NX Nastran 9.1 Release Guide

Contents

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As of version 2.1, we distribute the code in 4 formats: zip and tarred-gzipped (tgz), with or without binaries for external libraries. The bundled external libraries should allow you to build the test programs on Linux, Windows, and MacOS X without installing additional software. We recommend that you download the full distributions, and then perhaps replace the bundled libraries by higher performance ones (e.g., with a BLAS library that is specifically optimized for your machine). If you want to conserve bandwidth and you want to install the required libraries yourself, download the lean distributions. The zip and tgz files are identical, except that on Linux, Unix, and MacOS, unpacking the tgz file ensures that the configure script is marked as executable (unpack with tar zxvpf), otherwise you will have to change its permissions manually.

Chapter

1 GPU Computing

GPU Computing

The graphics processing unit (GPU) is used for many applications in which computations of large data can be done in parallel. A GPU is an add-on PCI Express card (PCIe) with its own onboard memory. The GPU approach to performance is to divide computations across a large number of relatively small cores. Some computationally intensive portions are offloaded to the GPU, while the remaining computations still run on the CPU.

NX Nastran now supports GPU computing for the following cards and architectures on a Linux system.

- Intel's MIC (Many Integrated Core) architecture, which is used by the Intel Xeon Phi, is supported for NX Nastran math computations. NX Nastran supports the Automatic Offload (AO) feature with the MIC-enabled MKL library. NX Nastran commonly calls MKL (math kernel libraries) in all solutions. When AO is enabled, and MKL library deems a computation as sufficiently large, it will automatically offload the computation to the MIC architecture.

  You can use the **intel_mic=1** keyword setting to enable MKL computations with Intel's MIC architecture. For example,

  ```
  nastran.exe intel_mic=1 input_file.dat
  ```

- AMD GPU cards, and the NVIDIA GPU cards are supported for NX Nastran matrix decomposition (DCMP module) and frequency response (FRRD1 module) computations. Enabling GPU computations for the DCMP module will decrease the time for matrix decomposition. The impact will be more significant for sparse matrices reporting a maximum front size larger than 30K in the .f04 file. Enabling GPU computations for the FRRD1 module will speed up modal frequency response solutions (SOL 111). The impact becomes significant when the number of modes is at least 5,000. It is suitable for SOL 111 models in which viscous or structural damping produces coupled damping matrices.

2 GPU Computing

You can use the **gpgpu=any** keyword setting to enable GPU for both FRRD1 and DCMP module computations. For example,

```
nastran.exe gpgpu=any input_file.dat
```

There are also keyword options to enable GPU for a specific module only, and for a specific GPU when you have more than one device. All keyword options are summarized below.

See OpenCL Precompiling Procedure.

Keyword Input Summary

You can use the new intel_mic keyword to enable MKL computations with Intel's MIC architecture.

intel_mic	
intel_mic=1	Enables MKL computations with Intel's MIC architecture.

You can use the new gpgpu keyword to enable GPU for both FRRD1 and DCMP module computations.

gpgpu	
gpgpu=none	Disables GPU for both FRRD1 and DCMP module computations.
gpgpu=any	Enables GPU for both FRRD1 and DCMP module computations with the first available AMD or NVIDIA GPU.
gpgpu=amd	Enables GPU for both FRRD1 and DCMP module computations with the first available AMD GPU.

You can use the new cl_frrd keyword to enable GPU for FRRD1 module computations only.

cl_frrd	
cl_frrd=1	Enables GPU for FRRD1 module computations with the first available AMD or NVIDIA GPU.
cl_frrd=2	Enables GPU for FRRD1 module computations with the first available AMD GPU.
cl_frrd=3	Enables GPU for FRRD1 module computations with the first available NVIDIA GPU.

You can use the new cl_dcmp keyword to enable GPU for DCMP module computations only.

cl_dcmp

cl_dcmp=1	Enables GPU for DCMP module computations with the first available AMD or NVIDIA GPU.
cl_dcmp=2	Enables GPU for DCMP module computations with the first available AMD GPU.
cl_dcmp=1 sys531=1	Enables GPU for DCMP module computations with the first available NVIDIA GPU (both cl_dcmp=1 and sys531=1 are required for this option).

