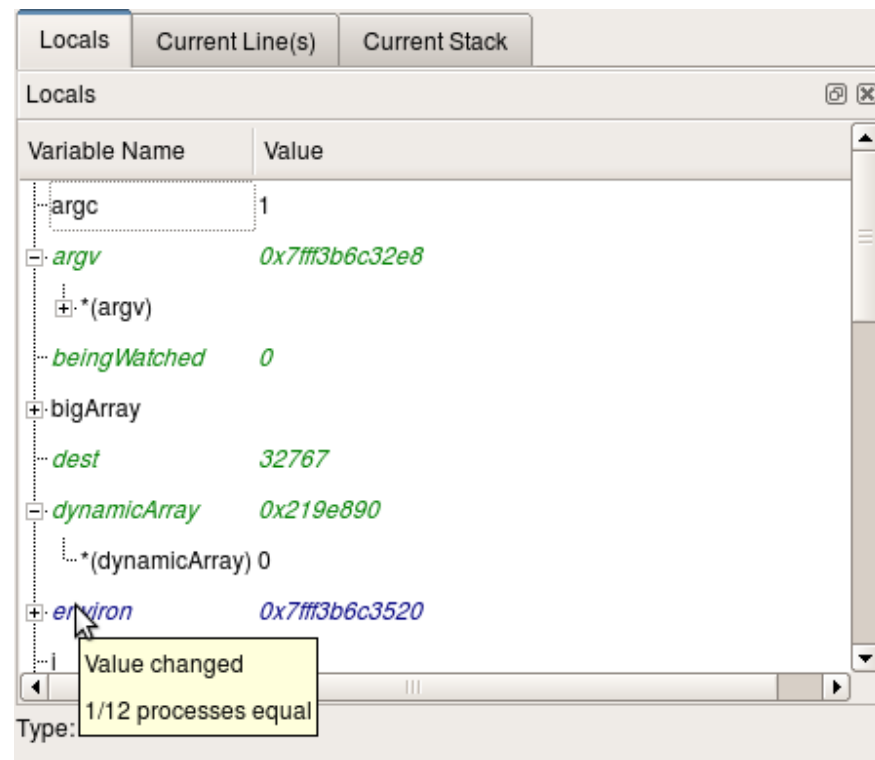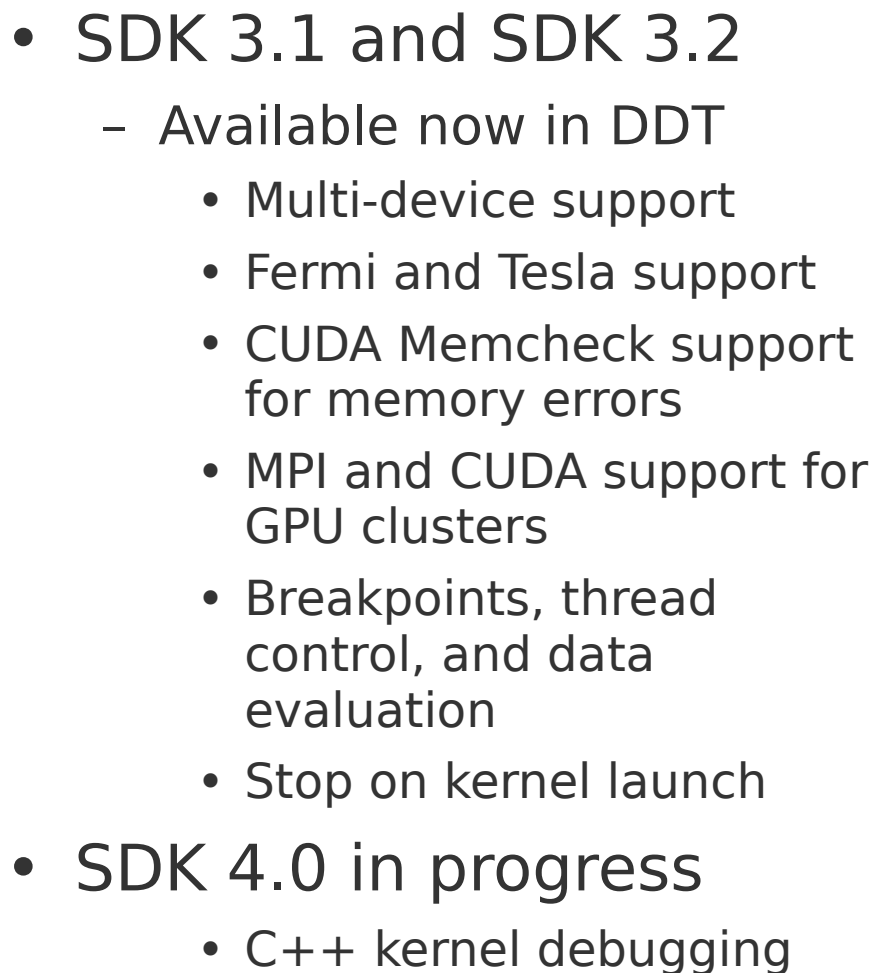
- Grid/block size problems
  - Incorrect dimensions lead to incomplete results

