

The OpenMP Source Code Repository: an Infrastructure to Contribute to the Development of OpenMP

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OmpSCR in brief:

- ▶ OmpSCR: **O**pen**M**P **S**ource **C**ode **R**epository
- ▶ A source code repository
- ▶ Containing OpenMP representative applications
- ▶ An infrastructure
 - ▶ download section
 - ▶ discussion forums
 - ▶ related links, etc.
- ▶ Web interface

Outline

Motivation

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The OmpSCR web infrastructure

Future work

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Let's consider the following paper:

X. Tian, M. Girkar, S. Shah, D. Armstrong, E. Su and P. Petersen
Compiler Support of the Workqueuing Execution Model for Intel SMP Architectures in Proc. of the 8th International Workshop on High-Level Parallel Programming Models and Supportive Environments Nice, Paris, September 2003 pp. 47–55

The paper contains experimental work related to the execution of the *Quicksort* algorithm

Reading it you can know

- ▶ Compiler
- ▶ Platform
- ▶ Number of processors involved
- ▶ Speedups obtained

Motivation

Nevertheless other fundamental details may still remain unrevealed:

- ▶ Is the data type integer or real?
- ▶ How do they generate the data?
- ▶ How many instances have been sorted?
- ▶ Have the authors considered the mean or the best time?
- ▶ When computing the time, have they considered the time for vector generation or only the sorting time?
- ▶ What is the sequential algorithm used to compute the speedup?

A first step to know the way in which experiments are performed is to have **some mechanism that allows access to the source code**

Reasons for this lack of information

- ▶ Space limitations when writing a paper
- ▶ There is no standard situation: each group uses their own codes
- ▶ Few codes are publically available
- ▶ May be there is no interest in providing this information...
- ▶ Frequently we use well known benchmarks

Effects

- ▶ Apart from benchmarks, there are no standard sets of codes
- ▶ It is difficult to **repeat** the computational results
- ▶ Computational results are not useful for real performance measures or comparisons
- ▶ Information interchange is not encouraged enough

Benchmarks seem to be the solution, but...

- ▶ There are **very few OpenMP specific** benchmarks
- ▶ They are oriented to a pure performance analysis
- ▶ Most of them pay attention to numerical applications
- ▶ In many cases they only show simple parallelizations of loops
- ▶ Not always they are freely accessible

Our Goals

- ▶ To become an **open, non proprietary** and **freely accessible** infrastructure
- ▶ To **standardize** a set of applications to be an alternative to the classic benchmarks
- ▶ To promote in the OpenMP community the **interchange** of:
 - ▶ Code and results
 - ▶ Discussions and opinions
 - ▶ Information
- ▶ To become a **meeting point** and a reference in the field of OpenMP research
- ▶ Help to **learn** OpenMP

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Directories structure

OmpSCR applications are distributed as a whole in a *tarball* archive

It contains a structure to be installed in a local account:

- ▶ applications
- ▶ bin
- ▶ doc
- ▶ common
- ▶ config
- ▶ include
- ▶ developer
- ▶ log

Installation

The repository includes scripts that ease installation and configuration in different platforms

The modular structure created by the scripts allow:

- ▶ Add and/or eliminate applications
- ▶ Modify the code used in initializations, time measurement, results presentation, etc.
- ▶ Selectively produce parallel or serial versions

Compilation uses `GNUmakefile`

Common toolkit-module

All the applications in OmpSCR present a common programming style
All use the functionalities provided by a **common module** included in the distribution that implements APIs for:

- ▶ Command line arguments processing
- ▶ Timers definition
- ▶ Time measurements
- ▶ Execution reports generation

This common module has bindings for C and Fortran90/95

Applications

The applications currently available in the OmpSCR are:

- ▶ Computing π
- ▶ Mandelbrot set area
- ▶ Molecular dynamic
- ▶ Quicksort
- ▶ Divide and conquer fast Fourier transform
- ▶ Bailey's "6-step" FFT
- ▶ Loops with dependences
- ▶ Cellular automaton
- ▶ LU decomposition
- ▶ Graph search

Characteristics

- ▶ The kind of applications included in OmpSCR goes from very simple examples of OpenMP parallelizations to complex codes with several parallel loops
- ▶ Applications are written in C or Fortran90/95
- ▶ One of the aims of OmpSCR is to make available the same code written in different languages to check the behavior of the corresponding compilers
- ▶ Some of the programs are provided in several versions using different parallelization strategies or primitives