Intel MIC Example

You use the intel_mic keyword to enable MKL computations with Intel's MIC architecture. For example,

```
nastran.exe intel_mic=1 input_file.dat
```

If an automatic offload occurs, you should see the following in your log file:

```
14:33:18  Application of Loads and Boundary Conditions started.
14:33:21  Application of Loads and Boundary Conditions completed.
[MKL] [MIC --] [AO Function]    DGEMM
[MKL] [MIC --] [AO DGEMM Workdivision]  0.00 1.00
[MKL] [MIC 00] [AO DGEMM CPU Time]      0.816250 seconds
[MKL] [MIC 00] [AO DGEMM MIC Time]      0.094590 seconds
[MKL] [MIC 00] [AO DGEMM CPU->MIC Data] 9397248 bytes
[MKL] [MIC 00] [AO DGEMM MIC->CPU Data] 24443904 bytes
```

Note: No messages are printed if Intel MIC was requested but not used.

Modal frequency response (FRRD1 module) Example

You can use the gpgpu or the cl_frrd keyword to enable GPU for both FRRD1 module computations. For example,

```
nastran.exe cl_frrd=1 input_file.dat
```

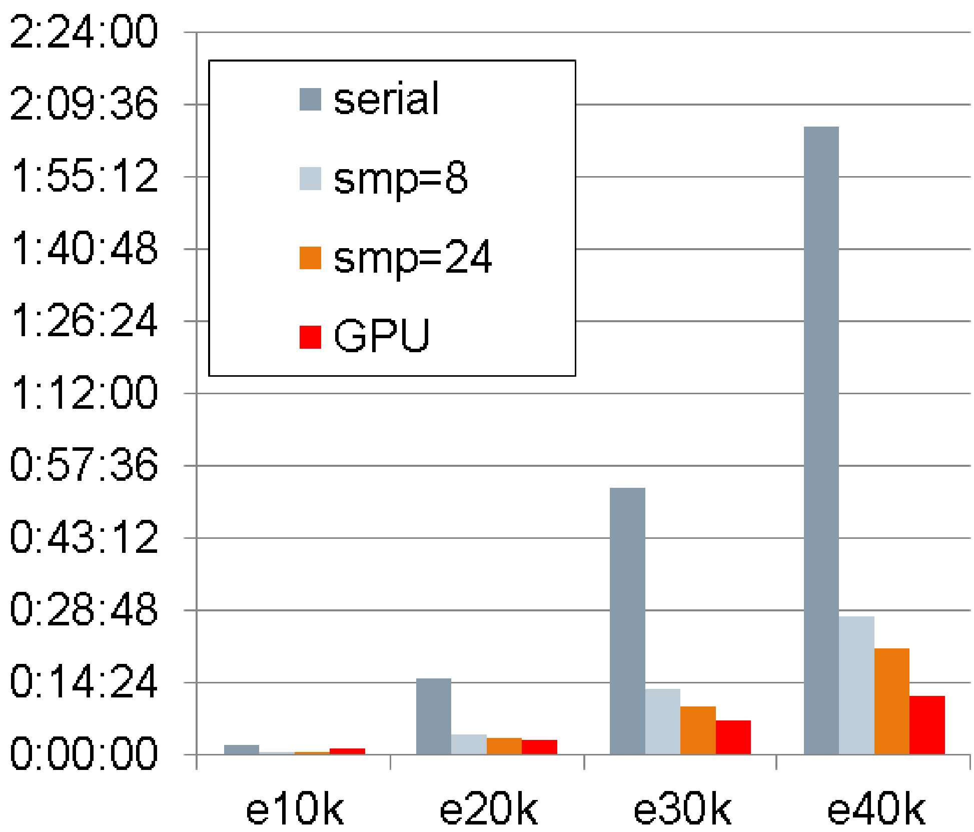
The FRRD1 module will report the following in the f04 file:

```
16:42:31     1:31    13595.0  ...     FREQRS  256     FRRD1   BEGN
*** USER INFORMATION MESSAGE 4157 (FRDGPU)
    PARAMETERS FOR FRDGPU FOLLOW
    MATRIX SIZE  =      7628                NUMBER OF FREQUENCIES =     64
    SYSTEM (107) =     32768                SYSTEM (573) =      1
Module  DMAP Matrix   Cols   Rows  F T  NzWds     Density  BlockT  StrL  NbrStr BndAvg
FRRD1   256  SCR 308   320   7628  2 4  30512 1.00000D+00     152  5204     469   7628
FRRD1   256  UHF       320   7628  2 4  30512 1.00000D+00     152  5204     469   7628
16:53:32    12:32  15161.0  1566.0   417.1   326.9    FREQRS  256   FRRD1   END
```

FRRD1 Performance Example

AMD 24 core Magny-Cours, Tahiti GPU (4GB)

Modes were computed up to the given frequency, where e10k = 1785 modes, e20k = 3631 modes, e30k = 5576 modes, and e40k = 7646 modes. GPU memory was exhausted around 10,000 modes.



