Dresden Realtime Operating System (DROPS)

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Objectives

- Realtime and *Timesharing*
  - on one system
  - in one application
- *Standard* Hardware Architectures
- A usable system

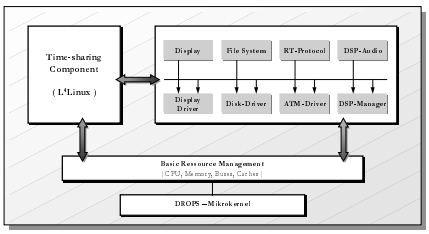
Realtime and Timesharing

- Separation, reduce interference
- Reservation + Adaptation
- Application areas:
  - media applications
  - measurement systems

Today's standard HW is

- Optimized for the average case
- Influenced by
  - memory and bus hierarchies (e.g. caches)
  - intelligent devices
- Hardly predictable

DROPS' Architecture



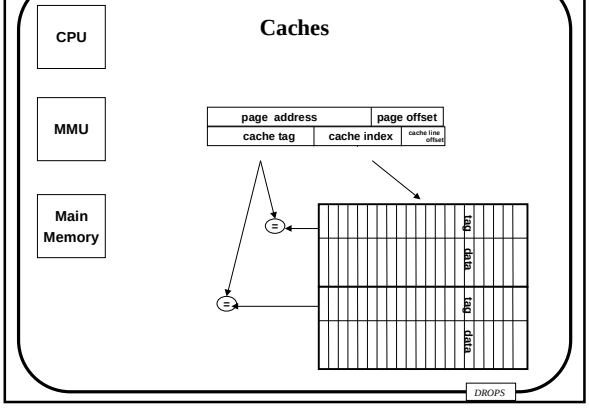
OS Controlled Cache Predictability for Realtime Systems

(Jochen Liedtke, IBM/Watson, Michael Hohmuth, Hermann Härtig)

Objectives

- partition caches to minimize interference
- OS-controlled
  - transparent to applications
  - not relying on cooperation of applications

Caches



DROPS

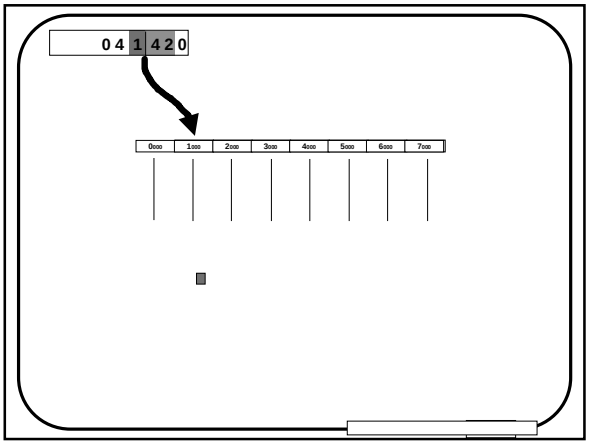
Cache Partitioning

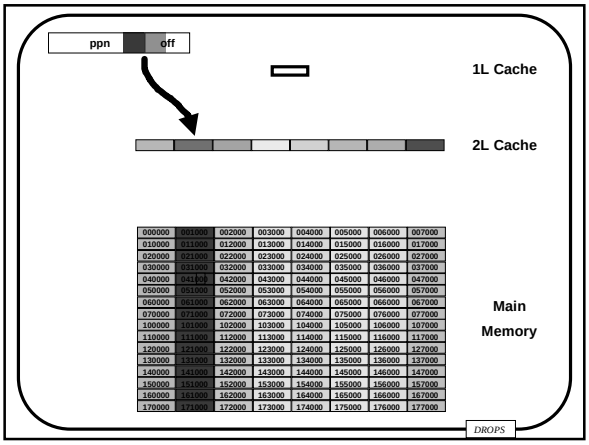
Address regions
that map to a given set of cachelines (a partition)
are used only by one task, thread, etc.

Works with virtually, physically tagged caches

Supported by tools (linkers etc) (Wolfe et. al.)

DROPS





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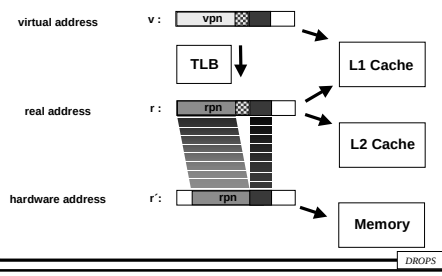
Colorable Memory



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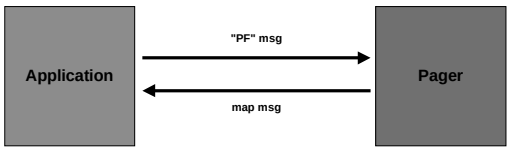
Page Fault Handling



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A simple Pager

```
DO
    wait for request (requestor, virtual address) ;
    virtual page := virtual address DIV pagesize
    IF requestor is real-time
        THEN source page := 2*virtual page  + 1
        ELSE source page := 2*virtual page
    FI ;
    send (requestor, map (source page * pagesize))
OD
```


Experiment 1

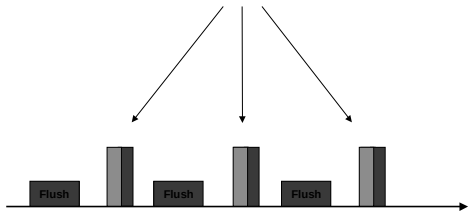
Scenario:

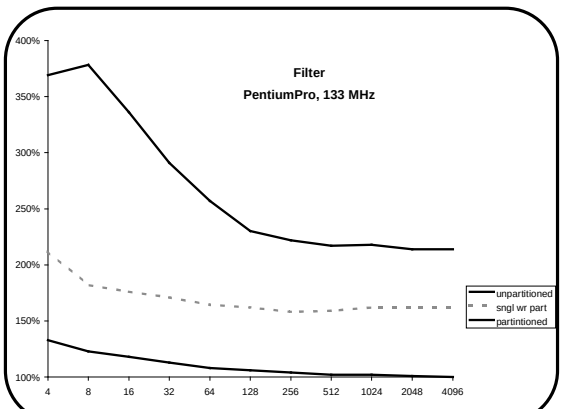
- high prio realtime task
- running in frequent short intervals

Which worst case delays are caused by prior cache uses in other tasks and the os?