- Easy to see with DDT
  - Use the multi-dimensional array viewer to look at data and find the rough edges
  - 3D display and filtering support
  - **New:** displays data from multiple processes
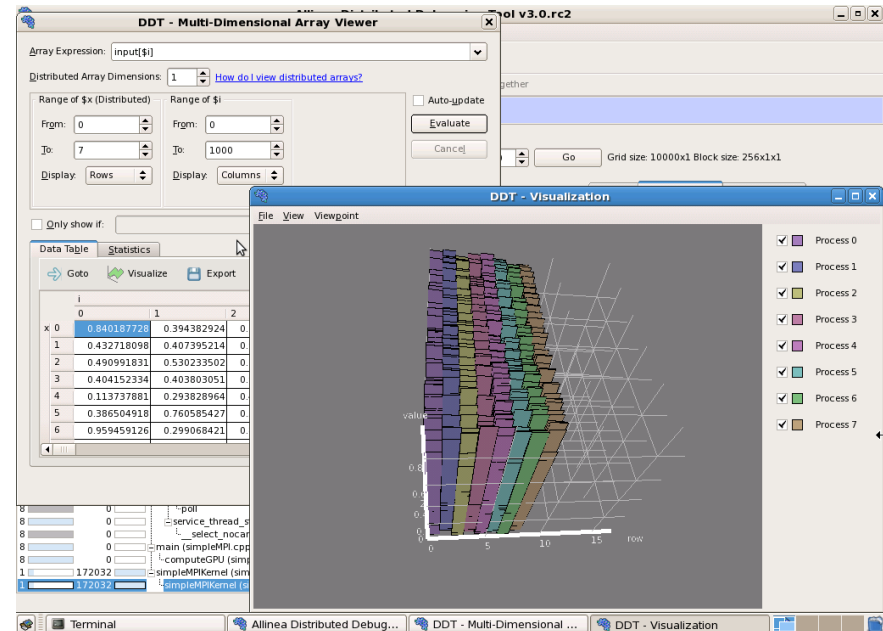
- Grid/block size problems
  - Sometimes lead to worse consequences: over-writing good values, or crashing

  - Bugs will often trigger "CUDA memcheck" errors
  - A mode of execution similar to DDT's beyond bound checks for CPU programming

SCALE TO NEW HEIGHTS

Latest DDT CUDA news

- SDK 3.1 and SDK 3.2
  - Available now in DDT
    - Multi-device support
    - Fermi and Tesla support
    - CUDA Memcheck support for memory errors
    - MPI and CUDA support for GPU clusters
    - Breakpoints, thread control, and data evaluation
    - Stop on kernel launch
- SDK 4.0 in progress
    - C++ kernel debugging

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- DDT 2.6.1 is installed and is default
  - To add DDT to your session:
    ```
    %  module load ddt
    ```
  - Presently requires CUDA 3.2
    ```
    %  module load cuda/3.2
    ```

- Recompile your application to support debugging
  - More than ordinary "-g" - requires "-G" as well
    ```
    %  nvcc –g –G prog.cu –o prog
    ```

  - Make copy of the sample and build it
    ```
    %  cp ~dlecomber/prefix.cu ~
    %  nvcc –G –g prefix.cu –o prefix
    ```
  - MPI applications supported too – but not today's session
    - "Just" add "-G -g" to the nvcc usages
    - ~dlecomber/SimpleMPI/src/SimpleMPI has a Makefile that works – feel free to use it later!

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- Now to start debugging
  - Load DDT:

    `%   ddt`

  - Choose "Run and Debug"
  - Select "prefix" using the file browser
  - The prefix example is not MPI – but it is CUDA
    - Tick "Run without MPI support"
    - Untick "Run without CUDA support"
  - Click "Submit"
  - **NOTE** – DDT submits your job to the queue – including for scalar jobs on Keeneland – by default

  - …. and now for the real debugging!

- Today's example is available on our website
  - http://www.allinea.com/ - Downloads/Whitepapers

- Tutorial material covers other topics
  - Good exercises for learning more about debugging MPI and what DDT can do
    - Memory debugging
    - Multi-dimensional arrays
    - Tips and tricks for getting the most out of the debugger
  - Fully worked through examples – with additional exercises
    - Located at: `~dlecomber/Training` on Keeneland system

- … Allinea is here to help
  - support@allinea.com is ready for you!