METIS installation guide

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1. Introduction

This document describes how to get, install, compile, test and run METIS for the two versions of the code. The licencing procedure is also described.

2. Different versions of METIS

METIS is available in two different versions:

- A standalone compiled version for Windows© which does not require a Matlab© licence but has some limitations.
- A version for Linux with all features available. This version requires a Matlab© licence and must be compiled on the computer where METIS is installed

3. Standalone compiled version for Windows

3.1. Introduction to standalone compiled version for Windows

The standalone compiled version for Windows© is a version of METIS running on any modern laptop or desktop with no need of any Matlab© licence. It is a pre-compiled code coming without source files. Some features are not available in this version.

3.2. METIS licencing for standalone compiled version for Windows

The signature of a licence is required for any installation of this version of METIS. The licence is free of charge. The name of the licence is “RESEARCH USER LICENSE AGREEMENT FOR METIS RUNTIME SOFTWARE”. The current contact person for the licencing process at CEA/IRFM is Frederic Imbeaux (frederic.imbeaux@cea.fr).

3.3. Requirements for standalone compiled version for Windows

This version of METIS is compliant with Windows 7 64bits and Windows 10 64bits. It is based on Matlab© version 8.0.0.783 (R2012b). METIS requires the installation of the corresponding Matlab© run time engine (MRE, https://fr.mathworks.com/products/compiler/matlab-runtime.html). The MRE is packaged with the METIS installer file and must be installed with the administrator privileges.

3.4. How to get standalone compiled version for Windows

This version of METIS is packaged in an auto installer zip file named:
“metisPC64_pkg_svn_<sversion_number>_LCSF.exe”
that is distributed by IRFM after the licencing process is conclusive.

3.5. Installation of standalone compiled version for Windows

The user must run the auto-installer zip file and follow instruction displayed by the installer program. If the MRE is not yet installed, the user has to install it as an administrator user. A “readme.txt” file contained in the archive provides more detailed information.

3.6. Run of standalone compiled version for Windows

Once METIS is installed, METIS can be launched by running the file “metisPC64.exe”. The program then starts after few seconds to one minute. This time is needed to load and launch the MRE. A

splash screen is displayed a few second and after the initialisation menu of METIS appears. For learning how to use METIS, refer to METIS “how to” manual (the file is named “Howto_METIS_final.pdf”). A logfile named “MetisPC64.log” reports all information about METIS messages, warnings and errors.

3.7. Limitation of standalone compiled version for Windows

This version of METIS has some limitations. The following features are not available:

- Command line is not available, METIS data cannot be manipulated with Matlab© language.
- METIS cannot be extended and METIS function cannot be personalised.
- Simulink workflows are not available. This version is not applicable for control purpose
- Edition of graph is limited to features available in the Matlab© figure menu
- IMAS data exchange and plot is not available, only exportation of data with IMAS format in a matfile is available
- Access to METIS variables is not available

4. Linux version of METIS

4.1. Introduction to Linux version of METIS

Next sections describe: the licencing process needed to have access to the METIS code under Linux; the system requirement for METIS under Linux and how to install, compile, test and run the METIS code under Linux.

4.2. Metis licencing for Linux version

The METIS code under Linux requires a licence agreement to be installed and used. If the user's Institute belongs to an ITER member state, the easiest way to get access to the code and its licence is to through the ITER Organization (current contact Simon.Pinches@iter.org). Indeed CEA has licensed IO to redistribute the code from its GIT repository. If the user's Institute does not belong to an ITER member state, please contact CEA/IRFM to obtain a specific licence (current contact frederic.imbeaux@cea.fr).

4.3. Requirements for Linux version

The Linux version of METIS requires Linux 64 bits, able to run the selected Matlab© version. Some parts of the compiled code are not compatible with the 32bits Linux version.

Linux version of METIS requires the following software installed:

- Matlab© code (https://fr.mathworks.com/products/matlab.html). METIS can run with Matlab 2012B to Matlab 2017A. The recommended version is Matlab 2012B.
- gcc compilation suite (including gcc and gfortran). The compliant version depends on Matlab version (https://fr.mathworks.com/support/sysreq/previous_releases.html). With Matlab 2012b, we use GNU Fortran (GCC) 4.4.7 20120313.
- Some BLAS and LAPACK library. With Matlab 2012b, we use atlas library libatlas.so.3.0.

Matlab© installation must include the following toolboxes:

- Signal (https://www.mathworks.com/products/signal/)
- Optimisation (https://www.mathworks.com/products/optimization/)
- Compiler (https://www.mathworks.com/products/compiler/)
- Simulink (https://fr.mathworks.com/products/simulink/)
- And optionally, depending of the use of METIS in Simulink: Control (https://fr.mathworks.com/products/control/) and Robust control (https://fr.mathworks.com/products/robust/).

If some toolboxes are missing, some features of METIS will not work, even if METIS stays mostly usable.

METIS Input/Output is fully done following the ITER Physics Data Model (https://imas.iter.org), which can be stored under the standard Matlab© binary format or in native IMAS data base format. We recommend however, for future communication with other codes and other programming languages, to use the IMAS Access Layer for storing data in a standard IMAS file format (IMAS is the ITER Integrated Modelling & Analysis Suite). Note that this is available for the Linux version only. For using the Access Layer, a license to use IMAS must be asked to the ITER Organization (current contact: Simon.Pinches@iter.org).