Example: Filter of varying size.

Filter





Experiment 2

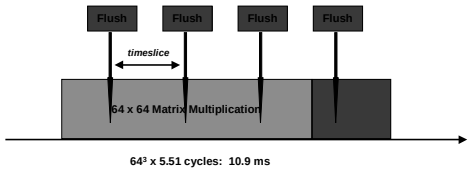
Scenario

- low priority task
- interpupted frequently

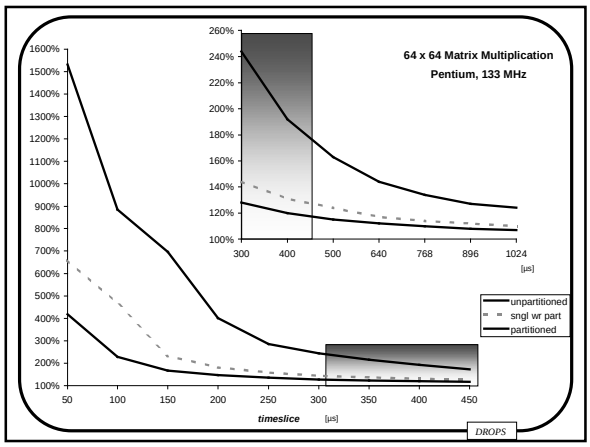
What is the effect?

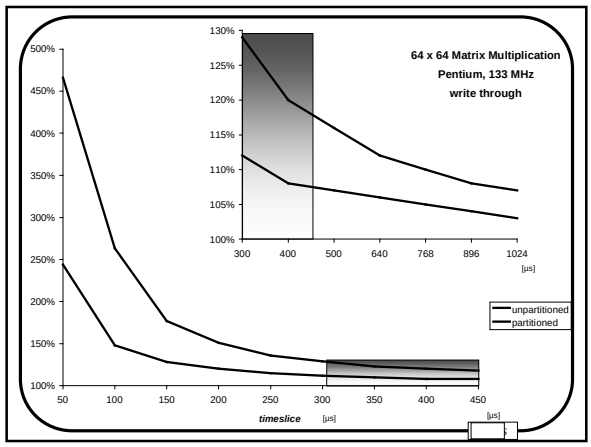
Example: matrix multiplication.

Matrix Multiplication



64^3 x 5.51 cycles: 10.9 ms





Experiment 3

Combination:
Low priority Task interrupted by known high prio task

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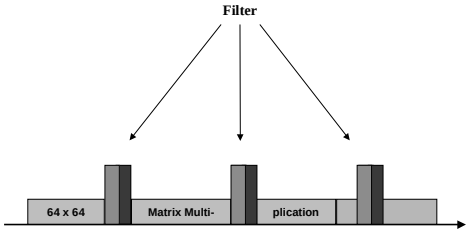
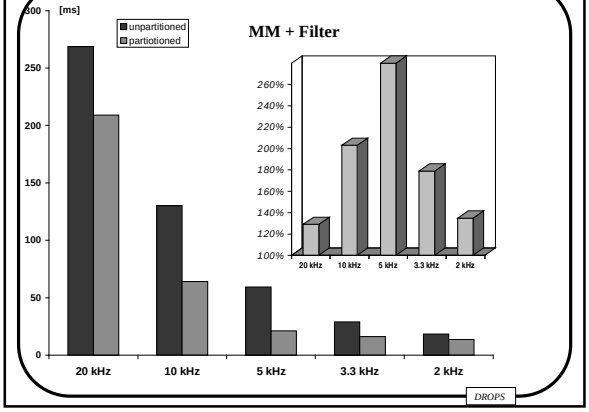


DROPS



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Other Penalty Sources

Interrupts
- must be known
- controlled by disabling and scheduling

TLBs
- limited by working set

Memory Refresh Cycles

DMA (-> Schoenberg)

DROPS

Conclusions

?

Effect on more complex tasks?

Interference with other penalties, e.g. bus sharing.

Taming Linux

(Michael Hohmuth, Jean Wolter, Hermann Härtig)

Problems with L4Linux in DROPS:

- grabs all resources
- drives all devices
- disables interrupts
- cache partioning

Resource manager

- Starts system servers besides L4Linux
- controls and hands out system resources
  - RAM
  - interrupt request lines
  - task numbers
- configurable via scripts

Soft Interrupts

- Linux uses cli(), sti() for critical sections
- not acceptable in rt environment

=>

- “soft” interrupts: never disable hardware interrupts
- new implementation of cli(), sti() using queued locks
- exeption: PIC programming

Device Drivers

- Linux drivers do not support QoS

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- new drivers
- Linux drivers replaced by stubs (using ipc)
- currently: SCSI, RTFS, ATM

Conclusions

- Linux can be tamed
- L4 => Fiasco (rt/C kernel with L4 interface)