OpenCL Precompiling Procedure

NX Nastran uses the OpenCL programming language with the AMD and NVIDIA cards. Before enabling GPU computations in an NX Nastran run with these cards, you can save run time by optionally precompiling the OpenCL kernels included with the NX Nastran installation. The precompiling step is only done one time. If you do not, NX Nastran will compile them automatically, but it will need to do this each time you enable GPU computations.

1. Copy the OpenCL source included with the NX Nastran installation at *installation_location*/nxn9p1/nast/cl/*.cl to a new location. For example, create a directory named “kernel_directory”.
2. Run “*installation_location*/nxn9p1/x86_64linux/clcompile *.cl” to compile the directory contents. This will produce files with the *.co extension.
3. Create the new environment variable **MAGMA_CL_DIR**, and set to the directory name and path containing the compiled OpenCL.
4. You can optionally create the new environment variable **NXN_CL_DEV**, and set to ”AMD”, ”NVIDIA”, or ”ANY”. This step is useful if you have multiple GPU devices, and you would like to select one for the compiling step. The **NXN_CL_DEV**

default is first available.
Note: The resulting *.co binary objects for one GPU will not work with another GPU.

General Caveats

Only Linux is currently supported.

FRRD1 computations cannot be GPU enabled with the ILP–64 executable type.

OpenCL is not supported for Xeon Phi.

NVIDIA caveat

The OpenCL numerical libraries are tuned for AMD and NVIDIA Fermi, Kepler cards. As a result, the older Tesla cards will run significantly slower (different architecture).

AMD caveats

Special instructions from AMD are required to run remotely on Linux.

The newest Hawaii cards are not supported.

The Tahiti and Cypress cards are supported with the 13.20 drivers.

You may need to define the environment variables GPU_FORCE_64BIT_PTR or GPU_MAX_ALLOC_PERCENT.

Chapter

2 Upward compatibility

New TOPOPT module

Performs Topology optimization with the LMS implementation of the GCMMA optimizer.

Format:

```
TOPOPT      EFILL,OBJMA,SENSMA,DVARMA,WMEMIN,FORCEM,BEGCM/EFILLI,WMEMOUT,/
            ITOITCNT/ITOMXITR/ITOPOPT/ITOOPITR/S,Y,DONE/
            ITODENS/ITOSIMP/ITORMAS/ITONGHBR $
```

Input Data Blocks:

EFILL	Element fill table.
OBJMA	Objective matrix.
SENSMA	Sensitivity matrix.
DVARMA	Design variable matrix.
WMEMIN	Cached working memory.
FORCEM	Force matrix.
BEGCM	Boolean element-grid connectivity matrix.

Output Data Blocks:

EFILLI	Updated EFILL table for subsequent iterations.
WMEMOUT	Updated cached working memory.

Parameters:

ITOITCNT	Input-integer, no default. The counter of iterations.
ITOMXITR	Input-integer, no default. The maximum number of iterations.
ITOPOPT	Input-integer, no default. Optimizer option: 1 External optimization branch. 2 Embedded optimization with LMS optimizer. 4 Embedded optimization with GCMMA optimizer.
ITOOPITR	Input-integer, no default. The number of the optimum iteration.
DONE	Output-integer, no default. The completion flag of the optimization.
ITODENS	Input-real, no default. The density of the material assigned to the elements in the EFILL list.
ITOSIMP	Input-integer-default=0. Penalty factor. ITOSIMP=1 to active penalty factor.
ITORMAS	Input-real, no default. The residual mass of the structure to be optimized.
ITONGHBR	Input-integer-default=0. Flag for checkerboard filter. ITONGHBR=1 to enable checkerboard filter.

Chapter 3 NX Nastran 9.1 Problem Report (PR) fixes

NX Nastran 9.1 Problem Report (PR) fixes

The following list summarizes the problems found in previous releases of NX Nastran and fixed in NX Nastran 9.1. If applicable, workaround information is provided for use with earlier versions of NX Nastran.

