Xenrelay: An Efficient Data Transmitting Approach for Tracing Guest Domain

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Contents

Introduction

- **Widespread virtualization utilization motivates deeper investigation of the performance implications of virtualization.**
- **Trace analysis is an important technology**
- **Designers of trace tool running in virtualization environment has to consider:**
  - Each Domain has its own address space
  - Small sized trace data and frequent trace events
  - trace data be handled in user space

Introduction

- **Xenrelay**
  - transfers large amounts of data from the guest domain kernel to the privileged domain user-space
  - Static shared memory and two mapping methods
  - A non-notification mechanism

Related work

- Several performance tools are implemented in Xen
  - Xenoprof
    - a system-wide statistical profiling toolkit
  - XenMon
    - performance monitoring tool
    - XenMon collects event log with Xentrace
- Xenrelay is based on *relayfs*

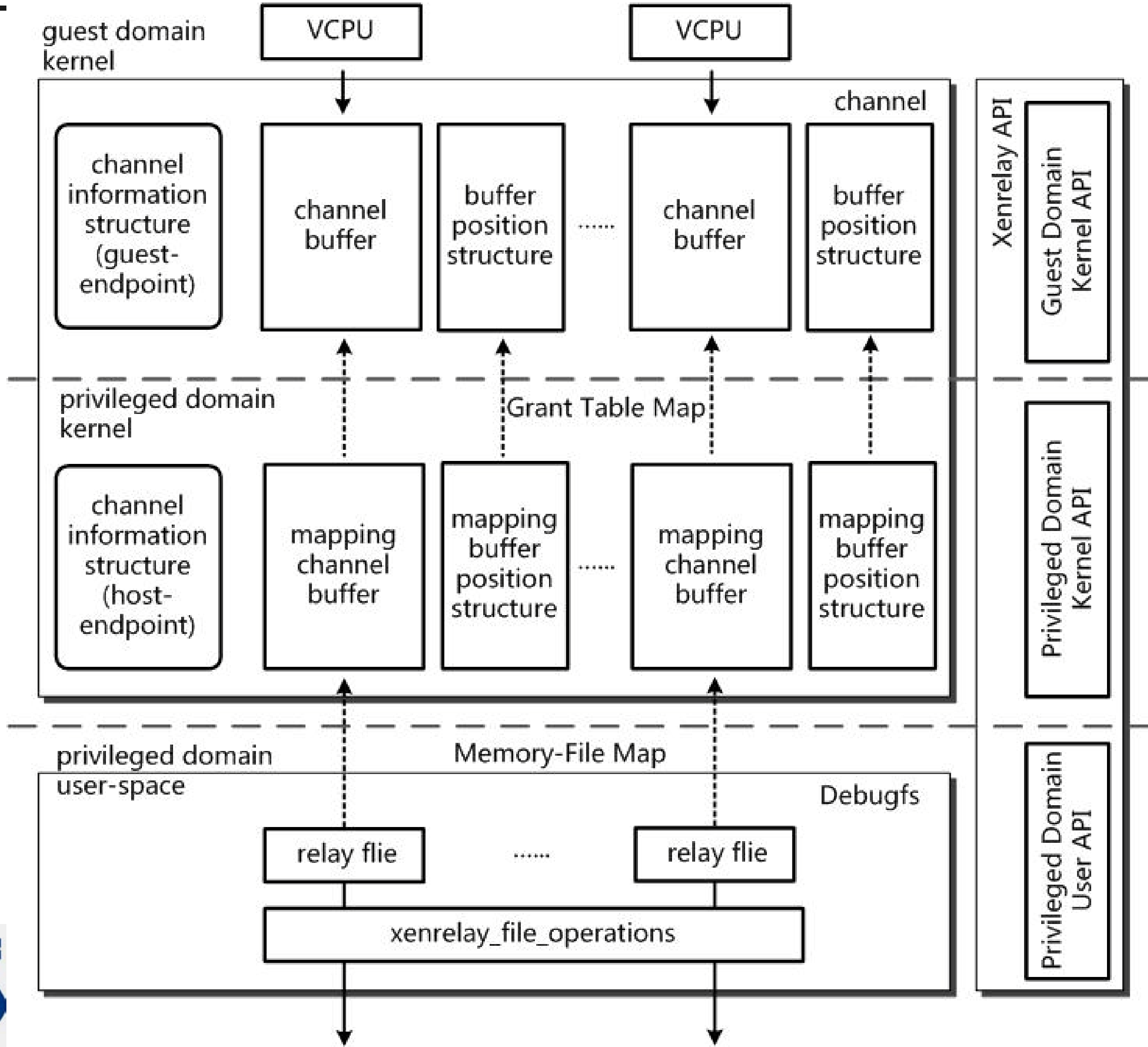
Related work

- Shared memory buffers
  - XenSocket
  - Xway
  - XenLoop
- Those approaches fall short of providing trace data transmission
  - More hypercall, more overheads
  - Head and other data for packing data
  - trace tool should not rely on subsystem

Xenrelay Overview

