

Scalability Problems In Shared Memory

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Braga, March 2013

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Memory Bandwidth

$$\text{Mem_bandwidth} = ((\text{PAPI_LLC_TCM}) \times 64 \times 1 \times 10^{-9}) / \text{exec_time}$$
$$\text{measured_mem_bandwidth} = (3826100 \times 64 \times 1 \times 10^{-9}) / 0.942194 = 0.2599 \text{ GB/s}$$
$$\text{System_memory_avail_bandwidth} = 14.8473 \text{ GB/s}$$

Instructions per cycle

$$\text{Total Instructions} = 211932871 \quad \text{Number of cycles} = 1548$$
$$\text{Instruction per cycle} = 136907$$

As seen in the December presentation, conv-diff has some locality problems (has it can also be seen by the high number of L1 misses (14937146)).

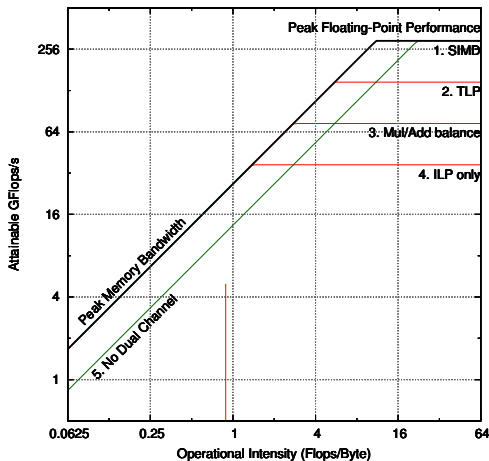


Figure : Roofline for rMBP and conv_diff

Task Granularity

In `conv_diff`:

- Only two parallel pieces of code run in parallel
- Large chunks of code
- Thread creation overhead is thus minimized

conv_diff is unsuitable for this sort of optimization:

Excessive task synchronization

- Reduction can't be used because values are updated in an array of pointers
- Synchronization must be forced on attributions

Loads Per Task

- Slight improvement using dynamic and guided scheduling
- Workload distribution also isn't the biggest problem

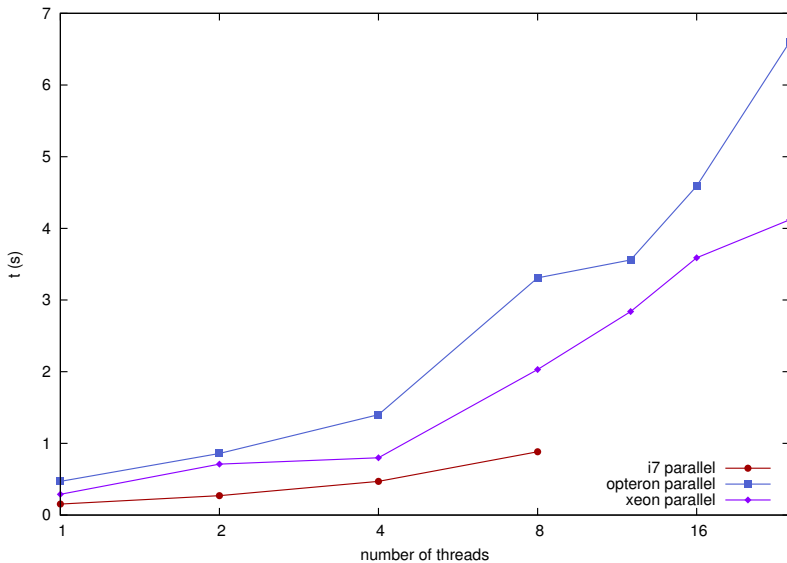


Figure : Scalability of the parallel region (original implementation)

