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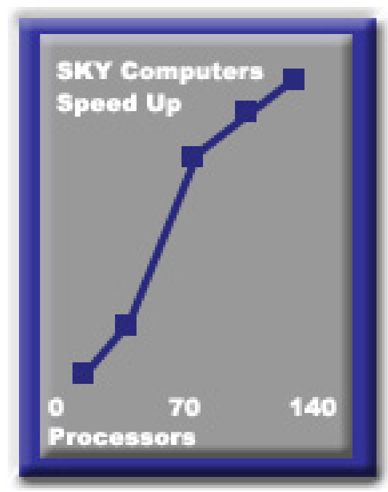
THE MULTICOMPUTING EXPERTS

A SKY Computers White Paper

System Speed Up: The Cornerturn Benchmark



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System Speedup Introduction

One critical measure of the performance of a multiprocessor system is *speedup*. Speedup measures how much more performance a multiprocessor system delivers compared to a baseline system. For example, assume a particular benchmark takes 10 seconds in a system with a single processor. In a system with four processors, the same benchmark takes 2.5 seconds. The speedup for a four-processor system running this benchmark would be 10 / 2.5 = 4. The multiprocessor system with four processors provides a speedup of 4 – it is four times faster than the baseline system.

Speedup is directly related to the efficiency of the interconnect fabric. As more processors are added to a system, more data must be exchanged between them, both to provide raw data for processing, and to co-ordinate their actions. The amount of data traffic in a multiprocessor system increases far faster than the number of processors. An efficient interconnect fabric allows additional processors to devote their power to processing, not to moving data.

This report compares the system speedup of a SKY Computers system using the Merlin compute nodes and the SKYchannel interconnect fabric with a Mercury Computer System (MCS) system using PPC750 compute nodes and the RACEWAY interconnect fabric. The MCS performance numbers are taken from an August 2000 public report that lists timings for a 1K x 1K cornerturn benchmark.[1] The raw numbers are in the Appendix. The cornerturn benchmark was run on systems with increasing numbers of processors.

The cornerturn benchmark definition is:

The input is a square matrix of size n x n, n = 1024. The matrix is stored initially in row-major order. In the distributed case, the rows are divided equally among the processing nodes. The benchmark times how long it takes to redistribute the data and store it in column-major order, again distributed evenly among the processing nodes in the distributed case

The requirement to do a cornerturn on the incoming data is common in most signal and image processing applications. As you can see from the definition, a cornerturn creates a large amount of inter processor traffic. In fact, all a cornerturn does is redistribute data – no processing is involved. As the number of processors increase, a cornerturn puts great stress upon the interconnect fabric. A good interconnect fabric will maintain high speedup numbers even as the number of processors and data traffic increases.