- **Main issue of Xenrelay**
  - create a channel through three layers
  - control the data transmission without lock and notification
- **Xenrelay contains:**
  - relay channel
  - API

Xenrelay Overview



Design and implementation

- Transmitting at the high speed
- Channel design
  - channel buffers, buffer position structure, channel information structure
  - channel buffer is a producer-consumer circular buffer
  - blocks until the transaction is complete
  - multiplexed I/O and Poll()

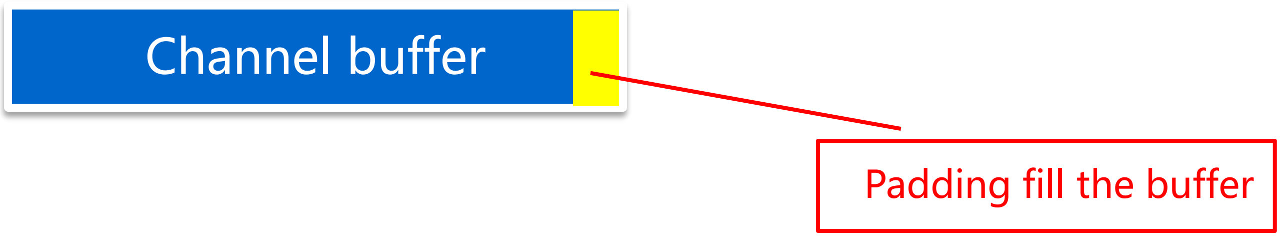
Design and implementation

- **Channel implementation**
  - Allocate high-order address
  - Map no-consisted pages into consisted pages
  - aggregate *buffer position structure* into a memory page
  - assigns an explicit size to data items
- **Channel bootstrap and teardown**
  - XenStore mechanism

Design and implementation

Data relay

- Does not split data
- Does not parse the data



Discussion

- Operation sequence
  - Open -> Connect -> Write -> Read -> Disconnect -> Close
  - Open -> Write -> Connect -> Read
    - be safe
    - easy to make data overflow
  - Close -> Disconnect
    - memory leak in guest domain

Discussion

- Data overflow
  - write faster than read
  - suspends writing and cause loss of new data
- Relay file
  - only the data in the end of file is valid

