

X-Kaapi installation and user guide

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Contents

| | | |
|----------|---|----------|
| 1 | Overview | 2 |
| 1.1 | X-Kaapi runtime | 2 |
| 1.2 | Supported Platforms | 2 |
| 2 | Installation | 2 |
| 2.1 | Using the debian packages | 2 |
| 2.2 | Installing from sources | 2 |
| 2.2.1 | Retrieving the sources | 2 |
| 2.2.2 | Configuration | 3 |
| 2.2.3 | Compilation and installation | 3 |
| 2.2.4 | Checking the installation | 3 |
| 2.2.5 | Compilation of the examples | 3 |
| 3 | Programming with X-Kaapi | 3 |
| 3.1 | X-Kaapi integration | 3 |
| 3.2 | Examples | 4 |
| 4 | Running X-Kaapi | 4 |
| 4.1 | Runtime environment variables | 4 |
| 4.2 | Monitoring performances | 5 |

1 Overview

1.1 X-Kaapi runtime

X-Kaapi is a runtime high performance parallelism targeting multicore and distributed architectures. It relies on workstealing paradigms. The core library comes with a full set of complementary programming interfaces, allowing for different abstraction levels. The following documents the install process, runtime options, as well as a description of APIs lying on top of the runtime and a set of examples.

1.2 Supported Platforms

X-Kaapi targets essentially SMP and NUMA platforms. The runtime should run on every system providing:

- a GNU toolchain (4.3),
- the pthread library.

It has been extensively tested on the following operating systems:

- GNU-Linux/x86_64,
- MacOSX/PowerPC.

There is no version for Windows yet.

2 Installation

There are 2 ways to install X-Kaapi:

- using the debian packages,
- installing from source.

2.1 Using the debian packages

Below is a list of the Debian packages provided for using and programming with X-Kaapi. A brief description is given for each of them:

- xkaapi-doc
X-Kaapi library documentation.
- libxkaapi0
X-Kaapi shared libraries.
- libxkaapi-dev
X-Kaapi development files for the low level C runtime.
- libxkaapi-dbg
X-Kaapi debug symbols for the above libraries.
- libkaapixx0
X-Kaapi C++ higher level interfaces standing on top of the X-Kaapi core library.
- libkaapixx-dev
X-Kaapi C++ interfaces development files.

2.2 Installing from sources

2.2.1 Retrieving the sources

There are 2 ways to retrieve the sources:

- download a release snapshot at the following url:
https://gforge.inria.fr/frs/?group_id=94.
- clone the project git repository:

```
> git clone git://git.ligforge.imag.fr/git/kaapi/xkaapi.git xkaapi
```

2.2.2 Configuration

The build system uses GNU Autotools. In case you cloned the project repository, you first have to bootstrap the configuration process by running the following script:

```
$> ./bootstrap
```

The *configure* file should be present. It is used to create the *Makefile* accordingly to your system configuration. Command line options can be used to modify the default behavior. You can have a complete list of the available options by running:

```
$> ./configure --help
```

Below is a list of the most important ones:

- `--enable-target=mt`
Select the target platform. Defaults to 'mt', for pthread.
- `--enable-mode=debug or release`
Choose the compilation mode of the library. Defaults to release.
- `--with-perfcounter`
Enable performance counters support.
- `--with-papi`
Enable the PAPI library for low level performance counting. More information on PAPI can be found at <http://icl.cs.utk.edu/papi/>.
- `--prefix=`
Overload the default installation path.

Example:

```
./configure --enable-mode=release --enable-target=mt --prefix=$HOME/install
```

If there are errors during the configuration process, you have to solve them before going further. It is likely there is a missing dependency on your system, in which case the log gives you the name of the software to install.