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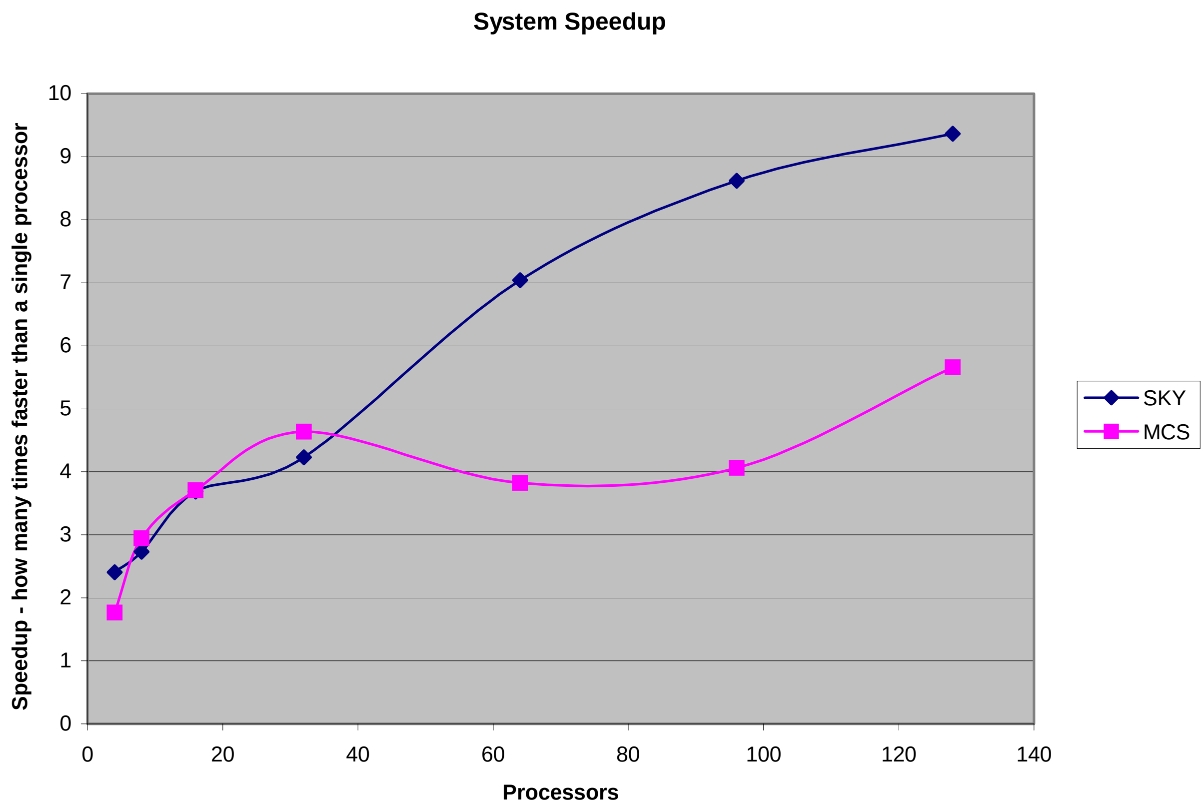
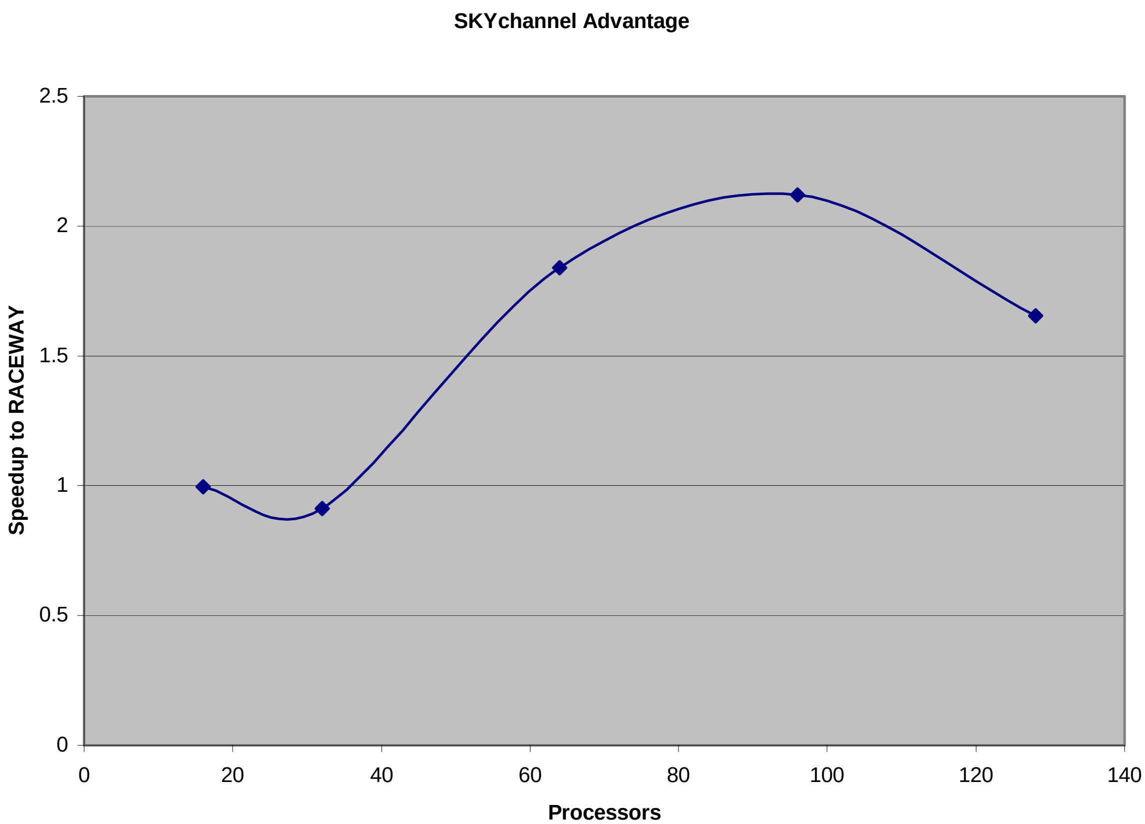
[1] APIs, Benchmarking & Power of Abstraction, Kanevsky and Pepe, 2000

