Dytran™ 2007 r1

Release Guide
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Dytran™ 2007 r1 is the most significant and comprehensive version of Dytran released by MSC.Software, bringing new simulation technology and faster solutions.

Dytran 2007 r1 is available on UNIX (HP RISC 2.0, HP-UX Itanium2, SGI, IBM, HP Alpha, Sun SPARC Solaris), Intel Linux (Red Hat 9), Linux Itanium2 IA64 (Red Hat AS 3), Linux EMT64 X86-64 (Red Hat Enterprise Linux WS3), Windows 32 bit (2000, and XP) and Windows 64 bit (XP) platforms.

Dytran 2007 r1 has many new powerful meshing technologies and capabilities in several key areas, resulting in higher degrees of robustness, performance, and ease-of-use. These include:

- Graded and nonuniform Eulerian meshes to dramatically increase the computational performance of Eulerian solver. These capabilities will benefit important FSI applications such as blast waves, sloshing, airbags and UNDEX (Under Water Shock Explosion) simulations.
- Multi-Stage and Resize capability to import the Euler results from a previous run with fine mesh into a new run with coarse mesh to significantly improve the simulation time.
- Speed up of coupling surface computations by automatically detecting and skipping stationary coupling surfaces resulting in 2X to 3X performance improvements in applications such as pipe flow problems, tank filling, sloshing, and airbags without the adaptive euler.
- Speed up of axi-symmetric mesh models through time step determination based on the axial and radial directions;
- Shipping and UNDEX applications can now use a special boundary treatment defined based on hydrostatic pressure profile;
- For bottle manufacturing, a new capability is introduced to model the gauge pressure in hot filling of bottles. When the fluid cools down the bottle contracts due to loading by negative gauge pressure.
- Capability to model pre-stressed concrete structures prior to blast or other type of dynamic loadings.
- Capability to model a Boundary Layer for viscous problems by using skin friction.


Dytran 2007 r1 does not include or support USA (Underwater Shock Analysis) code.

Dytran uses the Macrovision FLEXlm™ licensing system. If you already have an MSC.Dytran 2005 r3 license, you will not need to obtain a new authorization code to activate Dytran 2007 r1 on your computer. However, you will need to install the latest FLEXlm 10.8 license server available on Dytran installation CD. The enclosed Dytran 2007 r1 Installation Instructions describe how to install Dytran 2007 r1 on your computer.

If you need assistance while installing Dytran 2007 r1, please call the MSC Technical Support Hotline at 1-800-732-7284, or E-mail your support questions to mscdytran.support@mscsoftware.com.
Many new powerful features have been introduced in this release, resulting in higher levels of robustness, performance and ease-of-use. A major emphasis in the Dytran 2007 r1 release is to dramatically increase the performance of the FSI solver. In addition the enhanced robustness of the Multi-Material Euler Solver with strength will offer a unique and unprecedented technology to solve complex applications such as the ballistic example as shown below. With Dytran 2007 r1, simulating these new and complex FSI applications become a reality while existing applications can be predicted with much more fidelity.
Import of Euler Archives

In many cases, reading the Eulerian results can significantly reduce the simulation time by importing the Eulerian archives of an initial run. Moreover, results can be mapped onto a coarser or finer mesh. For example, the initial stage of a blast wave requires a fine mesh. After the wave front has become less steep, the run can be terminated and results can be imported in a new run. The results of the fine mesh are then mapped onto a coarser mesh. The mapping does not have an adverse impact on the integrity of the solution because it conserves momentum, mass, and internal energy. Since the new run is not a restart run, it is possible to add a coupling surface or to remodel items. For example, to simulate the impact on several structures in different positions, the propagation of the blast wave from ignition point to the vicinity of the structures only need to be done once.

![Figure 2-1 First Cycle of Run that uses Euler Archive Import](image)
Graded Meshes

In simulations with Euler and coupling surfaces, it is preferred to use orthogonal meshes. In addition, a non-uniform euler mesh can speed-up the simulation. The only non-uniform meshes that Dytran accepts are those created by Patran. But the non-uniform orthogonal meshes generated by Patran have drawbacks. The small mesh-sizes propagate to the boundary. So even at the boundary there are elements that have at least one small dimension. To obtain really coarse elements at the boundary, block structured meshes can be used. A block of fine elements is then glued into a block of coarse elements. This allows for orthogonal meshes that consist of really coarse and really fine elements. These graded meshes are useful in applications such as blast wave simulations.

