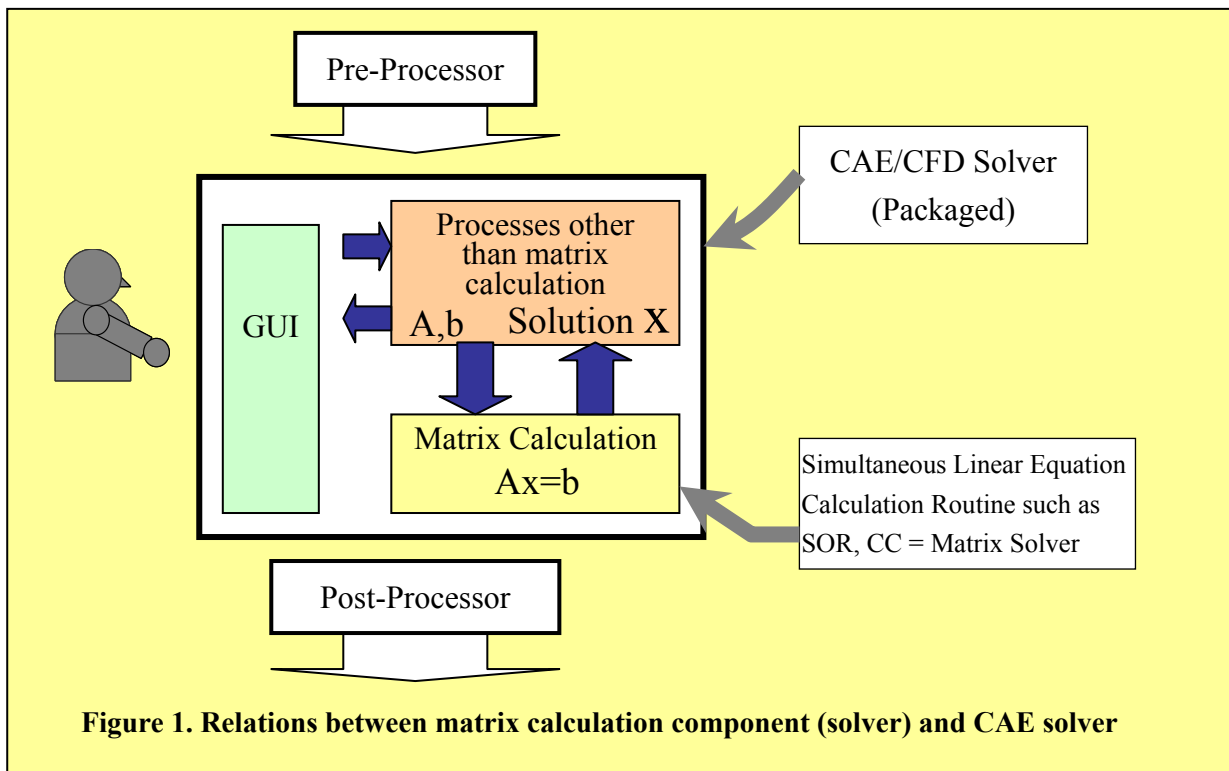


How to Evaluate/Install Super Matrix Solver

1. Relations between *Super Matrix Solver* and CFD (CAE) Solvers

The *Super Matrix Solver* (SMS) is a mathematical routine for solving simultaneous linear equation systems. Because the product name contains the word “Solver”, SMS is often confused with CAE/CFD solvers. As shown in Figure 1, SMS is used for calculating matrices (simultaneous linear equation systems) by being installed as a component of CFD solvers.



