# The Performance of Large Car Model by MPP Version of LS-DYNA on Fujitsu PrimePower

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## Abstract

*In order to get the accurate results, the car models become large and the computational time becomes long. I developed 1.2million elements car models based on NCAC Caravan model, for studying the performance of large number of elements models and large number of CPUs on MPP version of LS-DYNA.*
*1., The selection of parts of surface to surface contact is sensitive for the large number of CPUs.*
*2. Soft=2 contact is good performance compared with Soft=1 contact for large number of CPUs*

## Introduction

Many efforts have been doing to get the good accuracy in crash analysis by LS-DYNA. As well as the full integrated shell elements( TYPE=16 ), the modeling by the fine mesh is very popular[1], because of

1. to represent the car geometry more accurate,
2. to reduce the development cost and time by using the batch mesh generator,
3. to reduce the noise when slave nodes moves the edge of master segment, and
4. to reduce the mesh size effects.

On the other hand, these efforts increase the computational times. Type 16 shell elements are 3 times expensive than default Type2 shell elements. For explicit analysis, fine mesh needs more computational time than the increase of number of mesh number, for example, when the edge size of shell element reduces to half, number of elements becomes 4 times, but computational times becomes 8 times because the time step size also becomes half by Courant condition.

In order to execute these models, MPP, which parallel processing for distributed memory system, is introduced in LS-DYNA. The large car model is developed and the performance of large number of CPUs is reported in this paper.

## Car to Car Crash Model

The Caravan model was originally developed by NCAC[2]. The number of elements is 0.3 million. I developed large car model based on NCAC Caravan model. Shell element is divided to 4 , and the total number of elements becomes 1.2 million. I set up car to car crash Analysis. The total number of elements is 2.4 million.

The shell elements are modified to TYPE16 from TYPE2.
The contact definitions are:

C-1. single surface contact for each car( SOFT=2 )
C-2. surface to surface contact for car to car( SOFT=2 )
C-3. surface to surface contact between engine and surrounding parts( SOFT=2 or =1)
C-4. tied contact between solid elements and surface shell

In the original model, the modeling of Radiator and Radiator fan are very sensitive for numerical accuracy and many times terminated by negative volume, so I modify the modeling around the Radiator and material properties.

For domain decomposition, SY=1000 is used for MPP970R6763 single precision for Fujitsu PRIMEPOWER

## Consideration of Contact Parts

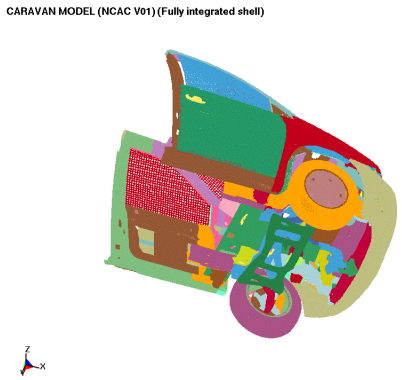


Fig.1 Model I

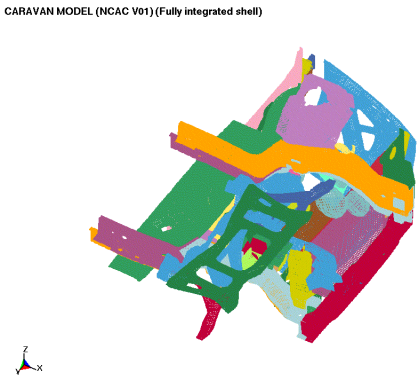


Fig.2: Model II

At first, contact definition C-3 is defined by engine and surrounding parts as shown in Fig.1. For 32CPU, the calculation cost of this contact is 1.3%, but for 128 CPU the calculation cost of the contact is 9.8% , since the element calculation and the other contact are speed-up. The elapse time of C-3 for 128CPU is longer than that for 32CPU, and the performance is not improved after 64CPU as shown in Fig.3 Model I.

In order to improve the performance, I reduce the number of surrounding parts as shown in Fig.2. By this modification, the performance is improved as shown in Fig.3 Model II. Model I need more communication for surface to surface contact than Model II.

