ACHIEVING PREDICTABLE TIMING AND FAIRNESS THROUGH COOPERATIVE POLLING

Anirban Sinha, Charles 'Buck' Krasic
University of British Columbia

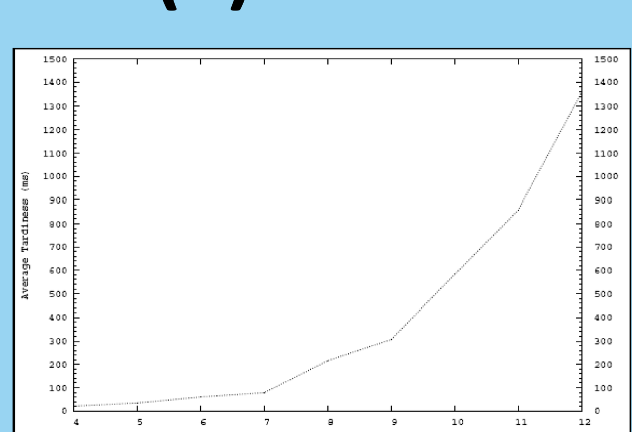
Ashvin Goel
University of Toronto

Can one CPU scheduler fit all?

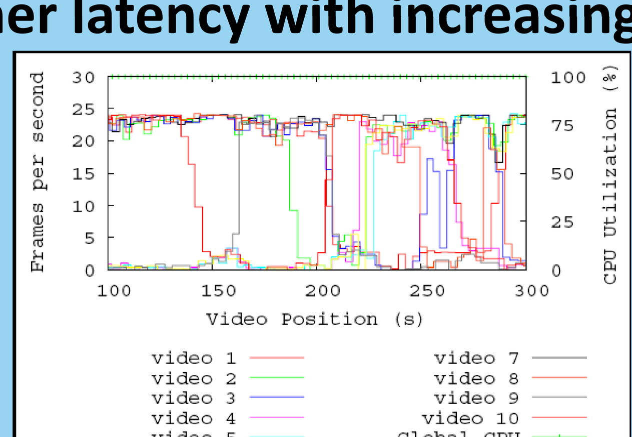
A. Traditional Scheduling Approach

- multi-level feedback queue algorithm – hasn't changed in 30 years.
  - Separate CPU and IO intensive jobs
  - Priority based.
  - Breaks down for mixed CPU and IO intensive jobs, like video applications, security enabled web servers, databases etc.
- Using real time priority leads to starvation and live locks.
- Behavior can be hard to predict
  - deadlocks, live locks or priority inversion may occur.
  - poor adaptation for adaptive time-sensitive workloads.

B. O(1) scheduler



Dispatcher latency with increasing videos



Frame rate of all 10 simultaneous videos

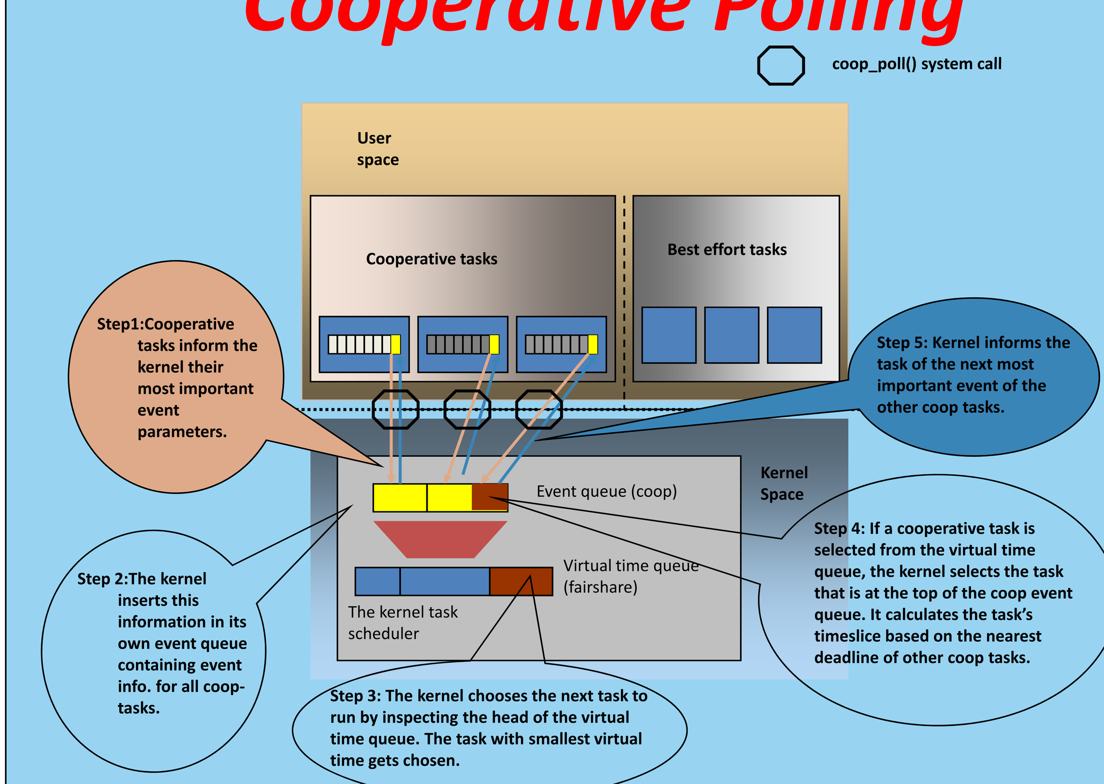
- Dispatcher latency:
  - actual – requested dispatch time.
- The latency increases quickly under heavy load with increasing videos.
- Some of the videos experience noticeable interruptions.