2. Procedures for evaluating *Super Matrix Solver*

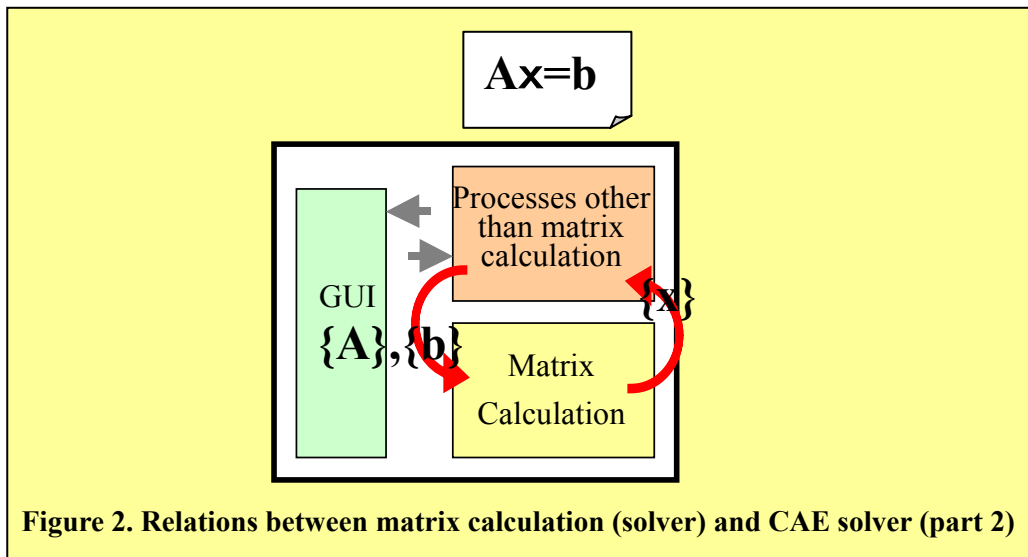
There are basically two (2) ways for evaluating SMS:

Method 1: VINAS conducts benchmark calculation using the data provided by users.

Method 2: Users install an evaluation version of SMS into their own solvers.

2.1. VINAS conducts benchmark calculation using the data provided by users

Matrix data given to the matrix calculation (solver) is the data used for SMS evaluation (see Figure 2).



For a simultaneous linear equation $Ax=b$, the coefficient matrix A and the right-hand-side vector b are given to the matrix solver. The matrix solver returns the solution vector x . For benchmark testing at VINAS, the users need to provide VINAS with the data for the coefficient matrix A and the right-hand-side vector b . (Also, convergence conditions and the number of iteration must be specified.)

2.1.1. Procedures for users to provide data for benchmark at VINAS

1) Prepare test data

Extract 2 to 3 pairs of matrix data ($\{A\}, \{b\}$).

It is preferable for performance evaluation purposes that matrix data extracted are “as large as possible” and “difficult (time consuming) to solve”. At the same time, for the purpose of average performance evaluation, please prepare the matrix of general size.

2) Measure the processing time for the calculation by original solver

For performance comparison between SMS and your current solver, please measure the calculation time in less than or equal to 0.1 second units, for your current solver from the beginning of calculation (reading of the file) until the convergence conditions are satisfied

3) Send to VINAS the exact same matrix data used in the step 2 described above. (Please refer to a separate document for explanations on data format). Also, please send the following information together with the matrix data, for the purpose of performance comparison with SMS:

- a) calculation results obtained from your current solver (vector $\{x\}$)
- b) calculation time information for calculation by your current solver
- c) convergence determination conditions (e.g. relative residual expressed in L^2 norm)

4) VINAS will report the process time and calculation results after calculating the matrix data provided using SMS.

2.1.2. Points to Consider

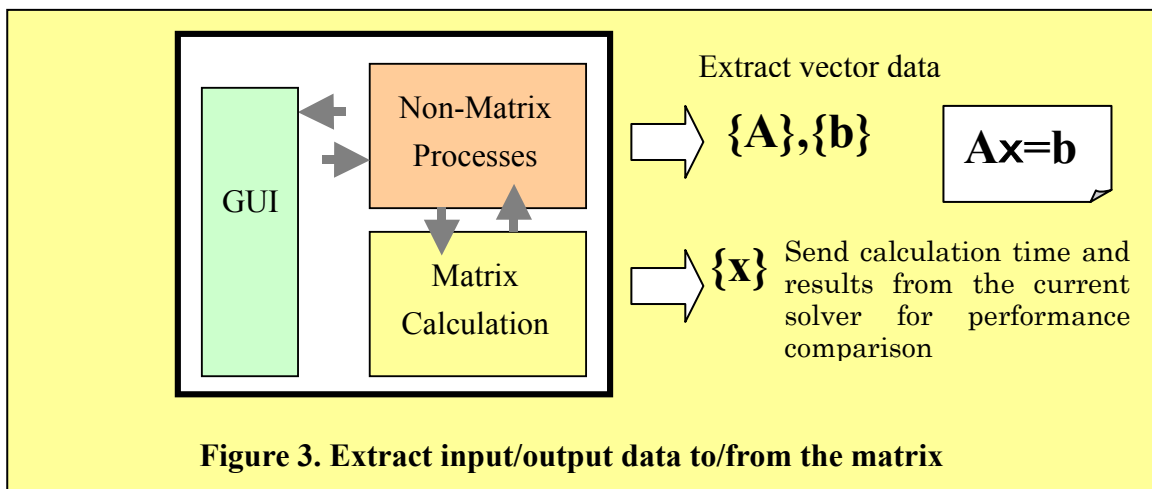
The following points are essential for benchmark testing:

1) Is it possible to extract the matrix data $\{A\}, \{b\}$?

