Interrupt filtering

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- Interrupt handling mechanism
- An interrupt is an asynchronous signal from hardware indicating the need for attention
- Key aspect: Synchronization policy

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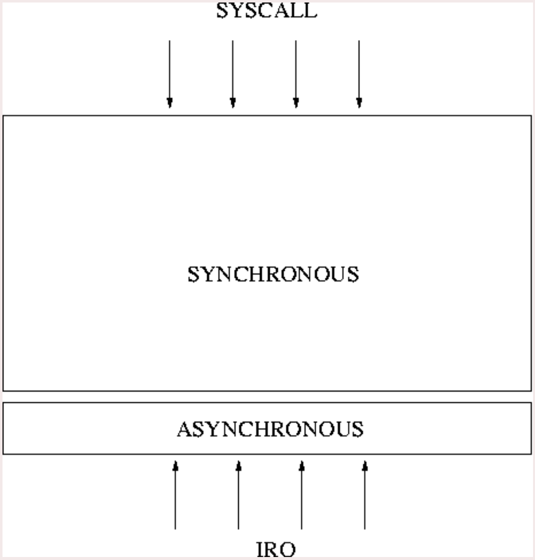
SYSCALL
SYNCHRONOUS
ASYNCHRONOUS
IRQ

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Outline

1 FreeBSD 4x

2 FreeBSD SMPng

3 Interrupt filtering

4 Performance

5 Implementation details

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- BKL ruled access to kernel space
- SPL calls used to synchronize top and bottom halves

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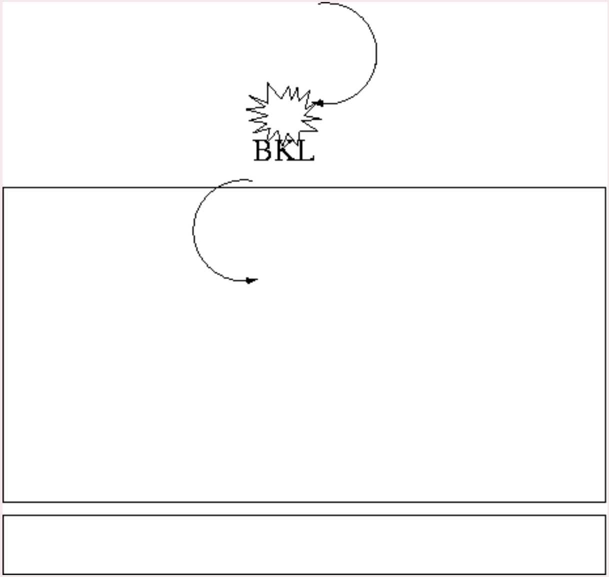
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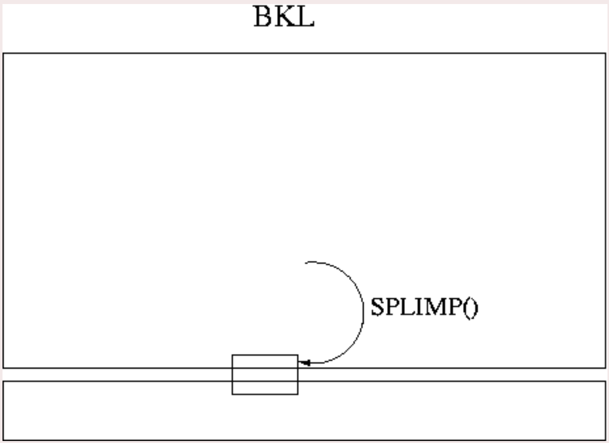
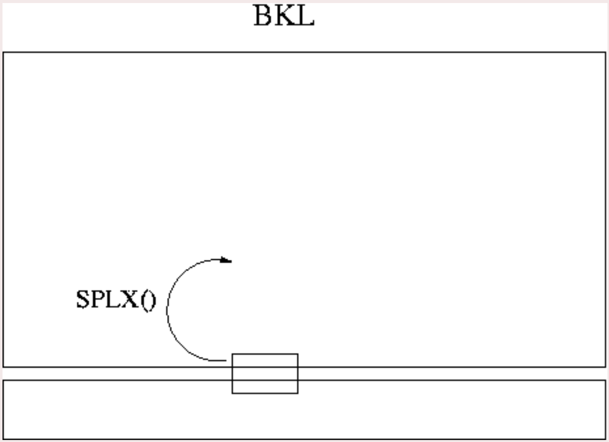