2.2.3 Compilation and installation

On success, the configuration process generates a Makefile. the 2 following commands build and install the X-Kaapi runtime:

```
$> make
$> make install
```

2.2.4 Checking the installation

The following checks the runtime is correctly installed on your system:

```
$> make check
```

2.2.5 Compilation of the examples

The following compiles the sample applications:

```
$> cd examples; make examples
```

3 Programming with X-Kaapi

3.1 X-Kaapi integration

Integrating X-Kaapi in your project requires the following steps:

- include the header files in your source code. Example:

```
#include <kaapi.h> /* C version */
#include <kaapi++> // C++ version
```

- add compilation options to your project using pkg-config. Note that if you changed the default install directory during the configuration process, the PKG_CONFIG_PATH environment variable must point to *install_dir/pkgconfig/*. Example:

```
# for C applications
gcc -o main `pkg-config --flags kaapi` main.c `pkg-config --libs kaapi`
# for C++ applications
g++ -o main `pkg-config --flags kaapixx` main.c `pkg-config --libs kaapixx`
```

- the following preprocessor macro must be defined to fully disable the debugging code. It can improve the generated code:

```
-DNDEBUG
```

Refer to the API documentation for information relative to the X-Kaapi programming interfaces.

3.2 Examples

The directory *examples/* contains sample applications using X-Kaapi. Both C and C++ are used. Some directly lies on top of the core runtime, while other make use of higher level interfaces. Below is a short description for some of them:

- *fibonacci_adapt.c*
Implementation of the Fibonacci sequence generation using adaptive task stealing.
- *fibonacci.c*
Same as above, using DFG tasks.
- *fibonacci.cpp*, *fibonacci_opt.cpp*
Same as above, using the *ka* C++ interface.
- *fibonacci_atha.cpp*
Same as above, using the *Athapascan* interface.
- *nqueens_kaapi*
Nqueens problem implementation using *ka* C++ interface.
- *nqueens_atha*
Same as above, using the *Athapascan* interface.
- *poisson3d-kaapi.cpp*
3 dimension Poisson solver implemented using the *ka* C++ interface.
- *matrix_multiply_cilk2kaapi.cpp*
Matrix multiplication using loop parallelization. Implemented using the *ka* C++ interface.

4 Running X-Kaapi

4.1 Runtime environment variables

The runtime behavior can be driven by using the following optionnal environment variables.

- *KAAPI_CPUCOUNT*
The number of process unit to be used by the runtime. No assumption is made regarding which unit is used. Example:

```
KAAPI_CPUCOUNT=3 ./transform 100000
```

- *KAAPI_CPUSET*
The set of CPU to be used. It consists of a comma separated list of cpu indices, first index starting at 0. By default, and if no *KAAPI_CPUCOUNT* is given, all the host cpus are used. Example:

```
#use cores 3, 4, 5, 6 and 9 only:
KAAPI_CPUSET=3,4,5,6,9 ./transform 100000
```

An index range can be used via the ':' token. Example:

```
#same as above using the range syntax:  
KAAPI_CPUSET=3:6,9 ./transform 100000
```

You may exclude a cpu from the set by appending the '!' token. Example:

```
#this will uses cores from 3 to 9, but not 4:  
KAAPI_CPUSET=3:9,!4 ./transform 100000
```

- KAAPI_STACKSIZE

Size of the per thread stack, in bytes. By default, this size is set to 64 kilo bytes. Example:

```
KAAPI_STACKSIZE=4096 ./transform 100000
```

- KAAPI_WSSELECT

Name of the victim processor selection algorithm to use.

- "workload": Use a user defined workload to driver the victim selection algorithm.
- any other value: falls back to the default random victim selection algorithm.

Example:

```
KAAPI_WSSELECT=workload ./transform 100000
```

4.2 Monitoring performances

If configured by `--with-perfcounter`, the X-Kaapi library allows to output performance counters.

- KAAPI_DISPLAY_PERF

If defined, then performance counters are displayed at the end of the execution. Example:

```
KAAPI_DISPLAY_PERF=1 ./fibo 30
```

- KAAPI_PERF_PAPIES

Assuming X-Kaapi was configured using `--with-papi`, this variable contains a comma separated list of the PAPI performance counters to use. Both counter symbolic names and numeric hexadecimal constants can be used. More information can be found on the PAPI website (<http://icl.cs.utk.edu/papi/>). Note that counter list cannot exceed 3 elements. Example:

```
KAAPI_PERF_PAPIES=PAPI_TOT_INS,0x80002230,PAPI_L1_DCM ./fibo 30
```