This graph compares the system speedup between SKY and MCS systems when doing a 1K x 1K cornerturn.



As you can see from the graph, the SKY system consistently delivers high speedup, even as the number of processors increases. The MCS system does not. In fact, adding more than 32 processors to the MCS system actually <u>decreases</u> performance. With 32 processors, the MCS system is about four and a half times as fast as the MCS baseline system (dual processors). As more processors are added, system performance declines. A MCS system with 96 processors delivers less performance than a MCS system with 32 processors. Only when 128 processors are used does the MCS system exceed the performance of a 32-processor system. Even with 128 processors, the MCS system is only about five and one half times faster than the baseline system. The MCS numbers show that RACEWAY is unable to handle the increase in data transfer load as more processors are added.

The SKY system with SKYchannel continues to increase system performance as more processors are added. A SKY system with 64 processors is over 7 times faster than a single processor. A SKY system with 128 processors is almost 10 times faster than the baseline system. SKY system performance does not decline when more processors are added. The SKYchannel interconnect fabric continues to deliver data efficiently, even under high loads. The last graph shows the ratio between SKY speedup and MCS speedup.



This clearly shows that the balanced SKY system architecture of fast compute nodes and fast interconnect fabric delivers a speedup advantage over a MCS system. The superiority of SKYchannel is even more pronounced as data traffic increases. A SKY system with 96 processors delivers over twice the speedup of a MCS system with the same number of processors.

This consistent SKY speedup means significant advantages:

1. Fewer SKY compute nodes than MCS compute nodes are needed to run a customer's application. With the SKYchannel interconnect, processors do processing, not data movement.

2. Additional processors can be added without causing a performance crash. Frequently, customers underestimate the number of processors needed to run an application. In a SKY system, customers can add more processors to increase overall performance. With a MCS system, adding more processors can overwhelm RACEWAY and cause a decrease in performance.

Additional benchmark information from SKY is available at www.skycomputers.com

Appendix

This appendix contains the raw data used to calculate the speedup figures for the MCS and SKY systems.

The following table contains raw numbers from the MCS report. It shows the 1K x 1K cornerturn timings for a MCS PPC750 system using the RACEWAY interconnect and the PAS library.

Number of processors	***2***	***4***	***8***	***16***	***32***	***64***	***96***	***128***
Time In milliseconds	55.219	31.19	18.73	14.90	11.91	14.43	13.59	9.76
Speedup	0	1.76	2.94	3.70	4.63	3.82	4.06	5.65

This table shows the 1K x 1K cornerturn timings for a SKY Merlin system using SKYchannel interconnect and the SKY library.

Number of processors	***1***	***4***	***8***	***16***	***32***	***64***	***96***	***128***
Time In milliseconds	62.05	26.180	23.036	17.087	14.887	8.949	7.31	6.727
Speedup	0	2.40	2.73	3.68	4.23	7.03	8.618	9.36