Headers

```
This program is part of the  
OpenMP Source Code Repository
```

```
http://www.pcg.ull.es/ompscr/  
e-mail: ompscr@etsii.ull.es
```

```
This program is free software; you can redistribute it  
and/or modify it under the terms of the GNU General Public  
License as published by the Free Software Foundation;  
either version 2 of the License, or (at your option) any  
later version.
```

```
This program is distributed in the hope that it will be  
useful, but WITHOUT ANY WARRANTY; without even the implied  
warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR  
PURPOSE. See the GNU General Public License for more details.
```

FFT Header

```
FILE :          fft.c
VERSION:        1.0
DATE:          May 2004
AUTHOR:        F. de Sande
COMMENTS TO:   sande@etsii.ull.es
DESCRIPTION:    Computes the FFT on an input signal
COMMENTS:      Uses a divide and conquer strategy and the
                transform is computed as a combination of the
                transforms of the even and odd terms of the
                original signal.
                The code requires nested Parallelism.
REFERENCES:    James W. Cooley and John W. Tukey, An Algorithm
                for the Machine Calculation of Complex Fourier
                Series , Mathematics of Computation, 1965, vol.
                19, no. 90, 297–301
BASIC PRAGMAS: parallel for
USAGE:         ./fft.par 8192
INPUT:         Size of the input signal
OUTPUT:        The code tests the correctness of the result
RESTRICTIONS: The size of the input signal MUST be a power of 2
REVISION HISTORY:
```

FFT main function

```
int main(int argc, char *argv[]) {
    ...
    NUMTHREADS = omp_get_max_threads();
    OSCR_init (NUMTHREADS, "D&C Fast Fourier Transform.",
    "Use 'fft' <size (in K)>", NUM_ARGS, PARAM_NAMES,
    DEFAULT_VALUES, NUM_TIMERS, NUM_TIMERS, TIMERS_NAMES,
    argc, argv);
    N = KILO * OSCR_getarg_int(1);
    ...
    initialize(N, a); /* Generate test input signal */
    Roots(N >> 1, W); /* Initialise imaginary roots */
    OSCR_timer_start(0);
    FFT(A, a, W, N, 1, D);
    OSCR_timer_stop(0);
    total_time = OSCR_timer_read(0);
    ...
    /* Display results and time */
    OSCR_report(1, TIMERS_NAMES);
    ...
}
```

FFT function

```

void FFT(Complex *A, Complex *a, Complex *W, unsigned N, unsigned
stride, Complex *D) {
    ...
#pragma omp parallel for /* Subproblems resolution stage */
    for(i = 0; i <= 1; i++) {
        FFT(D+i*n, a+i*stride, W, n, stride << 1, A+i*n);
    }
    B = D; /* Combination stage */
    C = D + n;
#pragma omp parallel for default(none) private(i, Aux, pW) shared
(stride, n, A, B, C, W)
    for(i = 0; i <= n - 1; i++) {
        pW = W + i * stride;
        Aux.re = pW->re * C[i].re - pW->im * C[i].im;
        Aux.im = pW->re * C[i].im + pW->im * C[i].re;
        A[i].re = B[i].re + Aux.re;
        A[i].im = B[i].im + Aux.im;
        A[i+n].re = B[i].re - Aux.re;
        A[i+n].im = B[i].im - Aux.im;
    }
}

```

Another example

Molecular Dynamic (MD)

- ▶ An implementation of the velocity Verlet algorithm for MD simulation
- ▶ Given positions, masses and velocities of n_p particles, the program computes the energy of the system and the forces on each particle
- ▶ Precision depends on the number of simulation steps
- ▶ C and Fortran versions are available
- ▶ Original fortran version can be downloaded from the OpenMP official web site

