

Outline

- Notion of a global address space
- Extended copy transfer (ECT) characterization
 - Bandwidth, spatial locality, temporal locality
- Performance of local/remote memory accesses and transfers
 - DEC8400, T3D, T3E
 - Intel P6, uni- and twin- Processor
- High speed communication and the memory system
- Evaluation with an application kernel

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Computer Systems Performance Analysis and Benchmarking (37-235)

Analytic Modeling
Simulation

Measurements / Benchmarking

Lecture/Assignments/Projects:
Dr. Christian Kurmann

Textbook:

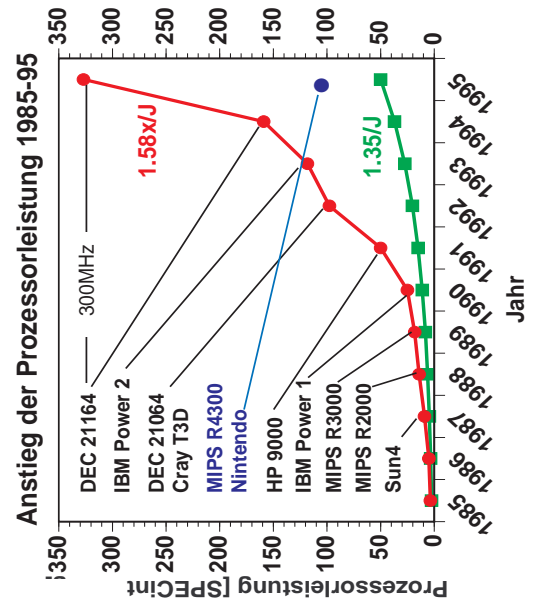
Raj Jain, "The Art of Computer Systems Performance Analysis", 1991 Wiley & Sons, New York

Topic of Today:

- Memory Systems Benchmarks (ECT-memperf)
- Modelling of an application (OPAL)

30.01.03 - 1 37-235 Perf.Eval.&Benchmarking © Stricker, Kurmann

Rechenleistung wächst explosionsartig!



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Memory System Performance Characterization
for PCs, Workstations and Parallel Systems

PDS Group ETH



Laboratory for Computer Systems
Swiss Institute of Technology
CH-8092 Zürich

Intel Microprocessor Research Lab

February 10, 1997

Caveat

Some parameter combinations are hard to measure, even with carefully tuned C code:

- Reduced performance for *large strides* and *small working-sets* is a measurement artifact and not architecture related.
- Compilers occasionally generate suboptimal instruction schedules for loads/stores.

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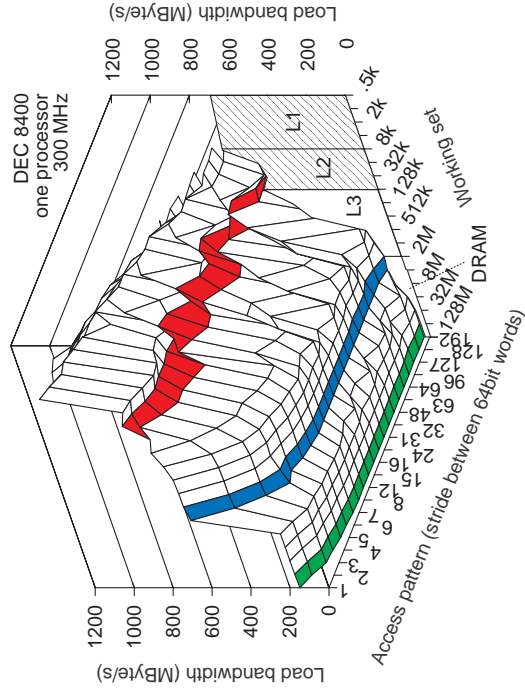
Extended Copy Transfer Characterizations

Contribution: New method to characterize the performance of memory systems:

- Categories
 - Access pattern, stride (temporal locality)
 - Working set (spatial locality)
- Value
 - Transfer bandwidth (large amount of data)
- Same chart resulting from one microbenchmark
 - Local and Remote transfers

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Local Load Access (DEC 8400)