BKL
SPLIMP()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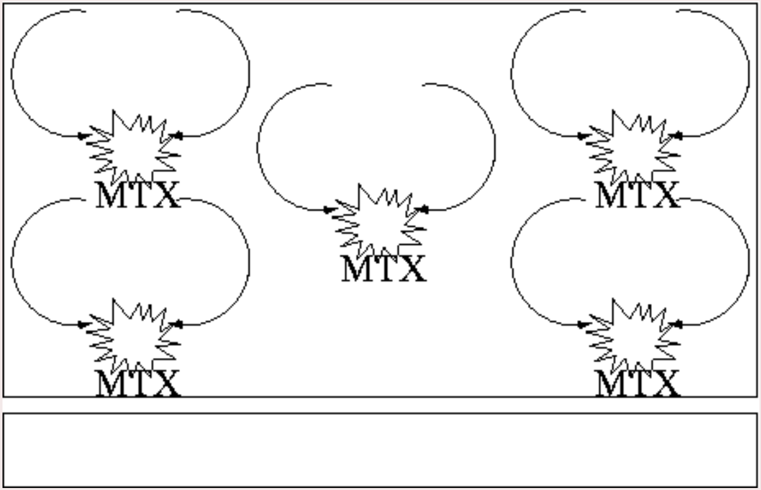
- Time critical handlers that don't block, can run in the context of the interrupted process (FAST)


MTX
MTX
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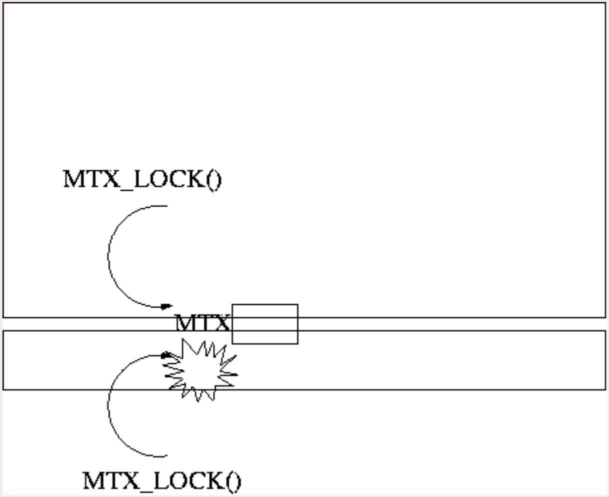
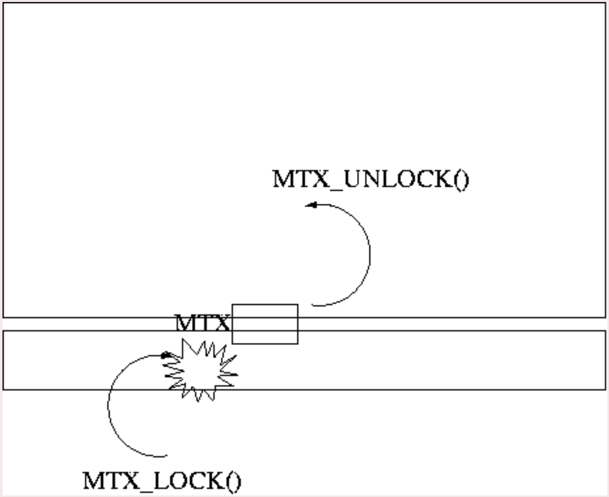