Figure 2-2  Graded Mesh

2-D Axi-symmetry

Dytran does not have a 2-D axi-symmetric solver. Instead, a pie-shaped model of small angle and consisting of one layer of elements can be used. For sufficiently small angles, this is a good approximation to a real 2-D axi-symmetric simulation. Because of the small angle, the element size in circumferential direction is small resulting in very small time steps. Since the combined hoop stresses result in a radial force, there should be no dynamics in the circumferential direction. Therefore, the time step computation can leave out the circumferential direction resulting in much shorter run times. But pie meshes created by Patran are written out in single precision. This leads to small errors in normals and causing dynamics in the circumferential direction. To avoid these errors, two approaches have become available and are activated by PARAM,AXIALSYM:

- Create a rectangular mesh. Dytran transforms it into a pie.
• Create a pie mesh with Patran and Dytran aligns the normals such that dynamics in circumferential direction is avoided.

This allows leaving out the circumferential direction from time step considerations.

Nonuniform Euler with MESH,BOX

With MESH,BOX, a bias can be specified for each coordinate direction. The ratio between the smallest and largest element size is the required input. The growth in element size can either start at the reference point of the MESH or at the center. To generate elements with constant element size in the center region, a second mesh of constant mesh-size can be defined and glued into the biased mesh by using the graded mesh functionality.
Hydrostatic Boundary Conditions

To simulate bubble collapse in UNDEX simulations, it is essential to have boundary conditions that resemble a hydrostatic pressure profile. This can be done by many distinct FLOW or PORFLOW entries but this is cumbersome. With the new PORHYDST and a new option for FLOW, this can be done automatically. These boundary definitions use a HYDSYTAT entry to prescribe a matching hydrostatic boundary condition. An example illustrating the use of these new definitions is shown in figure 3. A weak blast wave is ignited in the ocean. After initial expansion it starts to collapse and after the collapse it starts to expand again.

Figure 2-3  FMAT of Water at Maximum Expansion, Maximum Compression, and Second Blast Wave

Skin Friction

In many flow simulations, fluid moves along a wall or structures. Often the viscous effects are limited to a quite small region along structure surfaces, forming a boundary layer. If the size of this boundary layer is smaller than an Euler element, the shear forces from the viscous fluid on the structure can not be accurately computed. In Dytran 2007 r1, an empirical law is used to calculate the shear forces. Coefficient of skin friction is available either in literature or from experimental studies.

Moreover, the skin friction can account to some degree for turbulence and roughness of the structural surface. Figure 2-4 shows air flow past a cylinder. Flow conditions are such that the Reynolds number is large. According to experiment, vortex shedding takes place. Using only viscosity will not show this, but by using skin friction this occurs as shown in Figure 2-4.
Robustness of the Multi-material Euler Solver

The multi-material solver with strength has been made more robust. In particular:

- The removal of small masses could sometimes lead to zeroing out of the stress tensor
- VELMAX,NO did not work properly for multi-material clumps

New Models

User-defined variables such as EXUSR1 cannot be used in the user-defined material models of Eulerian models such as EXEOS. To allow material models based on additional user-defined variables, the following material models have been added:

- The EXEOS1
- The EXYLD1 for Eulerian materials
- The FAILEX2 for the multi-material Euler solver with strength

These models allow two user-defined variables.
CHAPTER 2
Eulerian and Fluid-Structure Interaction (FSI)

Automatic Skipping for Stationary Coupling Surfaces

The coupling surface computation needed for the interaction between Euler meshes and Lagrange structures is very CPU intensive, taking about 20% to 50% of total run time. A lot of CPU time is wasted for stationary coupling surfaces that do not move. In the past, COSUBMAX had to be added to avoid this situation. Dytran 2007 r1 automatically detects whether a coupling surface moves or is stationary. It does not redo the computation as long as the coupling surface is stationary.

Areas of application where stationary coupling surface regularly occur are tank filling, pipe flow, and sloshing. In an example of outflow of water from a bottle into a container, it took only 7 hours 22 minutes with Dytran 2007 r1 compared to 21 hours 45 minutes by Dytran 2005r3 without using coupling surface subcycling, giving a speedup of 2.9X.

In general, speedups between 2X and 3X apply to tank filling and pipe flow problems with stationary coupling surfaces where COSUBCYC had not been added.

