Distributed Shared Memory Integration

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DSM Portability

- The DSM performance issues have been preferred over portability issues.
- The APIs of DSMs fit only specific systems.
  - Migration might require a significant revision.
- Programs for SMPs should be rewritten if a scale up for a cluster is needed.
- Programmers need to acquire new programming skills for each DSM system.

What do We Aim for?

- A DSM API that will be identical to the standard UNIX API.
- A DSM that is not bundled within other IPC elements.
  - As an expansion, we require that all IPC elements will not be bundled within other IPC elements.
- The very same program can be compiled on a PC, an SMP or a cluster with even not a single change.

Approaches of DSM systems

- Virtual DSM
- Object DSM
- Thread Migration
- Compiler supported DSM

Virtual DSM

- Each page on each node can be ***available*** or ***unavailable***
- A process may handle only ***available*** pages.
- If a process encounters an ***unavailable*** page, the page will be fetched to the node and it status will become ***available***.
- A page can be ***available*** only at one node.

Object DSM

- The page resides only at one node.
- Each process that has to access the page will connect the page's host.
- Some systems allows the page having a replicas on one or more machine.
  - In such cases a writing should be done in all the replicas.

Thread Migrations

- Move the processes or the threads towards the pages, instead of moving the pages towards the processes.
- A process that tries to access a page, will be moved to the page's host.

Complier Supported DSM

- The program hints the compiler regarding the shared memory access manner.
- For example, hinting that a page is write-shared, will allow multiple threads to change its content without disallowing other threads from doing so.
- This approach is very efficient, but the API becomes very cumbersome.

Portable DSM

- Portability - Built as a user level lib.
- Usability - Having the same API as in standard UNIX systems.
- Disjointing - Creating a portable, stand-alone, multiple-processor IPCs, i.e. not a kernel implementation.

The Implementation

- The implementation was done in the most common approach - Virtual DSM; however it obviously can be implemented by any other approach.
- The well-known “Segmentation Fault” signal was used to check whether the page is ***available*** on current host.

Daemons

- dsmserver - Running only on the server processor and responsible for:
  - Allocations of page numbers to processes.
  - Saving pages after process termination.
- mcdaemon - Running on each processor and responsible for:
  - Transferring a locally ***available*** pages upon requests.