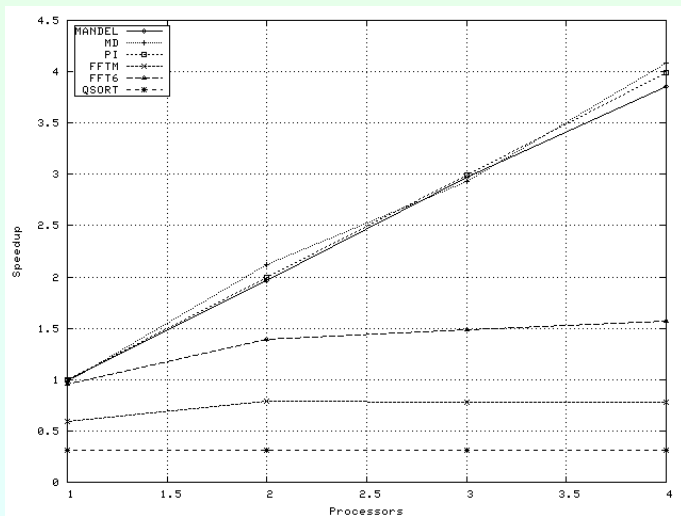
MD code

```
program md_fortran
  USE oscrCommon_f
  USE omp_lib
  ...
  call OSCR_timer_start(NUM_TIMERS)
  ! compute the forces and energies
  call compute(nparts, ndim, box, position, velocity, mass, force,
    potential, kinetic)
  E0 = potential + kinetic
  ! This is the main time stepping loop
  do i=1, nsteps
    call compute(nparts, ndim, box, position, velocity, mass,
      force, potential, kinetic)
    call update(nparts, ndim, position, velocity, force, accel,
      mass, dt)
  enddo
  call OSCR_timer_stop(NUM_TIMERS)
  total_time = OSCR_timer_read(NUM_TIMERS)
  call OSCR_report()
end
```

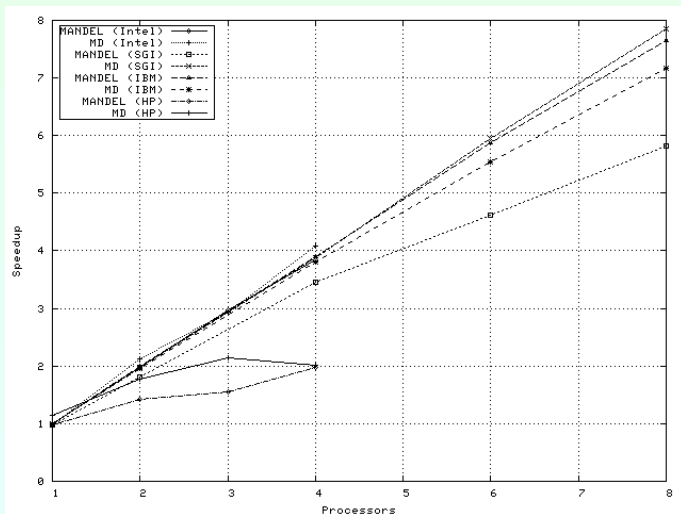
MD compute

```
subroutine compute(np,nd,box,pos,vel,mass,f,pot,kin)
  ...
!$OMP PARALLEL DO DEFAULT(SHARED) &
!$OMP PRIVATE(i,j,k,rij,d) REDUCTION(+ : pot, kin)
  do i=1,np
    f(1:nd,i) = 0.0
    do j=1,np
      if (i .ne. j) then
        call dist(nd,box,pos(1,i),pos(1,j),rij,d)
        pot = pot + 0.5 * v(d)
        do k=1,nd
          f(k,i) = f(k,i) - rij(k) * dv(d) / d
        enddo
      endif
    enddo
    kin = kin + dotr8(nd, vel(1,i), vel(1,i))
  enddo
!$OMP END PARALLEL DO
  kin = kin * 0.5 * mass
  return
end
```

Results in the Intel based PC



Results for Mandelbrot and MD applications



New applications

The repository must be open, not limiting the number of applications available on it

- ▶ We plan to follow a **collaborative approach**: we hope that different research groups contribute their own codes
- ▶ The number of programs available will clearly increase **depending on the interest raised** on the OpenMP users and developers community

Characteristics for new applications

Some characteristics that the OmpSCR applications should fulfill:

- ▶ They should be coded using ANSI C/C++ or standard Fortran90/95
- ▶ Both kernel applications and complete applications can be considered
- ▶ To ease their use by non-expert OpenMP users, they should be programs reasonably simple
- ▶ Applications will be representative of the real world, or applications that make evident situations that require special treatment when programmed using OpenMP