Other Enhancements and Bug Fixes

- 1-22315081 Mesh card does not work correctly with CTETRA elements.
- 1-23529951 Dytran SET=ALLLAGSOLID output no result in TETRA elements.
- 1-52062451 WALL cannot recognize truncated Set1D.
- 1-24132136 ALLCONTACTS creates %F when RCONN is present.
- 1-24379041 PLOAD4 on CPENTA gets an error.
- 1-24871891 Output file corrupted when using Tet4 elements.
- 1-24379041 Problem with CFACE1.
- 1-45435977 limit of five Euler materials for multi-material Euler solver has been increased to 10.
- 1-25870971 Dytran Computing Time increases with No. of Points of Stress-Strain Curve.
- 1-44696882 Errors in DETSPH format. If multiple DETSPHs are used and some fields are left blank than only the first DETSPH is processed correctly.
- 1-18620441 MATRIG summary shows double the mass and relocation of C.G when combined with prestress run.
- 1-44044341 The total distortional energy per material is not computed for Eulerian materials modeled by the multi-material solver.
- Cold gas Inflator.
- Hot filling with FFCONTR.
- For multi-material Euler problems with several materials, the material interfaces can easily be visualized in one plot by using the new HMAT variable. HMAT is the material with the largest volume fraction inside an element. The material ID used for HMAT is the internal material ID.
- Reversal does not always work correctly for quads.
• Handle dummy shells in COUP1FL.
• Bugs in dymat25: iteration criterion, effective stress output.
• Generalization of PORFLCPL and PORGBG for use in MD Nastran SOL700. PORFLCPL can also be used to couple GBAGs. Both a PORFLCPL and a PORGBG are allowed on a porous subsurface. Makes it easier to use with from CFD to GBAG.
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Software Installation

On the Windows platforms, Dytran 2007 r1 can easily be installed from CD-ROM as it uses the standard Windows Installation Wizard. On Unix and Linux platforms, the MSC.Software standard installation script can be used to install the software on your system. Dytran 2007 r1 is the successor of MSC.Dytran 2005r3.

Licensing

Dytran uses the FLEXlm license manager as the licensing system for nodelock and network licensing. To run Dytran, you need an authorization code from MSC.Software Corporation. If you already have a license for MSC.Dytran 2005, you will not need to obtain a new license for Dytran 2007 r1.

However, in all cases, you do need a new installation of the license server software. Specifically, the FlexFM license server needs to be at level 10 or higher. For this purpose, an installation of FlexLM v10.8.0 is part of this release on all supported platforms. The previous release of FlexLM was V9.2.

It is noted that Dytran 2007 r1 is not able to check out licenses when the FlexLM server is lower than version 10.

On Windows and Linux computers, Dytran requires an Ethernet card on your computer, even if your computer is not connected to a network. The FLEXlm licensing mechanism uses the Ethernet card to create the unique system identification encrypted in the license information file.

Release Platforms

Dytran 2007 r1 was built and tested on the following hardware with the listed software installed as given in Table 3-1.

Table 3-1  Supported Hardware Configuration

<table>
<thead>
<tr>
<th>Platform</th>
<th>Operating System</th>
<th>Compiler Version</th>
<th>OpenMP Parallel Support</th>
<th>OpenMP Parallel Support</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel Pentium III</td>
<td>Windows 2000-SP4</td>
<td>Intel 9.1*</td>
<td>Yes</td>
<td>Yes</td>
<td>Ethernet Card</td>
</tr>
<tr>
<td>Intel Pentium III</td>
<td>Windows XP-SP2</td>
<td>Intel 9.1*</td>
<td>Yes</td>
<td>Yes</td>
<td>Ethernet Card</td>
</tr>
<tr>
<td>Intel EM64T</td>
<td>Windows 64-bit XP-SP2</td>
<td>Intel 9.1**</td>
<td>Yes</td>
<td>Yes</td>
<td>Ethernet Card</td>
</tr>
</tbody>
</table>

* For correct operation of the Intel Fortran compiler, MS Visual Studio .NET 2003 must be installed prior to installing the Intel 9.1 compiler.

** For correct operation of Intel Fortran Compiler, MS Visual Studio .NET 2005 must be installed prior to installing the Intel 9.1 Compiler.