C. Pure Fairshare Scheduling

- Time based approach opposed to priority.
- No starvation. Overall fairness in the system.
- Better balance between desktop and server performance needs.
- Benefits from recent infrastructural components
  - Fine grained time accounting.
  - High resolution timers.
  - Effective data structures (heaps, red-black trees etc.)

Q: Can we do better?
A: Yes, by combining fair sharing with *cooperation.*

D. Overview of Our Approach: *Cooperative Polling*



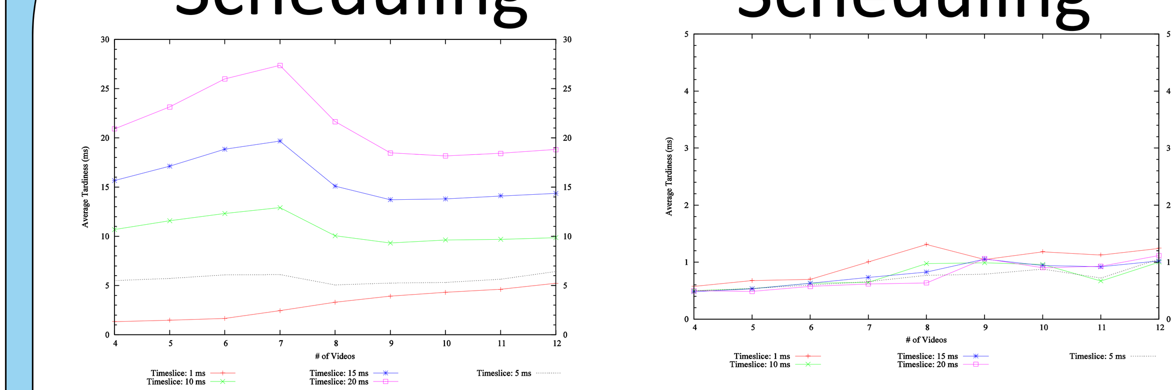
- Have overall fairness.
- Allow cooperation between time sensitive tasks via the kernel:
  - Give preferential treatment to TS tasks within the boundaries of fairness.
  - facilitates uniform fidelity across tasks.

