Core-Aware Scheduling: Balancing Application Parallelism with Core Availability

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PLATFORMLAB

Introduction

Motivation: Inefficient core and thread management

- Hard to get high throughput in low latency services
- Difficult to match application parallelism to available cores.

Proposal: Core-Aware Scheduling

- Thread scheduling moves to user level
- Kernel allocates cores to applications

Outline

Motivation

Proposal for Core-Aware Scheduling

Related Work

Current Status

Request for Feedback

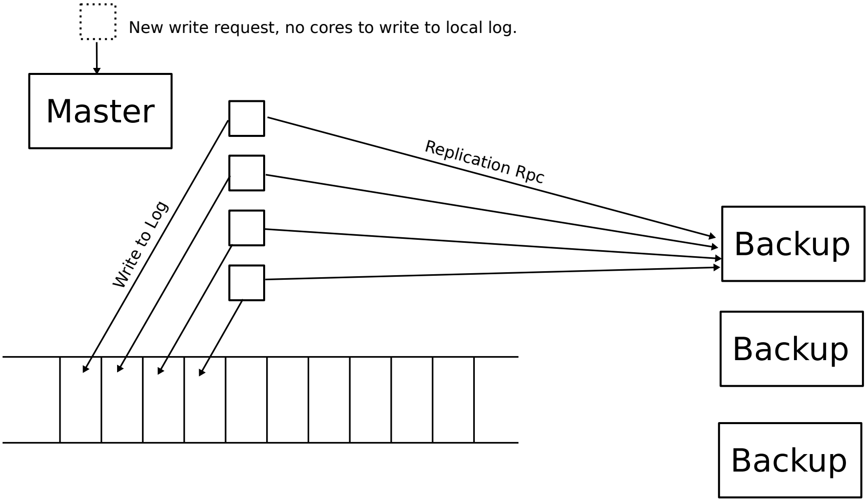
A Throughput Problem

RAMCloud write requests must make replication requests to backup servers, and wait for their return.

RAMCloud uses polling to avoid expensive kernel thread switches and and kernel bypass to avoid system calls.

When the master runs out of CPU cores it must cease processing requests.

Core Exhaustion Bottleneck



What happens under load?

Backups are slower to respond, since they coexist with masters.

Write requests wait even longer for backups, spinning cores for even longer.

Match application parallelism to available cores

Application servers can have many threads running such as log cleaners, worker threads, and failure detection threads.

We want to neither overcommit nor undercommit cores.

Overcommit cores ==> undesirable kernel multiplexing because there are multiple kernel threads per core

Under commit cores ==> idle cores.

When the log cleaner needs to run, we would like to scale down the number of worker threads so that we do not exceed available cores.

Core-Aware Scheduling: Kernel Core Allocator

Kernel scheduler class which allocates cores to applications on request.

In general, kernel never preempts a thread running on the cores it has allocated to the process.

Allow kernel to safely multiplex latency-sensitive applications with CPU-bound batch jobs.

Latency-sensitive applications can request only as many cores as they need, and give up cores when they no longer need it.

Core-Aware Scheduling: Userland Scheduler

Fast context switches enable practical core multiplexing in a low-latency system.

Manage thread priorities and parallelism level based on application-specified policies.

User-level scheduler requests dedicated cores from the OS, and always knows exactly how many cores it has.

Preempted Questions

How will you handle system calls for blocking IO?

Why is thread pinning insufficient?

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OpenMP supports neither core allocation nor explicit management of thread scheduling.

Current Status

Implemented a simple user-level dispatcher.

Measured a single direction context switch with no cache pollution at 9 ns on an Intel(R) Xeon(R) CPU X3470 @ 2.93GHz

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How do you decide on the number of OS threads for an application?

What is the relationship between this number and the number of cores on the machine?

Thank You!

If we did not talk at the poster session, please find me at the reception!

Send mail to hq6@cs.stanford.edu

Questions?