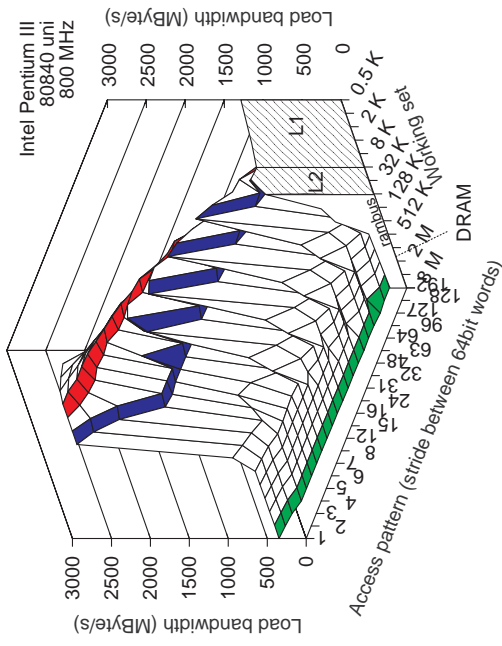
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Related work

- Trace based evaluation of a memory system
- Classic NUMA model
- A basic copy transfer model [ISCA95]

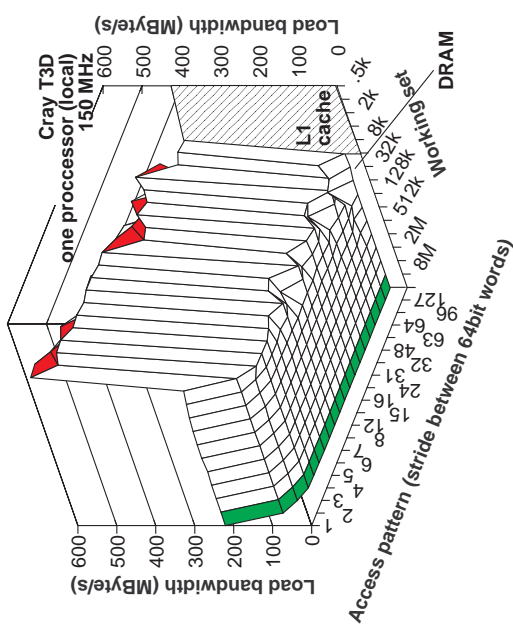
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Load Datenstrom Intel 80840 (800MHz)



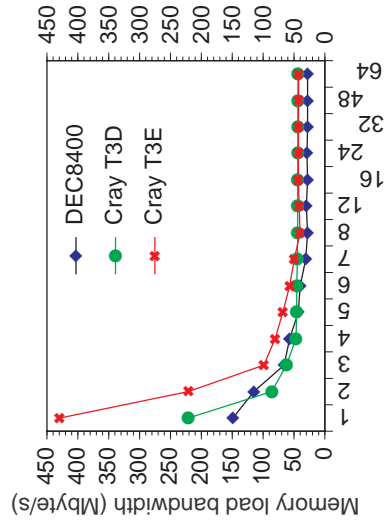
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Local Load Access (Cray T3D)



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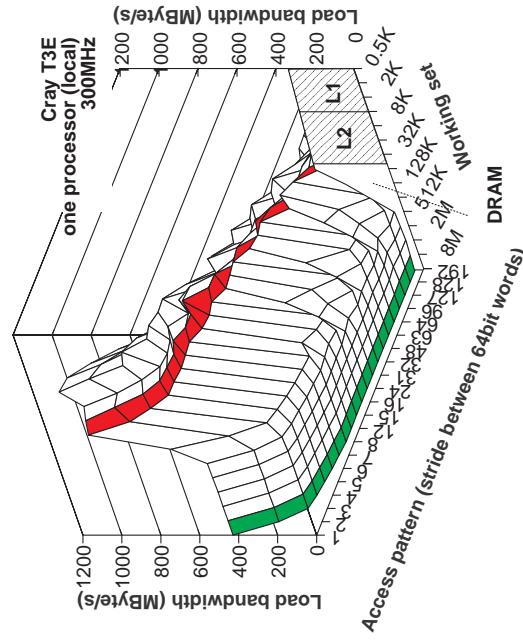
Comparison - Local (Working Set: DRAM)



Access pattern (stride between 64bit words)