*** Solaris 10 is also supported.
**Table 3-1  Supported Hardware Configuration (continued)**

<table>
<thead>
<tr>
<th>Platform</th>
<th>Operating System</th>
<th>Compiler Version</th>
<th>OpenMP Parallel Support</th>
<th>OpenMP Parallel Support</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGI R10K/R12K</td>
<td>IRIX64 6.5.22m</td>
<td>MIPSpro f90 7.4</td>
<td>Yes</td>
<td>Yes</td>
<td>N.A.</td>
</tr>
<tr>
<td>HP-UX – PA RISC 2.0</td>
<td>HPUX B.11.00</td>
<td>HP F90 V2.7</td>
<td>Yes</td>
<td>Yes</td>
<td>N.A.</td>
</tr>
<tr>
<td>HP-UX Itanium2</td>
<td>HPUX B.11.23</td>
<td>HP F90 V2.8.7</td>
<td>Yes</td>
<td>Yes</td>
<td>N.A.</td>
</tr>
<tr>
<td>HP Alpha</td>
<td>Tru64 Unix v5.1/1885</td>
<td>DF 90 V5.5-2602</td>
<td>Yes</td>
<td>Yes</td>
<td>N.A.</td>
</tr>
<tr>
<td>Sun Sparc Solaris</td>
<td>Solaris 8*** (= SunOS 5.8 )</td>
<td>Sun Studio 10 (FORTRAN 95 8.1)</td>
<td>Yes</td>
<td>Yes</td>
<td>N.A.</td>
</tr>
<tr>
<td>IBM RS/6000</td>
<td>AIX 5.1</td>
<td>XL Fortran 9.1</td>
<td>Yes</td>
<td>Yes</td>
<td>N.A.</td>
</tr>
<tr>
<td>Linux Itanium2 IA64</td>
<td>RedHat Advanced Server 3</td>
<td>Intel 8.1</td>
<td>Yes</td>
<td>No</td>
<td>Ethernet Card</td>
</tr>
<tr>
<td>Linux EM64T x86 64</td>
<td>RedHat Enterprise Linux WS 3</td>
<td>Intel 8.1</td>
<td>Yes</td>
<td>Yes</td>
<td>Ethernet Card</td>
</tr>
<tr>
<td>Intel Linux</td>
<td>Red Hat Linux release 9</td>
<td>Intel 8.1</td>
<td>Yes</td>
<td>Yes</td>
<td>Ethernet Card</td>
</tr>
</tbody>
</table>

* For correct operation of the Intel Fortran compiler, MS Visual Studio .NET 2003 must be installed prior to installing the Intel 9.1 compiler.

** For correct operation of Intel Fortran Compiler, MS Visual Studio.NET 2005 must be installed prior to installing the Intel 9.1 Compiler.

*** Solaris 10 is also supported.

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**MPI for Dytran LS-DYNA**

Dytran LS-DYNA requires MPI to be installed on every machine used. This is true even for single processor machines.

Dytran LS-DYNA expects hardware-specific native MPI to have been installed at default locations. When MPI is not properly installed on your Unix/Linux machine or is not installed at the expected default location, a job submission will exit with an error message to this effect. See Table 3-2 for details.
Memory Requirements

In general, the size of the memory required by Dytran depends on the size of the engineering problem you wish to solve. The default memory size is set to approximately 30MB. This default size is appropriate for smaller problems.

You can change the preset default in the Dytran Explorer so that it fits your personal needs. In addition, you can define the minimum and maximum memory size and use the slider in the front panel to select the desired memory size. On Unix and Linux platforms you can use the command-line option *(size=small/medium/large)* or you can enter the MEMORY-SIZE definition in the input file.
Dytran traces the usage of memory and prints a summary at the end of the output file of each analysis. The memory size listed in the summary is exact. It reflects the memory required for storing the model in core memory after one integration step. Additional memory required during the analysis is automatically allocated and de-allocated.

When you change the memory setting for an analysis through the Dytran Explorer, the settings will be stored to be used the next time that you run the analysis.

Under certain conditions, Dytran may stop and issue a message that it cannot allocate the required memory. Since the memory allocation in Dytran is dynamic, the system may require additional memory during an analysis. If the memory is available, it will be allocated and de-allocated when it is no longer needed. When your computer runs out of memory, the Dytran analysis may stop when it needs more memory to continue. You may solve this problem by closing applications on your computer that you do not need, or you can decrease the size of the core memory that Dytran allocates for the analysis if you are using substantially more than the analysis requires. You can find the information on the memory size requirements of the analysis in the memory summary at the end of the analysis. We recommend to use Dytran on a computer that has at least 256 MB of RAM.

**Performance**

**Single CPU (Dytran)**

Dytran 2007 r1 performance on single processor was evaluated on all the supported platforms and for some machines is compared to the previous release, MSC.Dytran 2005. Please refer to Table 3-3.
Table 3-3  Performance of MSC.Dytran 2005 and Dytran 2007 r1 on Single Processor

The performance between the two versions in general is comparable. Some performance improvement can be seen for SGI Altix, due to a platform specific compiler related enhancement. (This improved option did not compromise the quality of the results on this platform.) Also should be noted that for two models the code has improved performance for numbers 16 and 17. These models specifically have a very large number of composite property definitions and therefore these models show evidence that the code has become more efficient.