Characteristics for new applications

Some characteristics that the OmpSCR applications should fulfill:

- ▶ They should be codes extensively tested and validated in a wide variety of systems
- ▶ The code must be written according to quality standards
- ▶ The applications must be well documented
- ▶ It is a desirable property that the application be self-checking
- ▶ The programs must be freely distributed, and not affected by copyrights

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Web support

<http://www.pcg.ull.es/ompscr/>

The OmpSCR web site is based on PostNuke CMS

Site main sections:

- ▶ Downloads
 - ▶ Codes: repository, applications, routines, etc.
 - ▶ Documentation
 - ▶ Papers
 - ▶ Results
- ▶ Discussion forum
- ▶ FAQs
- ▶ Opinion articles
- ▶ Interest web links

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Welcome

Welcome to the **OmpSCR (OpenMP Source Code Repository)** web site. The aim of this site is to provide the basic infrastructure for sharing codes, results and discussions about them. All codes are freely available to the community.

Comments and codes are welcome.

OmpSCR: OpenMP Source Code Repository

Posted by: bgd on Wednesday, June 23, 2004 - 02:25 PM

OpenMP Source Code Repository

comments?  

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Poll

**Do you think the
OpenMP Source Code
Repository is useful?**

- Yes
- No
- I am not sure about it

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Votes: **2**
 Comments: **0**

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Menu for F. de Sande

http://www.etsii.ull.es/~sande/index_i.html

OmpSCR FAQ (Frequently Asked Questions)

[[Ask A Question](#)]

Category: [Main](#) -> [OpenMP Source Code Distribution](#) -> [Installation](#)

Question

- [Where can I get the last version of OmpSCR?](#)
- [Can I build the OmpSCR applications in my machine?](#)
- [Do I need to define environment variables?](#)
- [I have decompressed the .tar.gz file and I have got several directories. What's their meaning?](#)
- [I have decompressed the .tar.gz file. What's the next step?](#)
- [Once I've decompressed the OmpSCR, what should I do?](#)
- [When I run 'make' I get some error messages...](#)
- [Why 'gmake config' is needed?](#)
- [Why 'gmake config' does not work?](#)
- [I can't use 'gmake config'. What should I do?](#)
- [What's the format for the config/templates/user.cf.mk file?](#)
- [When making the configuration, the script ask for several parameters. What's their meaning?](#)
- [Where can I get the information for building user.cf.mk file?](#)
- [Where can I get *.cf.mk files for other machines?](#)
- [I have installed the user.cf.mk file. What should I do now?](#)
- [I want to add my own applications under my local OmpSCR structure. What should I do?](#)
- [How can I take my local installation of OmpSCR to a different machine?](#)

Answer

- [Where can I get the last version of OmpSCR?](#)

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



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Category: OmpSCR

Downloads also available in OmpSCR subcategories:

 [Applications](#) (7)  [Example config files](#) (3)  [OmpSCR developer modules](#) (2)

Sort downloads by: Title () Date () Rating () Popularity ()

Resources currently sorted by: Title (A to Z)

 [Full OmpSCR distribution \(v0.2\)](#)Description: **Full OmpSCR distribution version 0.2.**

Contains all applications, documentation, time and common routines, config scripts, etc.

Version: 0.2 | Filesize: 29.71 Kb

Added on: 17-May-2004 | Downloads: 10

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Sort downloads by: Title ([Δ/D](#)) Date ([Δ/D](#)) Rating ([Δ/V](#)) Popularity ([Δ/V](#))
Resources currently sorted by: Title (A to Z)

FFT (FFT.tar.gz)

Description: This program computes the Fast Fourier Transform on an input signal. The algorithm uses a divide and conquer strategy and the transform is computed as a combination of the transforms of the even and odd terms of the original signal. The code requires nested Parallelism.

Version: 0.2 | Filesize: 3.82 Kb

Added on: 17-May-2004 | Downloads: 8

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FFT6 (FFT6.tar.gz)

Description: Bailey's 6-step 1D Fast Fourier Transform. Computes the 1D FFT of an input signal (complex array).

The code performs a number (ITERS) of iterations of the Bailey's 6-step FFT algorithm (following the ideas in the CMU Task parallel suite). The code requires nested Parallelism.