MTX_LOCK()
MTX
MTX_LOCK()


MTX_UNLOCK()
MTX
MTX_LOCK()

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The problems

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- Interrupt masking at controller level

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  FILTER runs in interrupt context, checks the received interrupt, serves it/delegates more work

  ITHREAD runs in ithread context, can block

- ack the interrupt after filter execution

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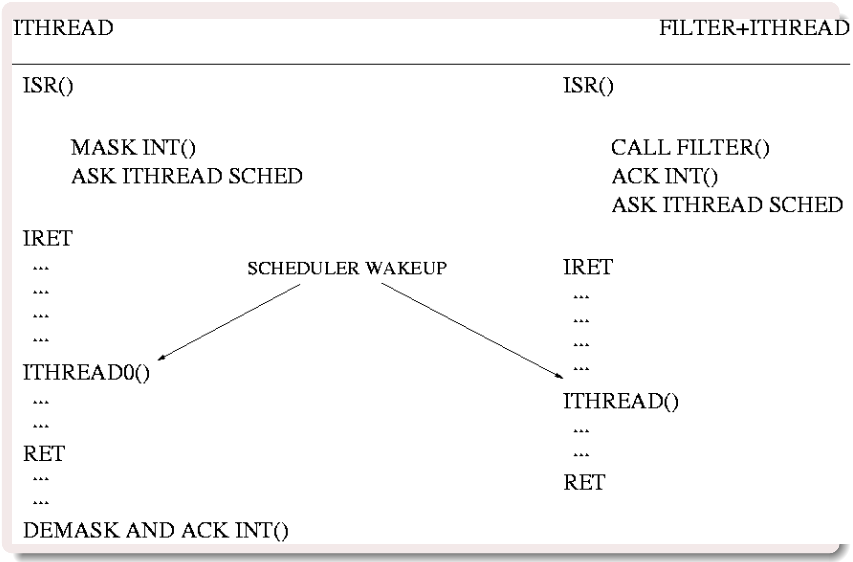
ITHREAD
FILTER+ITHREAD
ISR()
MASK INT()
ASK ITHREAD SCHED
IRET
...
...
...
...
ITHREAD0()
...
...
RET
...
...
DEMASK AND ACK INT()
SCHEDULER WAKEUP
ISR()
CALL FILTER()
ACK INT()
ASK ITHREAD SCHED
IRET
...
...
...
...
ITHREAD()
...
...
RET

