An Introduction to Balder – An OpenMP Run-time Library for Clusters of SMPs

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Motivation

- When compiling and executing OpenMP applications you normally need both a compiler and a run-time library
  - The run-time might be hidden
- Researchers have worked on run-time issues
  - No portable open source alternative for OpenMP 2.0
  - Researchers have been forced to roll their own
- Balder provides an alternative
  - Complements the OdinMP compiler with an open source run-time library
  - BSDish license
  - No “GPL virus” behavior

Contributions

- Balder, a portable OpenMP run-time library
  - Description of the library
  - Source code available
  - Support web-site in place
  - (Supports clusters)
- Performance evaluation

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Outline

- Overview
- Balder
  - History
- Cluster support
- Experiments
- Future work
- Summary and announcements

I won't go into details but will assume (basic) OpenMP knowledge

Do ask questions! Please, do interrupt me!

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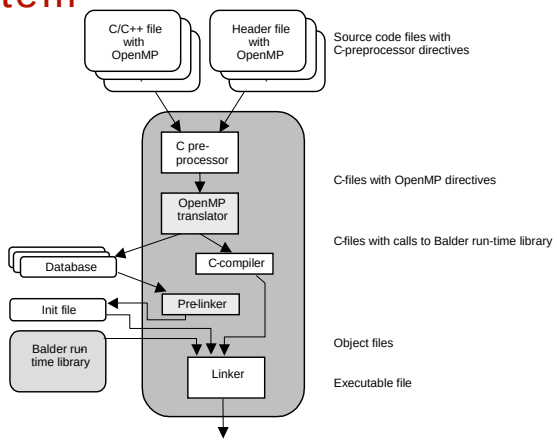
Overview of the compilation system



- OdinMP is an open source OpenMP source-to-source compiler for C and C++
  - Can inject instrumentation probes for POMP etc.

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What can Balder do?

- Provide support for the compiler
- Supports OpenMP 2.0
  - Supports nested parallelism
  - Probably also OpenMP 2.5
- (Also supports clusters)
  - However without nested parallelism at this point
- Multiple targets
  - Designed for portability
  - Linux on ia32 is considered stable
  - Commercial interest e.g., ARM Ltd
- Released under a BSDish license
  - www.odinmp.com
  - V1.0.2 is released!

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History

- Project began in 1998
  - Balder 1998
  - OdinMP 1999 (1998)
- Several compiler projects at first
  - OdinMP one of them
  - OdinMP/CCp another
    - Test run
    - Presented at EWOMP'99
    - OdinMP != OdinMP/CCp
- The Intone project 2000-2003
- First public OdinMP release in early 2002
- Source code some months later
- www.odinmp.com in late 2002
- Balder release May 2005

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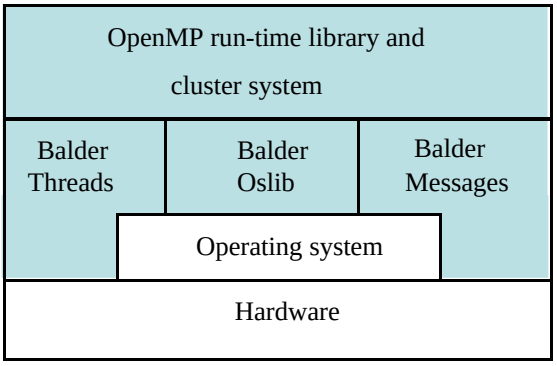
Balder overview



- Modulization for portability

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Cluster support

- Support for constructs implemented with message passing
  - Optimized SMP version
  - Cluster version
- The solutions used are the most portable
  - Tried hard not to sacrifice performance
- On clusters a shared address space is provided
  - A custom software distributed shared memory system is used
  - Very OpenMP specific
- Some standard library functions are replaced e.g., malloc and free

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Cluster compiler support

- Cluster support available in the OdinMP compiler
  - Global variables are allocated in the shared address space etc.
- Stack variables can be shared
  - Need system wide shared stacks
  - Compiler support

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Shared stack


```
f()
{
 int a;

 a=1;


}
```

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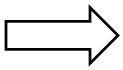
Shared stack


```
f()
{
 int a;

 a=1;


}
```



```
f()
{
 allocate stack frame;

 stack_frame->a=1;

 free stack frame;
}
```

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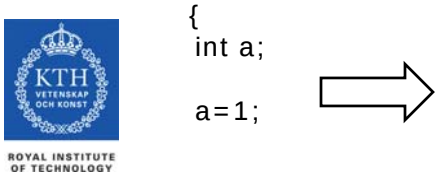
Shared stack



```
f()                          f()
{                            {
 int a;                       allocate stack frame;

 a=1;                         stack_frame->a=1;

                              free stack frame;
}                            }
```

- OdinMP can generate the necessary code

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Experimental setup

- Dual P-III 1 GHz
  Linux 2.4.25
- EPCC micro-benchmarks for OpenMP 1.0
  OdinMP 0.284.1
  Balder 1.0.1
  GCC 3.4.4
- Intel C/C++ compiler v. 8.0

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Results

OpenMP Construct	Intel compiler	Balder with OdinMP
Parallel construct	1.43 +/- 0.11	2.91 +/- 0.15
For construct	0.79 +/- 0.17	2.93 +/- 0.30
Barrier construct	0.48 +/- 0.19	0.49 +/- 0.12
Lock and unlock primitives	0.48 +/- 0.33	0.47 +/- 0.12

- All values in microseconds and with a 95% confidence interval
- In a previous study it was shown that differences these small will normally not degrade performance of applications
- Cluster performance looks very promising

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Future work

- OdinMP will support Fortran!
  - Fortran 77/90/95 and 2003 (when it arrives)
  - Effort just began
- The C/C++ parser will be overhauled
  - Aiming at full ANSI C++ support and better support for legacy C
- OpenMP 2.5 support
- Multiple targets for Balder are in the works
- Public release of cluster support is being considered
  - Improvements in the cluster system
  - Hybrid fine/coarse-grain coherency
- Let me know if you want anything in particular
  - I don't have access to each and every architecture there is
  - Accounts, donation of CPU time and other resources is very much appreciated

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Summary and announcements

- Overview of Balder
  (A few peeks into the cluster handling)
- Balder 1.0.2 is released
  Source code under a BSDish license
- OdinMP 0.287.2 is released
- Complete compilation system available for researchers
  "An OpenMP equivalent to Mpich"

Support web-site
http://www.odinmp.com

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