PERF016 – Performances of INFO_MODE and of CALC_MODES+OPTION=' BANDE' parallels

Summary:

The objective of this CAS-test is to measure the performances of the office plurality of two strategies of parallelization in INFO_MODE and CALC_MODES +OPTION=' BANDE' with cutting in sub-bands. The savings of time and memory are interesting and these accelerations (up to 2 times in peak report, 30/40 times in time on about sixty processors) can really facilitate many dynamic studies on modal basis.

1 Problem of reference

The cas-test perf013c is used as problem of reference.

Large modal calculations, in the face of problem and/or of many searched modes, are carried out *via* the operator CALC_MODES +OPTION=' BANDE' with cutting in sub-bands. This operator cuts out the frequential band of research in several contiguous sub-bands so as to reduce consumption in time and memory of calculation. This research by sub-bands also makes it possible to improve the robustness and the precision of the results.
To limit the déséquilibrages of load in modal calculation, they pre-are gauged *via* a call to INFO_MODE. This last operator activates same the two levels of parallelism as those of CALC_MODES +OPTION=' BANDE' with cutting in sub-bands.

The decomposition in sub-bands gets finally a last advantage, it arranges level of an explicit and very effective parallelism, by allowing the distribution of each sub-band on 1 or several processors. Thus, the modal calculations operated within each sub-band proceed jointly. If several processors are available for each sub-band, one can even call a second level of parallelism *via* linear solvor direct MUMPS. These two combined levels of parallelism make it possible to gain much in time and a little in peak report RAM (keyword NIVEAU_PARALLELISME=' COMPLET', value by default).

To center the profits mainly on the peak report or because the number of processors available is insufficient compared to the number of sub-bands, one can also limit parallelism to the only second level, that of MUMPS (NIVEAU_PARALLELISME=' PARTIEL').

The objective of this CAS-test is to measure the performances of these two strategies of parallelization in INFO_MODE and CALC_MODES +OPTION=' BANDE' with cutting in sub-bands. The savings of time and memory are interesting and these accelerations (up to 2 times in peak report, 30/40 times in time on about sixty processors) can really facilitate many dynamic studies on modal basis.

Modal calculation used takes again modeling C of the CAS-test *perf013*: square plate with a grid in elements of hulls ($N=4\mathrm{M}$ degrees of freedom), linear finite elements, search for 50 clean modes in 4 sub-bands with the modal solvor by default and linear solvor MUMPS. One tests the sequential configuration (modeling A), as well as the two parallel strategies out of 4 and 16 processors (modelings B/C and D/E).

For calculations CALC_MODES +OPTION=' BANDE' with cutting in sub-bands, one checks various values of frequency and different component from the unit effective modal masses [1] .
For calculations INFO_MODE, one tests the minimal, maximum values and the sum of the components 'NB_MODE'generated table.

2 Reference solution

See the CAS-test perf013c.

1 At the boundaries of the sub-bands to detect possible problems in communications MPI.

3 Modeling A

3.1 Characteristics of modeling A

Number of processor: 1

One uses modeling C of the CAS-test perf0013: square plate with a grid in elements of hulls, linear finite elements, search for 50 clean modes *via* the operator CALC_MODES +OPTION=' BANDE' with cutting in sub-bands. One uses the modal solvor and the value of the test of Sturm by default.
One pre-gauges modal calculation by a call to INFO_MODE on the sub-bands of frequencies: $[0.1\text{GHz}, 1.1\,GHz]$, $[1.1\text{GHz}, 2.0\,Hz]$, $[2.0\text{GHz}, 3.0\,GHz]$ and $[3.0\text{GHz}, 4.0\,GHz]$.

One parameter the linear brick solvor with the best currently available tool in *Code_Aster* for this kind of calculation: solvor MUMPS (METHODE=' MUMPS') coupled with renumerotor QAMD (RENUM=' QAMD') and invited in memory (to accelerate the many descent-increase, GESTION_MEMOIRE=' IN_CORE').

Characteristics of the grid: 667,489 NODE, 3,264 SEG2 and 665,856 QUAD4.
Many degrees of freedom : 4,024,530.

3.2 Results

Size	Reference
FREQ n°1	47,605
MASS_EFFE_UN_DZ n°1	0.420180
FREQ n°10	1546.457
MASS_EFFE_UN_DZ n°10	3,423 10^{-3}
FREQ n°21	3978.453
MASS_EFFE_UN_DZ n°21	1,467 10^{-3}

4 Modeling B

4.1 Characteristics of modeling B

Many processors: 4.

Identical to modeling A but calculation on 4 processors by privileging the first level of parallelism (that by default is carried out here *via* NIVEAU_PARALLELISME=' COMPLET').
Each sub-band is entrusted to a processor. Occurrences MUMPS, called jointly by each sub-band, thus work only on 1 processor.

4.2 Results

Identical to modeling A.

5 Modeling C

5.1 Characteristics of modeling C

Many processors: 16.

Identical to modeling A but calculation is carried out here on 16 processors by using two levels of parallelism (operation by default *via* NIVEAU_PARALLELISME=' COMPLET').
Each sub-band is entrusted to four processors. Occurrences MUMPS, called jointly by each sub-band, thus work each one on 4 processors.

5.2 Results

Identical to modeling A.

6 Modeling D

6.1 Characteristics of modeling D

Number of processor: 4.

Identical to modeling A but calculation is carried out here on 4 processors by privileging the second level of parallelism (NIVEAU_PARALLELISME=' PARTIEL'). All the sub-bands are treated the ones after the others.

Only occurrences MUMPS, called for digital factorizations and the descent-increase required by the modal solvor, work in parallel on 4 processors.

6.2 Results

Identical to modeling A.

7 Modeling E

7.1 Characteristics of modeling E

Identical to modeling D but calculation is carried out here on 16 processors.

7.2 Results

Identical to modeling A.

8 Summary of the results

These results were got in version 11.3.9 on machine IVANOE with 1 process MPI by node. For recall, the performances in version 11.2 (parameters by default) were: $9296\,s$ and $23.5\,Go$ (for CALC_MODES +OPTION=' BANDE' with cutting in sub-bands) and $2016\,s$ and $17.0\,Go$ (for INFO_MODE).

V11.3.9 INFO_MODE/ CALC_MODES	With	B	C	D	E
Type of parallelism	1×1	4×1	4×4	1×4	1×16
Elapsed time	$1008\,s$ $3544\,s$	$387\,s$ $1123\,s$	$170\,s$ $636\,s$	$422\,s$ $1853\,s$	$253\,s$ $1432\,s$
Vmpeak	$7.8\,Go$ $17.2\,Go$	$7.8\,Go$ $19.5\,Go$	$7.8\,Go$ $13.8\,Go$	$7.8\,Go$ $10.6\,Go$	$7.8\,Go$ $9.5\,Go$