Coupling DDT and Marmot for Debugging of MPI Applications

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Outline

• Motivation
• Introduction to DDT and Marmot
• Coupling DDT and Marmot
• Conclusions
Motivation

- Parallel programming is complex and error-prone
- Couple stand-alone tools to cover different levels of debugging and correctness checking of MPI applications
- Need for a user-friendly environment

Introduction to DDT and Marmot
DDT – Distributed Debugging Tool

- Source-level debugger for scalar, multi-threaded and large-scale parallel C, C++ and Fortran codes
- Support for all MPIs
- Easy-to-use graphical interface
- www.allinea.com

What is Marmot?
History of Marmot

Now – what Marmot REALLY is

- Tool for the development of MPI applications
- Automatic correctness checking at runtime:
  - Detect incorrect use of MPI
  - Detect non-portable constructs
  - Detect possible race conditions and deadlocks
- No source code modification, just relinking and run with 1 additional process
- Different output formats (txt, html, xml)
- C and Fortran binding of MPI -1.2 is supported, also C++ and mixed C/Fortran code
- Development is still ongoing (not every possible functionality is implemented yet...)
- Tool makes use of the so-called profiling interface
output html

export MARMOT_LOGFILE_TYPE=1

output cube

export MARMOT_LOGFILE_TYPE=2
Marmot

- Portable tool, tested on many platforms (ia32/ia64, Opteron/Xeon, IBM, SX6, SX8,...)
  - Different compilers (Intel, GNU, NEC,...)
  - Different MPIs (mpich, Open MPI, Lam-MPI, NEC MPI, intel MPI, Voltaire MPI,...)
- Marmot works basically anywhere, main challenges:
  - Guess all configure options right
    - not possible to find everything automatically, e.g. --with-mpi-dir=... etc.
  - Link examples correctly
- www.hlrs.de/organization/amt/services/tools/debugger/marmot

Design of MARMOT (1)
Simple example – with DDT, without Marmot
Design of MARMOT (2)

Client (Application)

```c
MPI_Init{
  PMPI_Init();
  initComm;
  MapResources;
...
}
...
MPI_Recv{
  doSomeChecks;
  PMPI_Recv;
}
```

Debug Server

```c
MPI_Init{
  PMPI_Init();
  initComm;
  MapResources;
...
}
	//don’t leave MPI_Init
DebugServerCode;

tLogging;
...
}
```

Integration with DDT

- Marmot’s special MPI_Init (last process):
  ```c
  export DDT_MPI_Init=PMPI_Init
  ```
- Compile everything with `–g` (including marmot code)
Simple example – with DDT & Marmot (scary, isn’t it)

Design of MARMOT (3)

Client (Application)

```c
MPI_Init(
    PMPI_Init();
    initComm;
    MapResources;
    ...
}
...
MPI_Recv{
    doSomeChecks;
    PMPI_Recv;
}
...
```

Debug Server

```c
MPI_Init{
    PMPI_Init();
    initComm;
    MapResources;
    ...
} //don’t leave MPI_Init
    DebugServerCode;
    logging;
    if (error)
        insertBreakpointError;
    if (warning)
        insertBreakpointWarning;
    ...
```
DDT & Marmot

- Insert breakpoint calls in our debug server (highest rank) when error/warning is detected (mpo-breakpoints.cc ~ 30 lines of code)
- Just compile Marmot’s mpo-breakpoints.cc source file with `-g`
- Display Marmot warnings (stderr/variables windows, further ideas)

Simple example – with DDT & Marmot (breakpoints)
Simple example – with DDT & Marmot (warning detected)
Simple example – with DDT & Marmot (error display)

Conclusions and Future Work

• DDT & Marmot – it works!
• It’s not rocket science... but takes some considerations, e.g.
  - how to handle this last Marmot process (hide it completely eventually? DDT to add breakpoints automatically)
  - how to handle error dialogues? Add information? Message queues?
  - adapt Marmot’s build process (shared libraries) to be able to switch Marmot on/off through DDT GUI ($LD_PRELOAD$)
Conclusions and Future Work

• Tested with simple examples on various platforms
  – Tests with real applications to be performed
  – Shared lib approach tested on few platforms

Conclusions and Future Work

• Marmot is alive and kickin’
• It’s under active development by HLRS and ZIH
• Also within the ParMA project – Parallel Programming for Multi-core Architectures
  www.parma-itea2.org
  (collaboration with Vampir, Kojak, DDT, OPT,...)
Thanks for your attention