E. Overview of our implementation

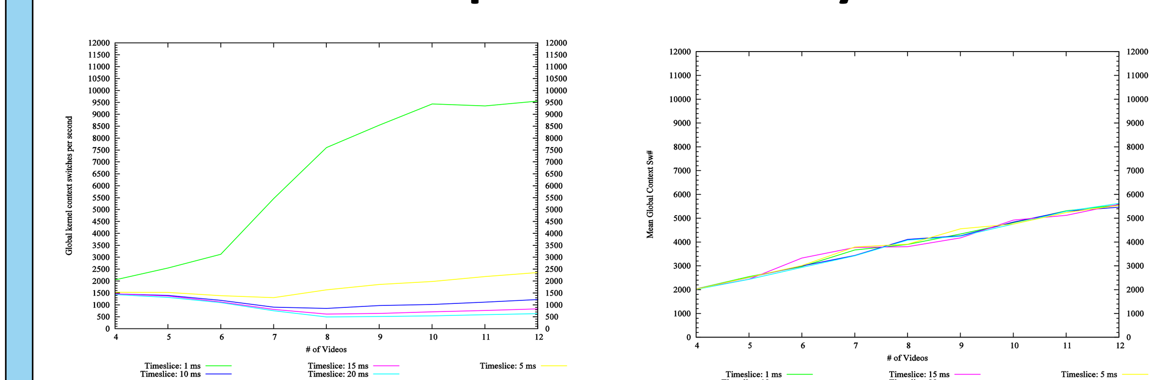
- Virtual time based.
- One new system call :coop_poll()
- Uses efficient heaps for priority queues.
- Benefits from high resolution one-shot timers & precise time accounting in the kernel.
- We use playback of multiple videos to represent a rich workload of multiple time-sensitive applications.

F. Pure Fairshare *vs* Cooperative Approach

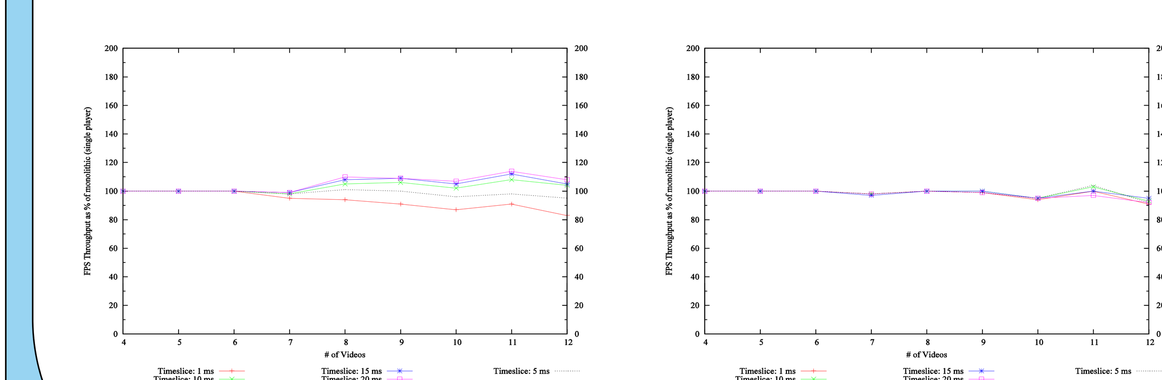
Fair-share Scheduling	Cooperative Scheduling



Dispatcher Latency.



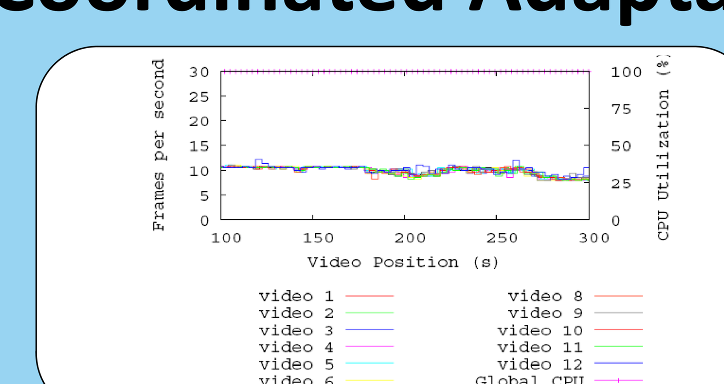
Context Switch Rate.



Throughput as a % of single player case.

- Fairshare at finest granularity has 5x latency of coop, yet context switch rate is 2x worse.
  - ***Cooperative approach leverages application information to context switch in a much more strategic fashion.***

G. Coordinated Adaptation



Frame rate of all 12 videos at overload.

The videos are able to maintain a uniform quality even at overload.

H. Conclusion

Coop + fairshare:

- Gives better timeliness (smaller latency) even under overload.
- Facilitates coordinated adaptation for multiple adaptive tasks.
- Informed context switching is cache efficient – leading to a better timeliness-throughput balance.