In some types of CFD solvers, the matrix solver exists as an independent module (such as those that are routinized). In other types of CFD solvers, the matrix solver is commingled with other modules and hard to replace.

With CFD solvers with an independent matrix solver, extract the matrix $\{A\}$ and vector $\{b\}$ from the arguments that are given to the matrix solver.

In case the matrix solver is completely integrated to the CFD solver, change the source code, and dump the matrix data $\{A\}, \{b\}$ into a file.

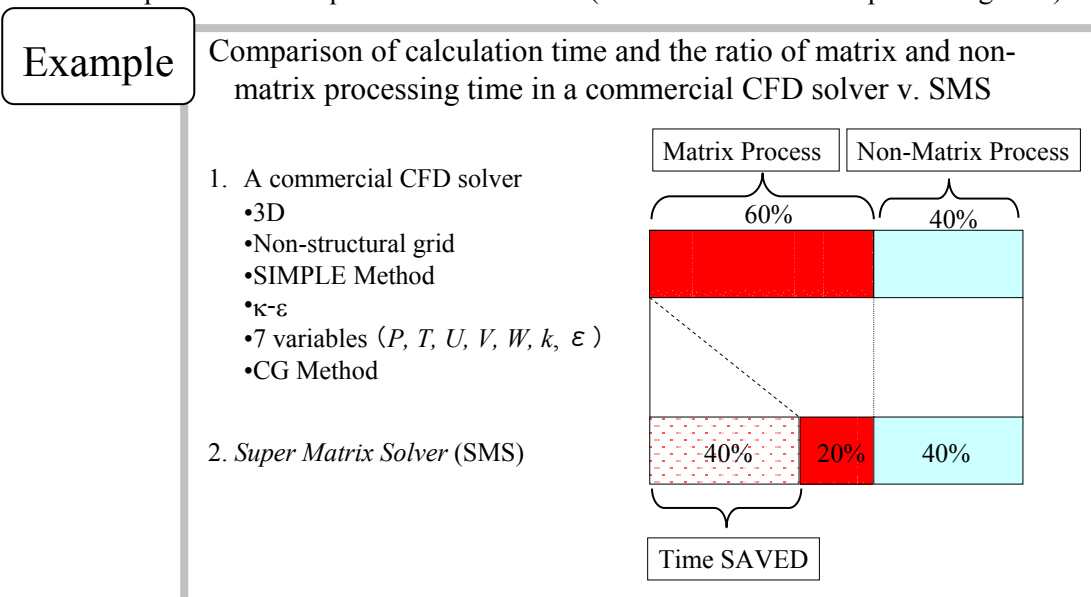


2) Is it possible to measure the calculation time of the original (your current) matrix solver?

This information is essential for performance comparison of solvers alone.

3) Could the ratio between matrix processing time and non-matrix processing time be determined out of an entire processing time of the CFD solver?

For a commercial CFD solver provided in an example to the right, 60% of the calculation time is spent on matrix processing, and 40% on non-matrix processing. Suppose that the calculation using SMS would reduce the matrix process time by 1/3, then the total processing time for SMS would be 60% of the total process time required for CFD solver (40% reduction in total processing time).



2.2 Method 2: Users install an evaluation version of SMS into their own solvers.

Users may assess the integration performance on their own by using the evaluation version of SMS. In order to do this, users need to convert their data in the format that is readable by SMS. Also, program changes are required for enabling the program to give arguments to SMS.

Please refer to the product manual that comes with the evaluation version of SMS, for integration procedures and arguments. Be sure to reference the documents provided by VINAS to check if it is possible to integrate SMS into your current solver, and whether or not the integration of SMS into your current solver would be effective.

3. Matrix Data Format

At VINAS, we employ a proprietary QMF format for efficient storage of sparse matrix information. While QMF format is effective for memory use reduction, users who are not familiar with this data format may find it complicated. For this reason, evaluation version of SMS employs VS data format, which allows for a simple data generation by users.

For benchmark testing, required data structure changes depending on natures of problems.

Please refer to a separate document explaining VS format for required data structures as well as VS format.

4. Sending Data to VINAS

Please send your data to VINAS in the form of CF-R or MO.

You could also upload the data to our FTP site, so please let us know if you wish to do so.

END