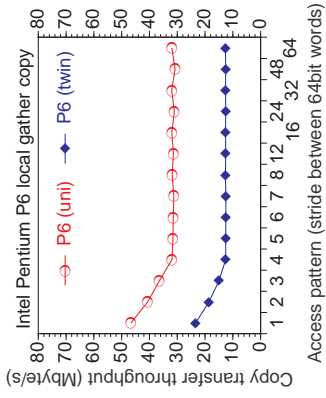
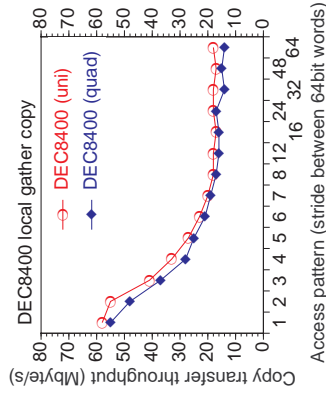
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Local Load Access (Cray T3E)



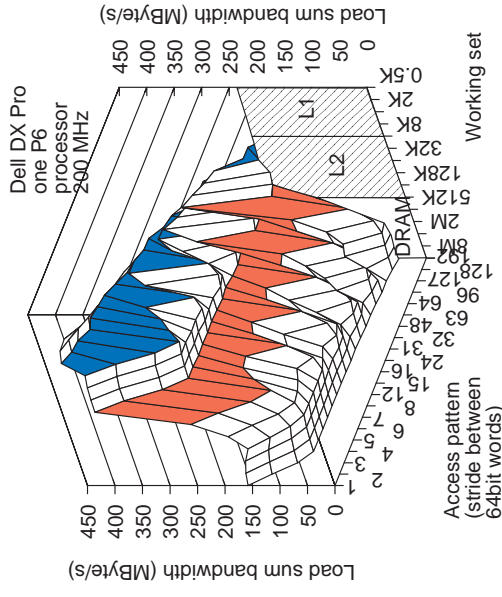
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Comparison - Local Copy (Working Set: DRAM)



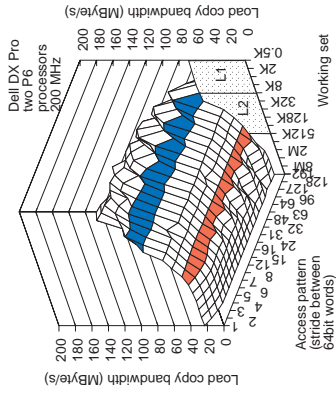
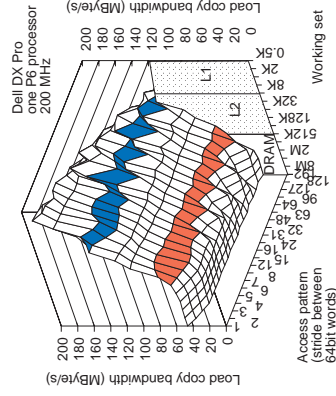
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Local Load Access (P6 single)



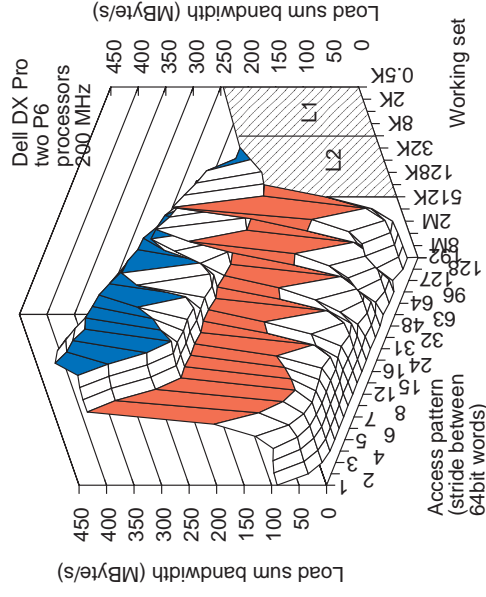
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Local Copy (P6 single/twin)



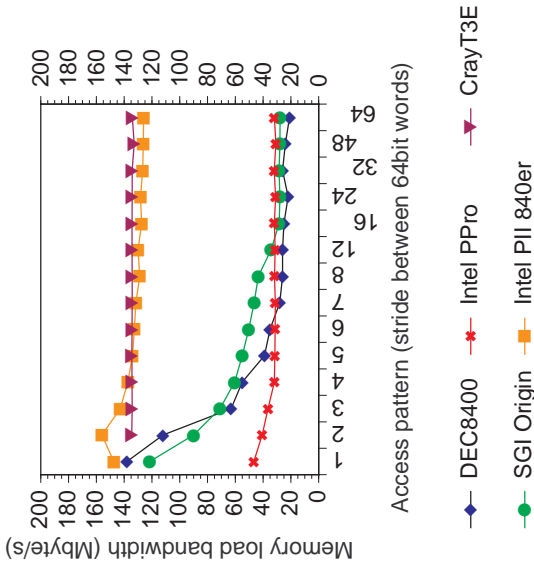
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Local Load Access (P6 twin)