Let’s see some code: bfe, em, re, aac, xl

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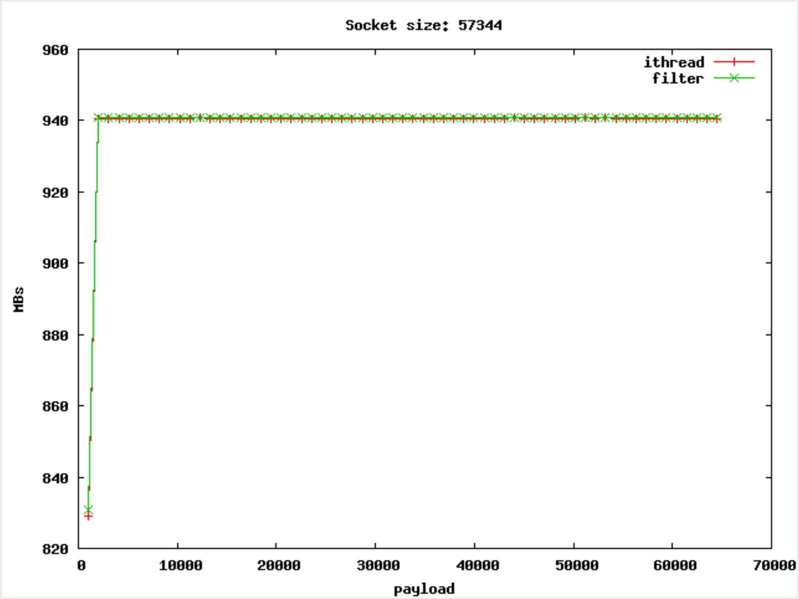
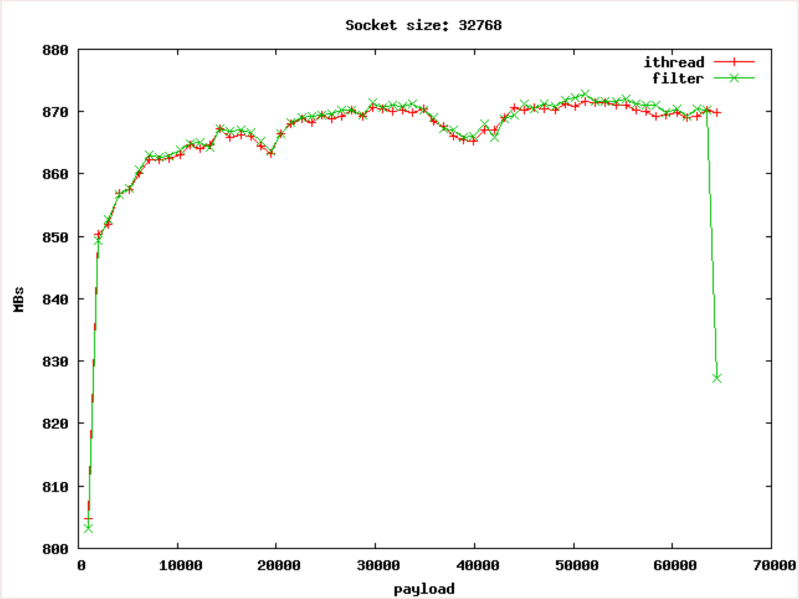
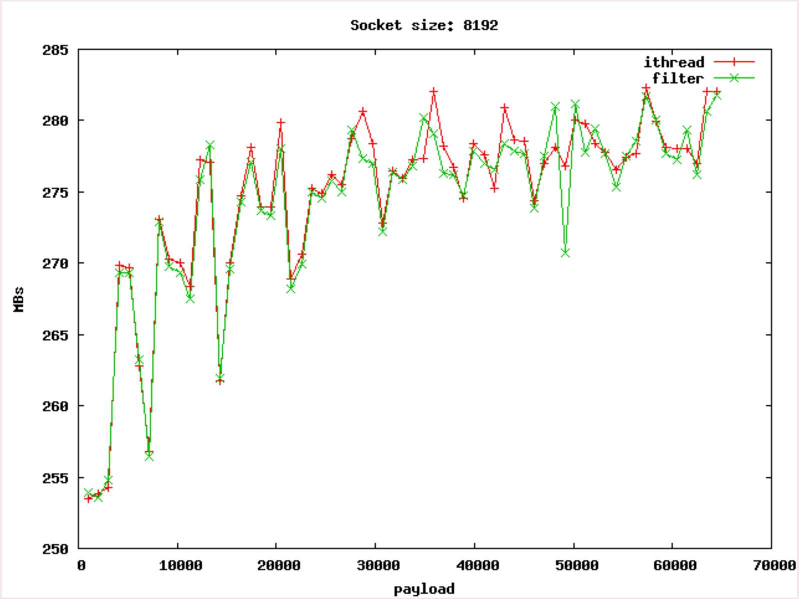
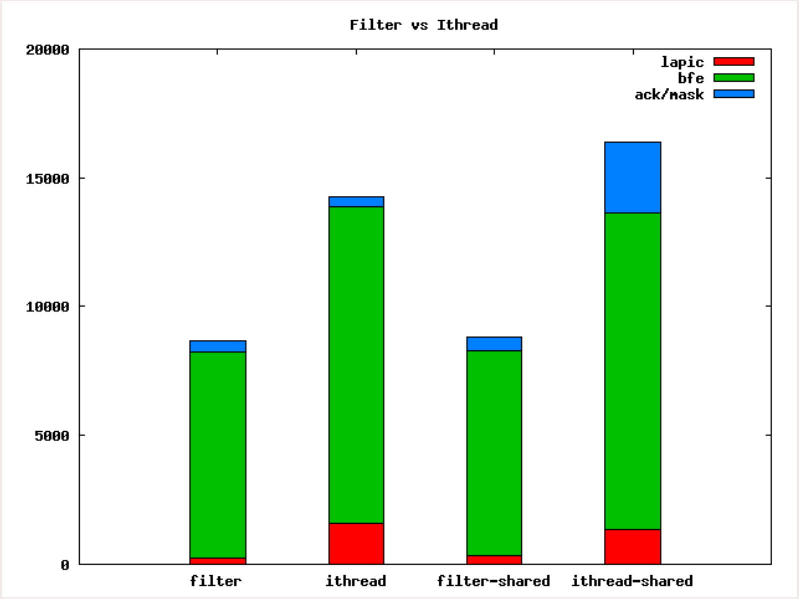
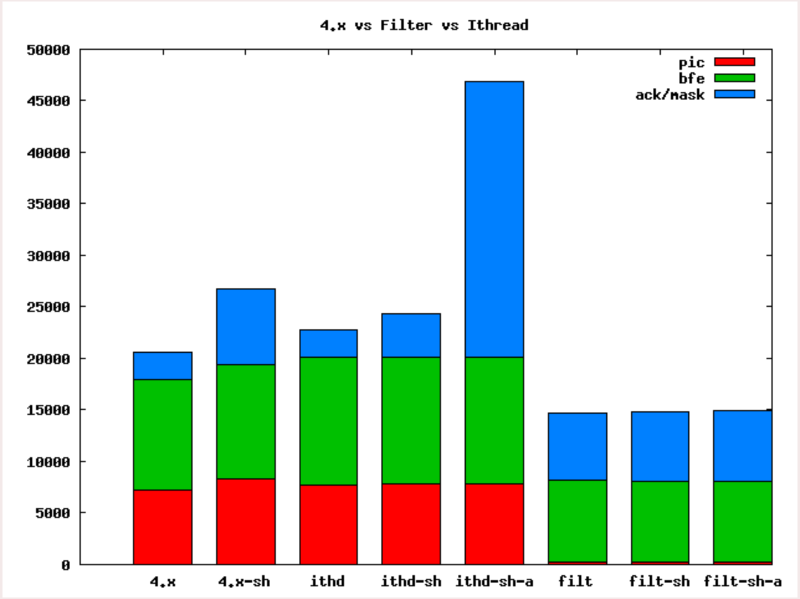