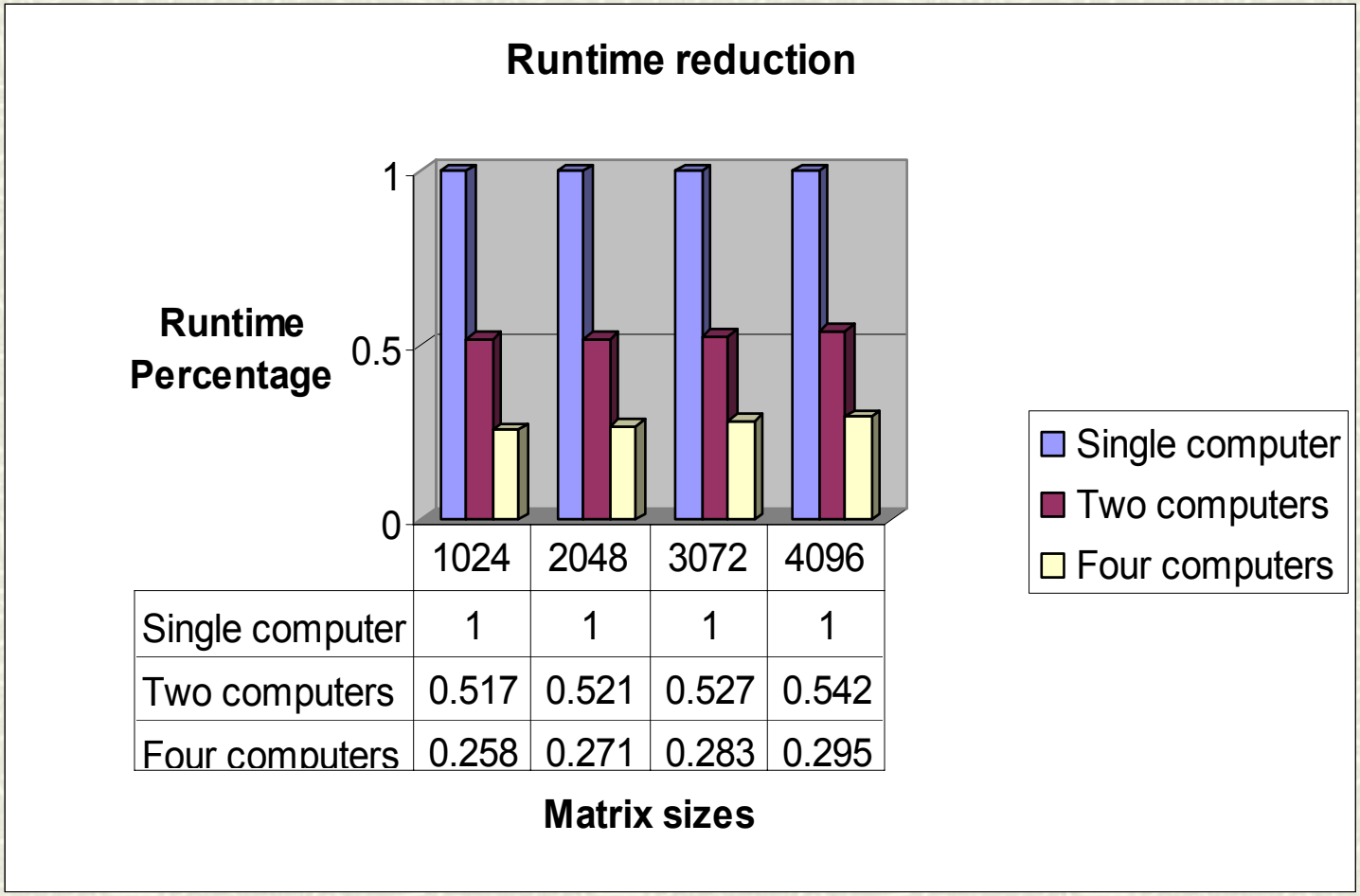
Handling Segmentation Faults

- When a process accesses an ***unavailable*** page, UNIX will send the process a "segmentation fault" signal.
- A dedicated signal handler in the library will catch the signal.
- The signal handler checks whether it is a real "segmentation fault" or an ***unavailable*** page.
- If it is an ***unavailable*** page, a multicast is sent requesting the page.
- The mcdaemon in the processor that has the page, will send the page and will mark it as an ***unavailable*** page.

Semaphores

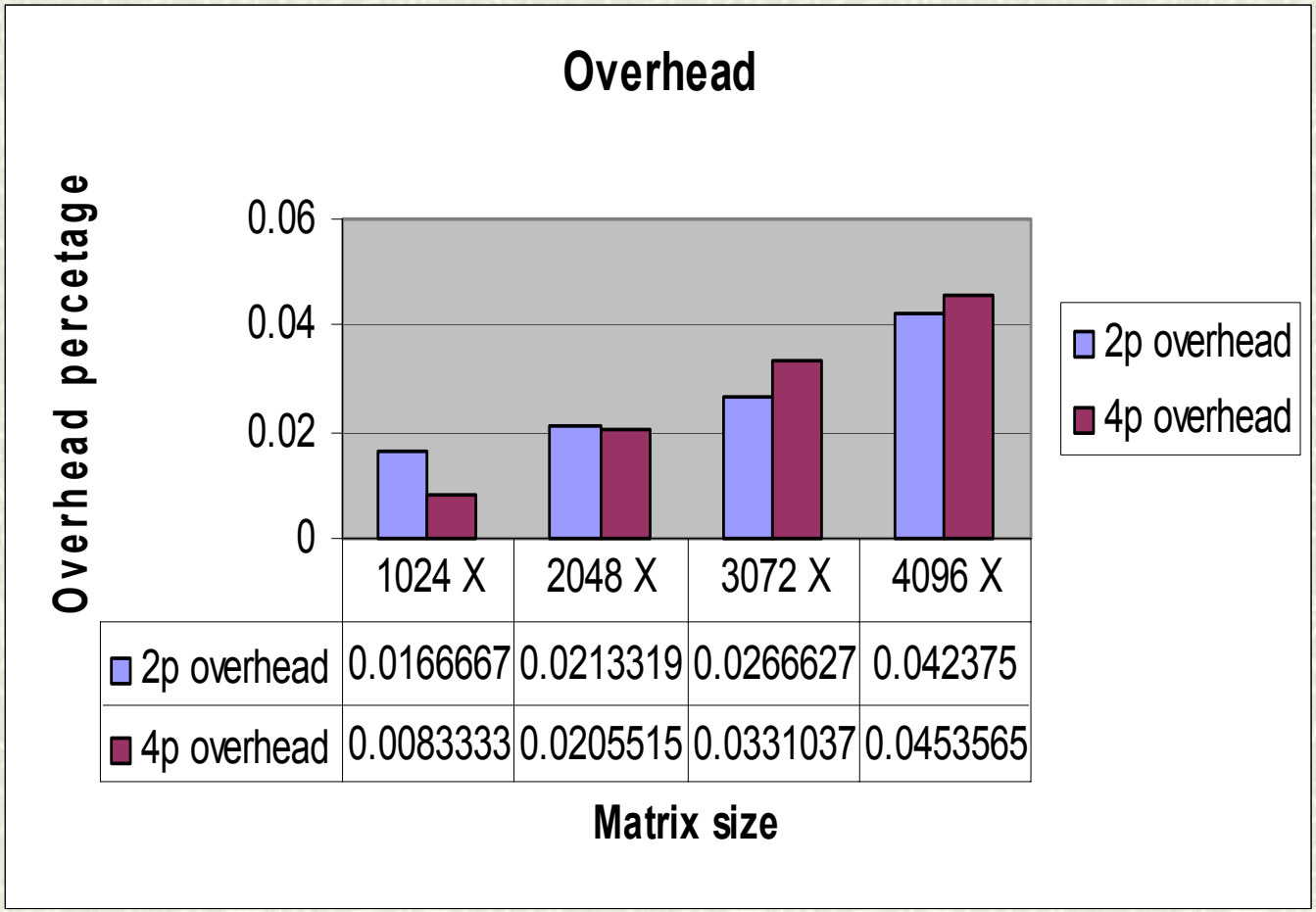
- A supplementary IPC element for the DSM is the Remote Semaphores.
- Similarly to DSM, the Remote Semaphores have two daemons:
- Server Daemon on the server processor that handles the id numbers and the location of the semaphores.
- Client Daemon on each client processor that handles the real semaphores.

Benchmark - Dense Matrix Multiplication



	1024	2048	3072	4096
Single computer	1	1	1	1
Two computers	0.517	0.521	0.527	0.542
Four computers	0.258	0.271	0.283	0.295

Oevrhead



	1024 X	2048 X	3072 X	4096 X
2p overhead	0.0166667	0.0213319	0.0266627	0.042375
4p overhead	0.0083333	0.0205515	0.0331037	0.0453565

Conclusions

- Nowadays DSMs are very sophisticated and complicated; thus can help solve many advanced problems.
- However, the cumbersome API deters programmers from using advanced DSM packages.
- We believe this common UNIX API for DSM can bring the integration of advanced DSM packages into play.