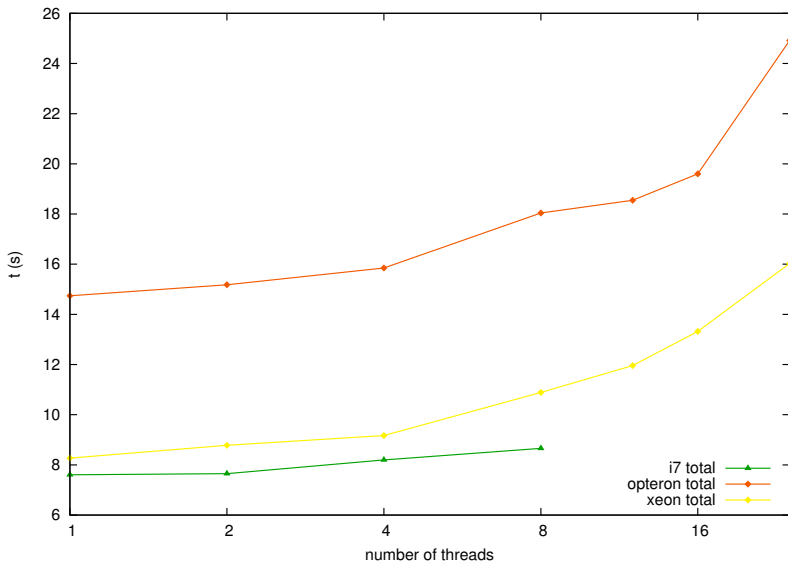


Figure : Total execution time (original implementation)

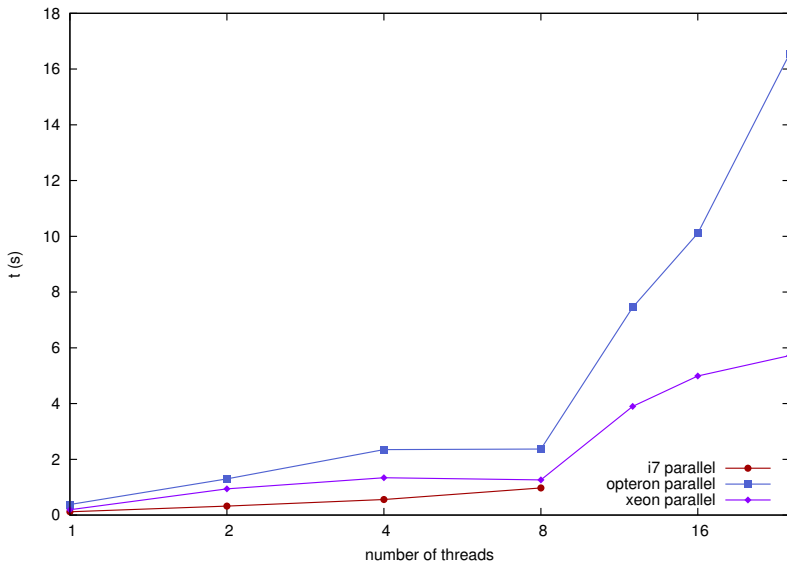


Figure : Scalability of the parallel region (without atomic directive)

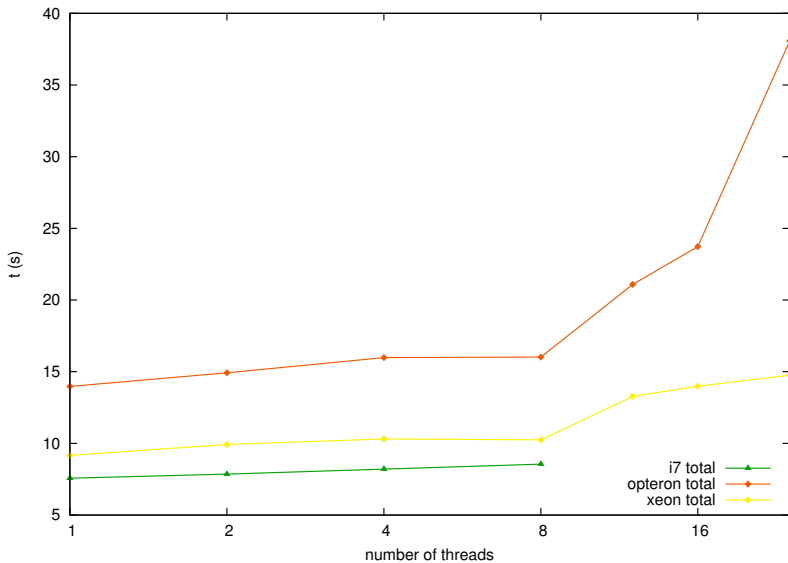


Figure : Total execution time (without atomic directive)

Conclusion

- Bad data locality hinders the entire application performance
- Implementation either AoS or SoA is expected to improve performance dramatically
- High chance that locality problem hides other problems
- Maybe what is not a problem now will prove to be so in the near future

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