Socket size: 57344
ithread
filter
MBs
payload
960
940
920
900
880
860
840
820
0
10000
20000
30000
40000
50000
60000
70000


Socket size: 32768
ithread
filter
MBs
payload
880
870
860
850
840
830
820
810
800
0
10000
20000
30000
40000
50000
60000
70000


Socket size: 8192
ithread
filter
MBs
payload
285
280
275
270
265
260
255
250
0
10000
20000
30000
40000
50000
60000
70000


Filter vs Ithread
20000
15000
10000
5000
0
lapic
bfe
ack/mask
filter
ithread
filter-shared
ithread-shared


4.x vs Filter vs Ithread
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
pic
bfe
ack/mask
4.x
4.x-sh
ithd
ithd-sh
ithd-sh-a
filt
filt-sh
filt-sh-a

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      struct resource *r,
      int flags,
      driver_filter_t filter,
      driver_intr_t handler,
      void *arg,
      void **cookiep
  );
  ```
- `int driver_filter_t(void*);`

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FILTER_STRAY	event not recognized
FILTER_HANDLED	interrupt is acked/turned off
FILTER_SCHEDULE_THREAD	schedule the ithread

- no other value can be returned with FILTER_STRAY
- if a filter wants to schedule an ithread, it returns FILTER_HANDLED | FILTER_SCHEDULE_THREAD
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