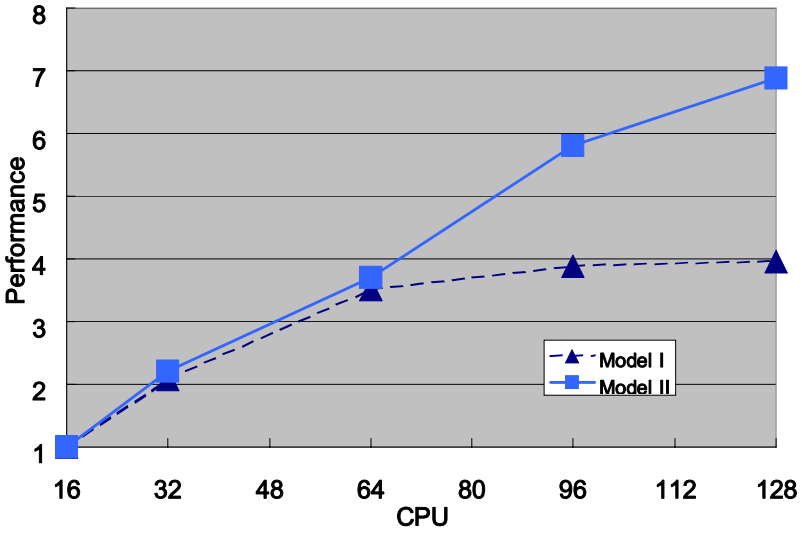


Fig3: the performance of Model I and Model II

## Contact Type

LS-DYNA has two types of CONTACT. One is node-to-segment type contact ( SOFT=0 or 1 ), the other is segment based contact( SOFT=2 ). For a small number of CPUs, both contacts give almost the same performance. The effect of changing the C-3 contact from SOFT=2 to SOFT=1 for Model II. is shown in Fig.4. SOFT=2 contact gives better performance than SOFT=1.

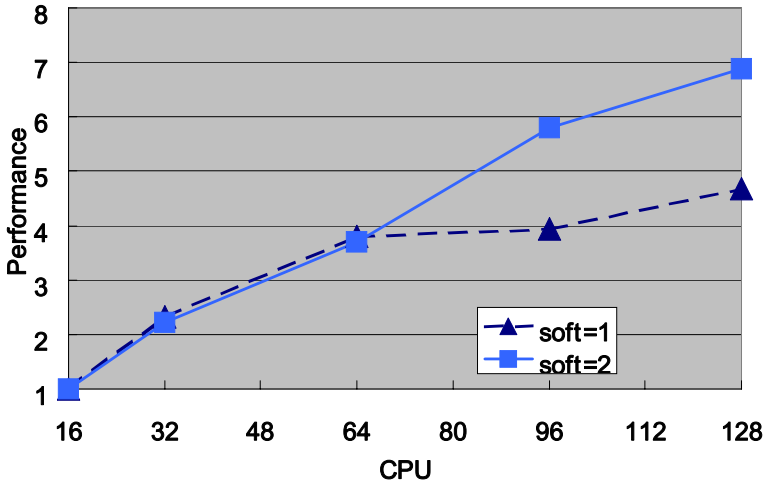


Fig. 4 the performance of SOFT=2 and SOFT=1

## Summary

1. For large number of CPUs, the selection of parts, which will be contact, is more sensitive for performance. The contact for small area has possibility to control the total performance.

2. SOFT=2 contact is more good performance in comparison with SOFT=1 contact for surface to surface contact. SOFT=1 surface to surface contact is 2pass algorithm of nodes to segments, on the other hand SOFT=2 surface to surface contact is segment based 1pass algorithm [3], and the communication cost of SOFT=2 may be smaller than that of SOFT=1.

The car to car crash model for C-3 contact with Model II and SOFT=2 is submitted to TOPCRUNCH[4] for BMT data( car2car-ver10).

## Acknowledgment

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### References

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[2] National Car Crash Center http;//www.ncac.gwu.edu/vml/models.html

[3] Livermore Software Technology Corp. LS-DYNA Theoretical manual

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