PR#	Release Reported	Problem Description
1948176	8.5	An NX Response Simulation model which included AUTOMPC and USET,U3 failed with a Memory Access Violation error.
1955496	8.5	A performance degradation was noticed in NX Nastran 8.5 as compared to NX Nastran 8.1 when using sparse data recovery.
1955923	8.5	A local coordinate system used to define a solid element bolt axis caused the fatal error SFM 22201.Workarounds are to use the basic CS, or define a new system such that the z-axis is the bolt axis.
1956028	8.5	A fatal error occurred when using the SSET field on the ACMODL bulk entry.
1966353	8.5	A model which included CRAC3D elements with 64 grids failed with errors. A work around is to set the material density to zero.
1970675	9.0	Slow performance was noticed in a SOL 401 run which included sys442=1 (solution monitor output). The slow performance was a result of too many plot points in the solution monitor output. The number of plot points has been reduced.
1973418	8.1	The Grid Point Force Balance computation didn't include the thermal force in a model which included more than 10 subcases. A workaround for previous releases is to include a separate TEMP(LOAD) in each subcase.

2224853	8.5	The computation of RMAXMIN output failed to complete because of a lack of memory in core. The workaround is to set system cell 497 to “1” which forces this computation on scratch.
2231704	8.5	Fatal error occurred when PCOMPS and STATSUB were used with RFORCE.
2235168	9.0	Unexpected temperature results occurred in a SOL 153 steady state thermal anlaysis with a model which included a glue definition.
6912451	7.1	Unexpected results occurred when the REPCASE and SET case control commands were defined.
6925918	9.0	Solution failure during metis ordering on Windows.
6928207	9.0	A SORT2 ACCELERATION request failed to output in a system run which included external superelements.
6930413	9.0	When AF normalization is used in a modal solution, the generalized mass and stiffness values written to the op2 file did not match the F06 file output.
6945696	8.5	A duplicate element ID caused a SOL 200 run to fail.
6947494	8.5	The residual vector calculation failed in SOL 111 with a fluid-structure model, and auto-SUPORT is requested with PARAM,AUTOSPRT,YES.
6954608	6.1	Unexpected results occurred if the ACCEL entry was applied to grids with negative coordinates.
6959756	9.0	A fluid-structure model requesting modal contribution output with an enforced motion input using the constraint mode method of enforced motion produced a fatal error.
6972858	9.0	A SOL 111 Rotor Dynamics analysis failed when scr=mini set was defined.
6980625	9.0	Results were incorrect when multiple ACSRCE entries were defined with opposite phases.
6988413	9.0	In an NX Model Update solution, residual vectors were being computed as a result of the RESVEC default changes which occurred in NX Nastran 9.0. Residual vectors will no longer be computed in this solution by default. In general, when a SOL 200 subcase includes ANALYSIS=MODES, the default is now RESVEC=COMPONENT.
6992702	9.0	Plane stress elements which included thermal loads produced incorrect results in all solutions.
6993337	9.0	CFAST elements ignored the x,y,z points when (GA,GB,GS) were all blank.

7101809	9.0	Fatal occurred with AMLS version 5.x when a FLSPOUT output request was included.
7104227	8.0	When RESVEC(NODYNRSP) was defined, the residual vectors were still included in a SOL 111 frequency response.
7104236	9.0	No residual vectors were generated if they were requested for RVDOF only.
7105679	8.5	The INPUTT2 module was not reading the matrix data block correctly as a result of an OP2 conversion problem running with the ILP–64 executable.
Other Fixes		
N/A	9.0	A refinement failure could occur with a contact or glue definition. Bad intersections between the source and target faces were not being trapped.
N/A	9.0	A fatal error occurred in SOL 401 when forces were applied to a fixed node in a time = 0.0 subcase.
N/A	9.0	The limits on RSTEP and RSTART fields on the ROTORD entry have been removed to allow rotation in a reverse direction and analysis for a decreasing RPM.
N/A	9.0	The parameters RESVEC and RESVIINER were not overriding the RESVEC case control default settings.
N/A	9.0	Constraint force computations were causing a crash in solutions 108, 109, 111, 112.
N/A	9.0	Parameter was missing param in DMAP that controls ply-layer strength ratio output.
N/A	9.0	Incorrect results as a result of m-set processing of UOO sets when using an external superelement which was reduced in a static solution.
N/A	9.0	The OP4 file format has been updated in order to import alternate formats.
N/A	9.0	Performance issues with the INPUTT4 module when running the ILP–64 executable have been corrected.
N/A	9.0	An option to control the maxminum number of flutter iterations for SOL 145 was requested. The new system cell 583 has been created to allow this control.

Chapter

4 System description summary

System description summary

The list of supported systems is included in the **README.txt** file located in the NX Nastran installation under the *nxn9p1* directory.