SMP (Dytran)

Dytran supports Shared Memory Parallel (SMP) on multi-CPU hardware. The percentage of functionality that runs in SMP mode has been increased with respect to the previous release (see Tables 3-4 and 3-5).
Table 3-4  Performance of Dytran 2007 r1 on Single and Dual Processors
Table 3-5  Performance of Dytran 2007 r1 on Single and Quad Processors

In the tables above, a value of 0 means that there was no performance increase or decrease. If the number is 100%, the performance was doubled and if negative the performance was decreased (= longer elapsed CPU time).

The platforms used for this study:

<table>
<thead>
<tr>
<th>Platform</th>
<th>CPU Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPUX RISC 2.0</td>
<td>550 MHz, pa-risc 2.0</td>
</tr>
<tr>
<td>Windows64 EM64T QuadCore</td>
<td>EM64T Family 6 Model 15 Stepping 4 GenuineIntel ~2667 MHz</td>
</tr>
<tr>
<td>Linux X8664 2xDualCore EM64T</td>
<td>Intel(R) Xeon(TM) CPU 3.60GHz</td>
</tr>
<tr>
<td>HP Itanium2</td>
<td>Intel(R) Itanium 2 Family Processors 900 MHz</td>
</tr>
<tr>
<td>SGI IRIX64</td>
<td>500 MHZ IP35 Processors</td>
</tr>
<tr>
<td>IBM AIX</td>
<td>PowerPC_POWER4 1453000000 Hz</td>
</tr>
<tr>
<td>Linux X8664 AMD Opteron</td>
<td>Dual Core AMD Opteron(tm) Processor 280 2411.119 MHz</td>
</tr>
<tr>
<td>SGI Altix</td>
<td>1400 MHz Itanium 2 Rev. 5 Processor</td>
</tr>
<tr>
<td>Solaris</td>
<td>Sparcv9 processor 900 MHz</td>
</tr>
<tr>
<td>HP Tru64 Unix</td>
<td>Alpha EV6.8CB (21264C) 1000 MHz</td>
</tr>
</tbody>
</table>
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Running Dytran on Windows

On Windows, submit a Dytran analysis by double-clicking the Dytran icon. The icon should be available on your desktop. Alternatively, you can use the Start Menu to locate Dytran under the Programs Folder. Once you picked either the icon or the menu entry, the Dytran user environment appears on your screen.

The .Dytran Explorer provides an on-line help system that contains information about the functionality of the Dytran Explorer. The Dytran Explorer provides some basic postprocessing and animation tools.

Running Dytran on Unix and Linux

On Unix and Linux platform you would use the command line interface like:

- `dytran jid=xxx` to submit Dytran
- `dytrandmp jid=xxx` to submit Dytran LS-DYNA

Note that the `dytrandmp` job submission script expects MPI to be properly installed.

Before running a dytrandmp job, it is required to insert the following line as the first line in the input deck:

```
*dytran
```

Postprocessing Dytran Results

Dytran results can be postprocessed with Patran. With MSC.Patran 2005, the Direct Result Access (DRA) method is available for both regular Dytran output files (ARC,THS) as well as for the d3plot file which is generated by the LS-DYNA option.

In addition, on Windows, you can use the VisualVrml postprocessing, animation and Visual Time History tool. The tool is built-in inside the Dytran Explorer and offers web-based postprocessing capabilities. When using the LS-DYNA option, a conversion tool of the d3plot file to regular Dytran ARC files is available by right-clicking on the file inside Dytran Explorer.
Postprocessing Dytran Results of Windows on UNIX

If you wish, you can postprocess the analysis results obtained from a Windows platform on a UNIX computer. In this case, you need to convert the binary result files (.ARC and/or .THS) files to a UNIX format. You can perform this conversion by using the right-mouse button menu in the Dytran Explorer. Point your mouse at the file that you wish to convert, click the right mouse button, and select the Convert to binary... menu item. The converted files will have the sb_ prefix. For Compaq Alpha workstations, the native Windows result files can be used directly without conversion.

Alternatively, when running on windows, you can select the option to output result files in UNIX format by default. To set this option, select the Preferences from the Options menu. Choose Formats and select Convert output files automatically to UNIX-format. If you select this option, the regular Windows result files and the converted UNIX-format files are written at the end of the analysis. You can recognize the UNIX-format files by the UX prefix.