LS- Dyna on MPP Platforms,
Experiences and Practical
Recommendations

4th European LS- DYNA
Conference
23rd May 2003
Ulm, Germany

Rainer Emrich, Udo Jankowski
Tecosim GmbH, Rüsselsheim, Germany

Tecosim in brief

• Company founded in 1992
• Strategic CAE Partner of Major Automotive Manufacturers
• CAE- Attributes:
  - Crash-, Occupant simulation
  - CFD
  - S+D/NVH
  - Durability/Optimization
  - Powertrain (PT)
• State-of-the-Art IT Infrastructure
• Currently 77 Employees
  at 5 Locations
• Co-operative Venture with
  several design service suppliers
Locations and References

- Rüsselsheim
- Köln
- Leonberg
- Basildon, Essex, UK
- Coventry, West-Midlands, UK

Application Fields & Distribution

30 %  **Vehicle & Body CAE**
- Attributes: NVH / Durability
- Fatigue Analysis

50 %  **Vehicle & Body CAE**
- Attributes: Crashworthiness / Occupant & Pedestrian Safety

10 %  **Computational Fluid**
- Attributes: Thermal Management / Propulsion / Aerodynamics

10 %  **Component CAE**
- Attributes: Topology
- Optimisation, Powertrain Analysis
- Fatigue Analysis
Overview/ Agenda

1. MPP in different domains
2. Boundaries of MPP
3. Market development of MPP Systems
4. HPC evolution @ Tecosim
5. Update on MPP Performance of LS Dyna
6. Load balancing on a cluster machine
7. Modelling recommendations to improve performance
8. Summary / Further Steps

MPP in different domains

Comparison
of the performance of MPP machines

With 100 trillion connections, each computing 200 calculations per second we get 20 million billion calculations per second meaning:

20000 Tflop/s or 20Pflops/s

The Earth Simulator is expected to have a maximum performance capability of 36 trillion calculations per second with 5120 SX5 proc. meaning:

36 Tflop/s
I do not think parallelism is natural to the human brain (although without being accused of sexism, I would like to say that the female brain seems to incorporate a certain degree of parallel working, which is unfamiliar to a mere male). The programs we write are typically conceived as a string of sequential instructions which we expect to be carried out on a sequential computer. Just as a computer program may be interrupted, in order that the processor perform another task, so the human brain can cope with a few levels of interruption, switching between tasks, but not working on different tasks at the same time.

„Parallel Processing at CERN“ by E. McIntosh, B. Panzer-Steindel (1996)

Amdahl's Law

\[ S = \lim_{P \to \infty} \frac{1}{s + \frac{1-s}{P}} = \frac{1}{s} \]

\( S \) = speedup which can be achieved with \( P \) processes

\( s \) = proportion of a calculation which is serial

\( P \) = Number of Processors

\( 1 - s \) = parallelizable portion
Boundaries of MPP

Theoretical Speedup for MPP

HPC Evolution for PC platforms

1991: October first "official" version, Linux 0.02. released
1998: First PC versions of explicit crash codes on the market mainly SMP
2000: First release of LS Dyna Linux MPP
2001: Radioss Linux MPP Version release
2002: Pam Crash Linux MPP Version release
HPC Evolution @ Tecosim

1996: SGI Powerchallenge 8 Processors SMP architecture

1997: SGI Power Challenge 16 Processors SMP architecture

1998: NEC SX4 with 2 processors vector machine SMP architecture

2001: First PC usage for number crunching

End of 2001: Purchase of NEC PC Linux cluster

May 2003 NEC PC Linux cluster with 48 CPU’s