METIS is also using the MUMPS library (http://mumps.enseeiht.fr/), which is an open-source software released using the CeCILL-C license: http://www.cecill.info/licences/Licence_CeCILL-C_V1-en.html.

4.4. How to get the code sources

4.4.1. ITER member

Once the user has an ITER account and grant access to ITER Git repository for METIS, the code is available here: https://git.iter.org/projects/SCEN/repos/metis/browse. For more information on the ITER Integrated Modelling Programme and IMAS, see here: https://imas.iter.org.

4.5. Installation of Linux version

4.5.1. From Git

The project can be clone from ITER Git server:

```
git clone ssh://git@git.iter.org/scen/metis.git
```

4.5.2. From archive

For users who do not have access to the Git server, we will provide an archive “tar” compressed that will be accessible from ftp://ftp.cea.fr. In this case we will provide access information and “hash key” of the archive in sha256 format, allowing checking the integrity of the archive. Once the user has got the archive, he must check the integrity of the archive (with Linux command sha256sum) and untar the archive (tar xvfz <archive_name>).

4.6. How to compile METIS sources

The METIS code can run without any compilation, but, in this case, the METIS run is very slow. We recommend compiling METIS: Firstly, a configuration file named “arch.inc” must be created. Some examples of configuration file can be found in the directory “architecture” under the root directory of METIS. The simple way for starting is to copy one of these examples in the root directory of METIS under the name “arch.inc”. This file must be edited. Generally, only a few number of lines have to be changed:

1. Path to Matlab must be set in lines like:

```
#MATLAB library
MATLABHOME=/Applications/Matlab_2012B
MATLABLIBDIR=$(MATLABHOME)/bin/glnxa64
```

2. Path to BLAS and LAPACK libraries must be set in lines like:

```
#BLAS library
BLASLIB=  -llapack –lblas
#LAPACK library
LAPACKLIB=$(BLASLIB)
```

3. Path for temporary files has to be set in lines like:

```
#Temporary working directory for writing temporary files
#put the absolute path
CRONOSTEMPDIR=/tmp
#Temporary working directory for writing temporary files accessible from all nodes
for // computation
#put the absolute path
CRONOSTEMPDIR_EXCHANGE=/tmp
```

4. Option for compilation of some mexfile FORTRAN has to be set in lines like:

```
#pre-processing for matlab version
#if you use a version later than MATLAB 7.3
#then put MATLABVERSION=-DMATLAB73
#or MATLABVERSION=-DMATLAB86
#for version later than 2014A
#else put nothing
MATLABVERSION=-DMATLAB73
```

We recommend also setting variable MPI to empty for simplifying the compilation process without real effect on computation performance in METIS code:

```
###################
#PARALLEL VERSION#
###################
#if use MPI  put MPI=-DMPI else put MPI=
#be carfull no space before and after =
# MPI=-DMPI
MPI=
```

Other sections or lines of the arch.inc file can need some changes when the compiler used is not gcc and gfortran.

Once arch.inc is configured, to launch the compilation, just execute:

```
make clean; make
```

in the root directory of the METIS code (where arch.inc and Makefile files are located).

If the compilation is successful, then the message:

```
#################
#COMPILATION OK#
#################
```

will be displayed.

4.7. Test METIS compilation

Once the METIS code is compiled, it is time to test it. A set of unitary test cases is embedded in sources of the code (in the directory "certification/metis/"). The command to run tests is:

```
make testmetis
```

The run time of tests is about a half an hour. If the code is correctly compiled, tests must finish without crash. During tests execution, a logfile named "log" is filled. To check results, the command is:

```
grep CRONOSTEST log
```

The output of this command is a list of lines displaying one of these messages:

- CRONOSTEST: OK
- CRONOSTEST: WARNING = <some number> of norm
- CRONOSTEST: ERROR = <some number> of norm

If all messages are of the kind "CRONOSTEST: OK", tests have all succeeded. When some or all messages are of the kind "CRONOSTEST: WARNING", it is a signature of differences in Matlab, libraries or processors versions. These differences produce some rounding error that accumulate along the computation and bring small variations in METIS results. When some messages are of kind "CRONOSTEST: ERROR", test case raising an error must be identified in "log" file and the cause of differences must be investigated. In most of the cases, it is due to large differences in versions of Matlab, libraries or processors versions compared to versions used to build test cases and no differences can be detected simply in the results.

4.8. Run Linux version

Once the METIS code is compiled and tested, METIS is ready to be used. METIS can be launched directly from the shell or from Matlab©. To run METIS from the shell, launch the script named "metis". To run METIS from Matlab©, firstly add a path to the root directory of METIS installation and then launch the command "metis" (mfile metis.m).

METIS must start by opening the initialisation menu (figure 1). The next step is to learn how to use METIS code. The best way is to read METIS "how to" located in directory "doc" (the file is named "Howto_METIS_final.pdf").

Figure 1: METIS initialisation GUI window

5. Contact and support

The contact person for the licencing process is Frederic Imbeaux (frederic.imbeaux@cea.fr).

The contact person at ITER is Simon Pinches (Simon.Pinches@iter.org).

The contact person for METIS code installation and use is Jean-François Artaud (jean-francois.artaud@cea.fr).

The code is provided as it is without any warranties and without commitment to support (see licence agreement). Outside of any formal collaboration, help will be provided depending on the availability of contact persons.