Version: 0.2 | Filesize: 5.72 Kb

Added on: 17-May-2004 | Downloads: 5

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Loops with dependencies (loopsWithDependencies.tar.gz)

Description: Parallelizing an inner loop with dependencies.

Version: 0.2 | Filesize: 4.84 Kb

Added on: 18-May-2004 | Downloads: 4

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Mandelbrot (Mandelbrot.tar.gz)

Description: This program computes an estimation to the Mandelbrot Set area using MonteCarlo sampling. The best known estimate so far is 1.50659177 +- 0.00000008.

The Mandelbrot set is a fractal that is defined as the set of points c in the complex plane for which the sequence $z_{n+1} = z_n^2 + c$ with $z_0 = 0$ does not tend to infinity.

Version: 0.2 | Filesize: 3.05 Kb

Added on: 18-May-2004 | Downloads: 2

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Molecular Dynamic (MolecularDynamic.tar.gz)

Description: This program implements a simple molecular dynamics simulation, using the velocity Verlet time integration scheme. The particles interact with a central pair potential.

Version: 0.2 | Filesize: 3.69 Kb

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Applications  All about OmpSCR applications Moderated by: admin , bgd , sande	1	1	Jun 29, 2004 - 06:12 PM by admin 
Web Site  Discussion about OmpSCR web site Moderated by: admin , bgd , sande	1	1	Jun 29, 2004 - 04:17 PM by sande 

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 = No new posts since your last visit.

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Offline		ajdorta				[Edit Delete]
Offline		angely				[Edit Delete]
Offline		arturo	Arturo			[Edit Delete]
Offline		bgd	Antonio Javier Dorta Lorenzo			[Edit Delete]
Offline		delgadom				[Edit Delete]
Offline		fdoperez				[Edit Delete]
Offline		fgarzon				[Edit Delete]
Offline						

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Any kind of information about other benchmarks

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Announcements of OpenMP related conferences and call for papers.

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OpenMP related webs

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Any kind of information about OpenMP benchmarks

There are **25** Links and **11** Categories in our database

The OmpSCR community

We want to appeal the OpenMP community to

- ▶ Register in the site
- ▶ Contribute new codes
- ▶ Write opinion articles
- ▶ Participate in the discussion forums
- ▶ Provide links to related pages
- ▶ Give us feed-back

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- ▶ Register in the site
- ▶ Contribute new codes
- ▶ Write opinion articles
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Outline

Motivation

OmpSCR: The repository

The OmpSCR web infrastructure

Future work

Conclusions

Future work

Some of the tasks in deployment stage:

- ▶ Popularization of OmpSCR among the OpenMP users and developers community
- ▶ Finding and including new applications in the repository
- ▶ To appeal to the active working groups on this field to contribute **your own codes**
- ▶ Conducting computational experiments on different platforms
- ▶ Publishing the results in the web site

A benchmark?

Will the OmpSCR become a benchmark?

- ▶ Although OmpSCR is not proposed as an OpenMP benchmark on its own, we do not exclude the possibility of a further development in this direction
- ▶ The acceptance and contribution of the OpenMP community will determine the long term scope of OmpSCR

Tasks

The development of a complete benchmark implies (at least) the following tasks:

- ▶ All the benchmark applications should contain code for automatic correctness check
- ▶ Applications should print at the end of their execution a common and complete report of performance
- ▶ Appropriate input data characteristics and sizes must be clearly stated for each application
- ▶ A protocol for the communication of the benchmark results should be devised

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In this work we have introduced OmpSCR, an infrastructure which purpose is to be a forum for the OpenMP users and developers community

It allows:

- ▶ To show and to evaluate different parallelization schemes for a given application
- ▶ To evaluate and publish performance results of OpenMP codes on different platforms, using different languages or compilers
- ▶ To provide free access to source codes and results published on the repository
- ▶ Researches may use it to publish the source codes developed and used for their experimental research

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- ▶ It may also allow the OpenMP community to discuss about **new parallel constructs and mechanisms** to be included in the language, showing the effect of their proposals on real codes
- ▶ Finally, it can be used as a resource to help in the OpenMP **learning**, presenting real implementation examples of the language features

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The OpenMP Source Code Repository: an Infrastructure to Contribute to the Development of OpenMP

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