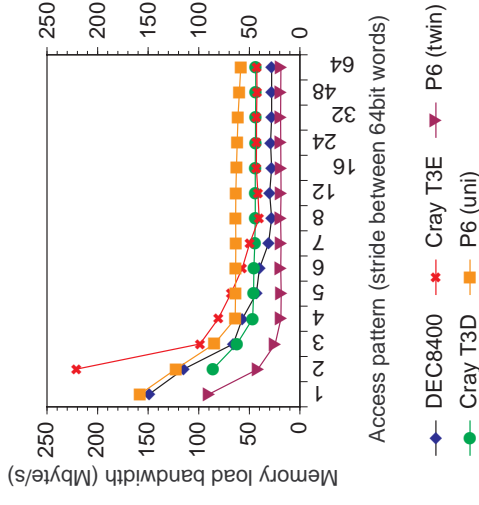
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Vergleich - Local Copy



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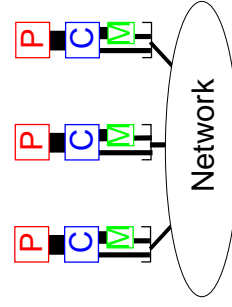
Comparison - Local Access (Working Set: DRAM)



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Local/Remote: Parallel Computers

Parallel & Network Computers



Nectar (Classic, Gigabit, Credit), SHRIMP
Cray T3D/T3E, Intel Paragon, NEC Cenju

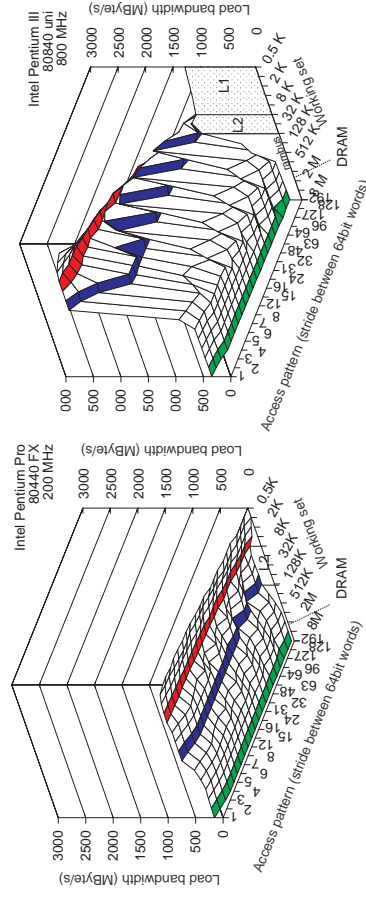
P: Processor

M: Memory

C: on-chip/on-board Caches

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Entwicklung 1996 to 2000

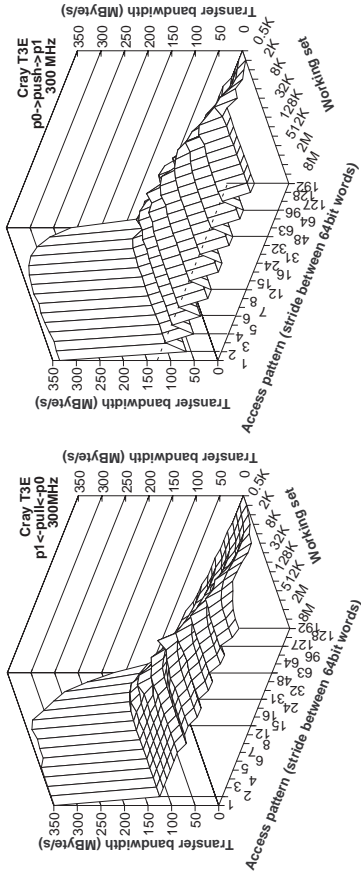


80440FX (200MHz)

80840 (800MHz)

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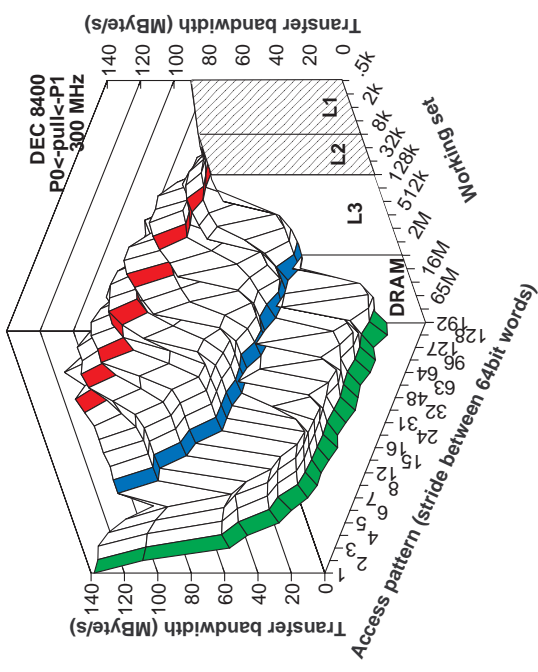
Remote Copy on Cray T3E (push, pull)



**Performance numbers on T3E are likely to improve
New machine software not as mature as T3D**

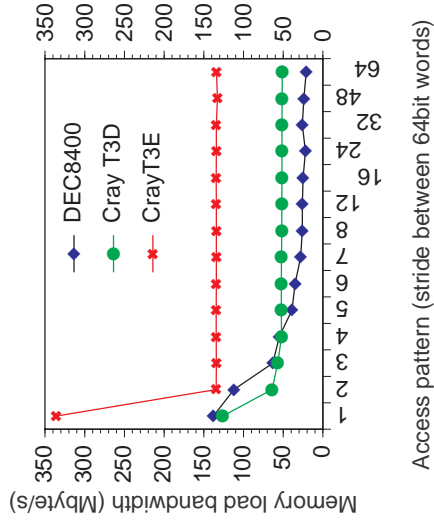
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Remote Copy Transfer (DEC 8400)



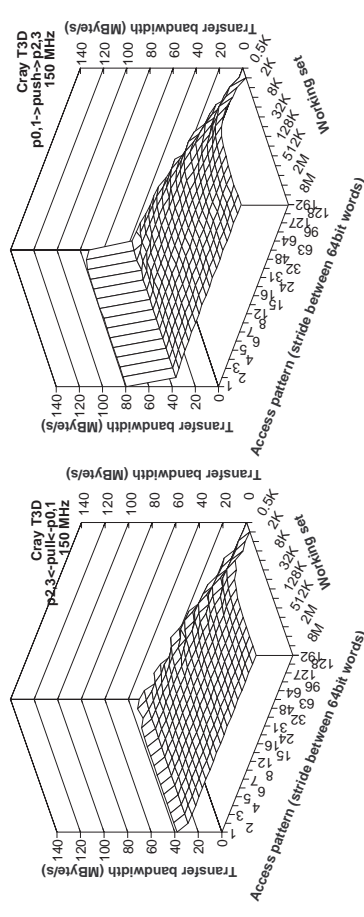
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Comparison - Remote (Working Set: DRAM)



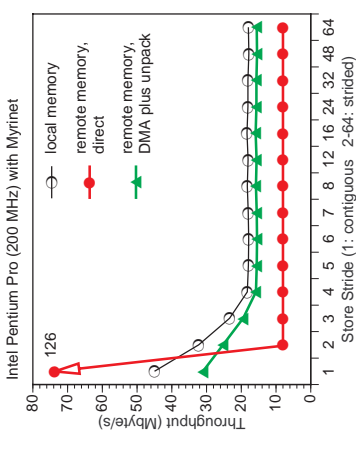
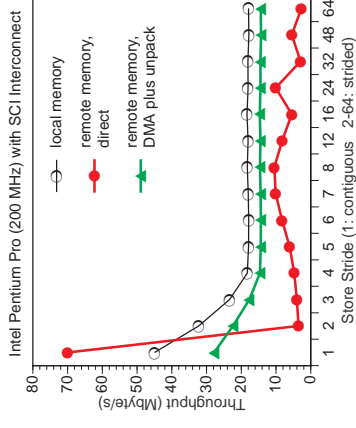
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Remote Copy Transfer on T3D (push/pull)



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Remote Transfer im Cluster (Working Set: DRAM)



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Conclusions

- The introduction of a **global address space** asks for a new memory system **performance model**.
- Streaming support (MPPs) instead of L3 caches (SMPs) can result in **better memory systems** and **faster computation**.
- **Fast communication** puts a high demand on the memory system. Current PC platforms need some improvements.