Experimental testbed

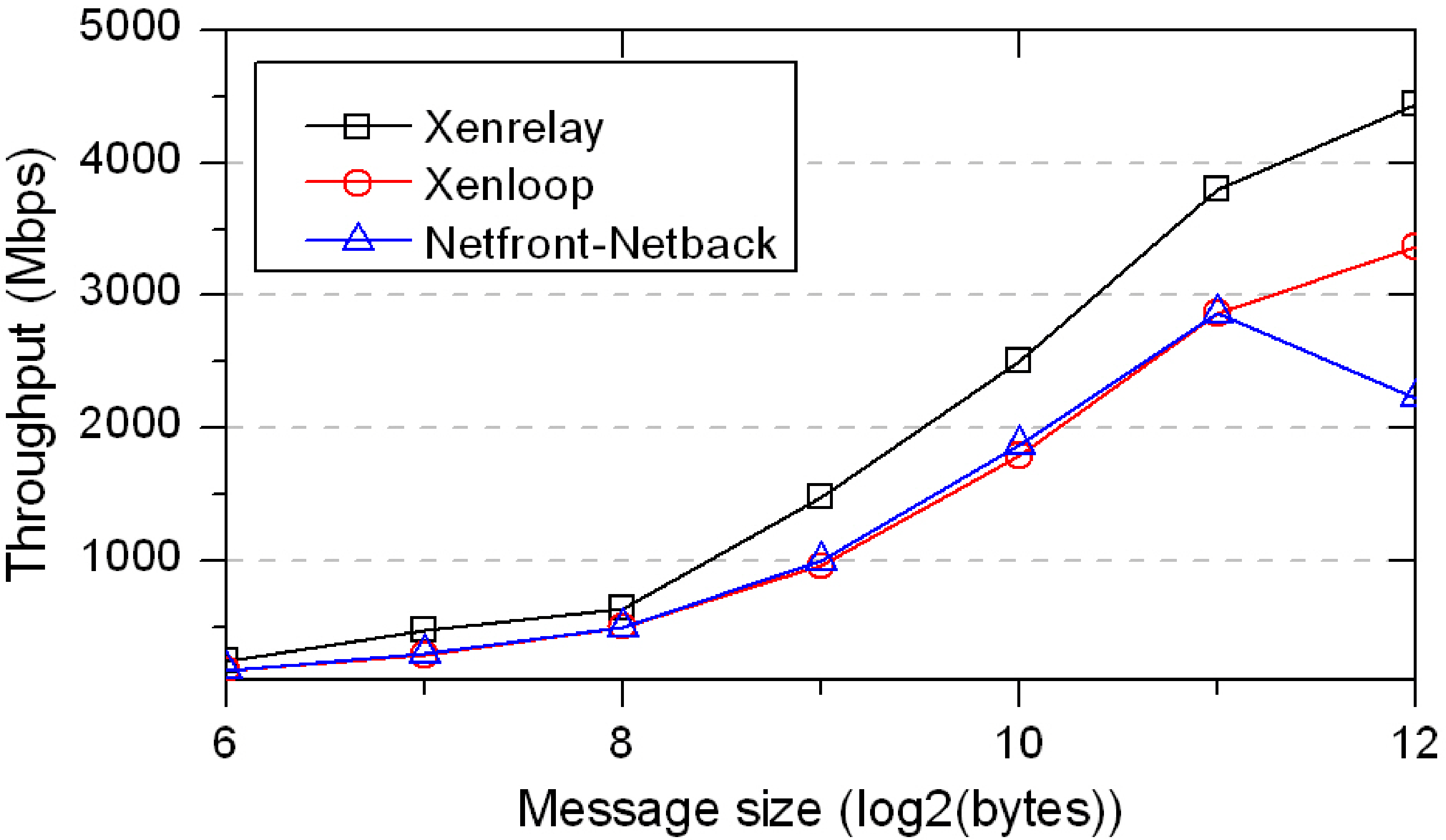
- Experiment setup
  - A server-class machine
    - two Intel Xeon E5310 CPUs (1.6 GHz and four cores CPUs)
    - 4GB Memory
    - 500GB SATA disk (rotation speed is 7200rps)
  - Xen version 3.3.1 and linux kernel version 2.6.18_X64
  - Each guest domain has 1 VCPU, 512MB memory and 10GB disk image

Experimental testbed

- Data transmission scenarios
  - Netfront-Netback
  - XenLoop
    - ✓ netperf's TCP_STREAM test
  - Xenrelay
    - ✓ Move a fixed size of data in relay channel from DomU to Dom0 repeatedly
    - ✓ 100MB data in total

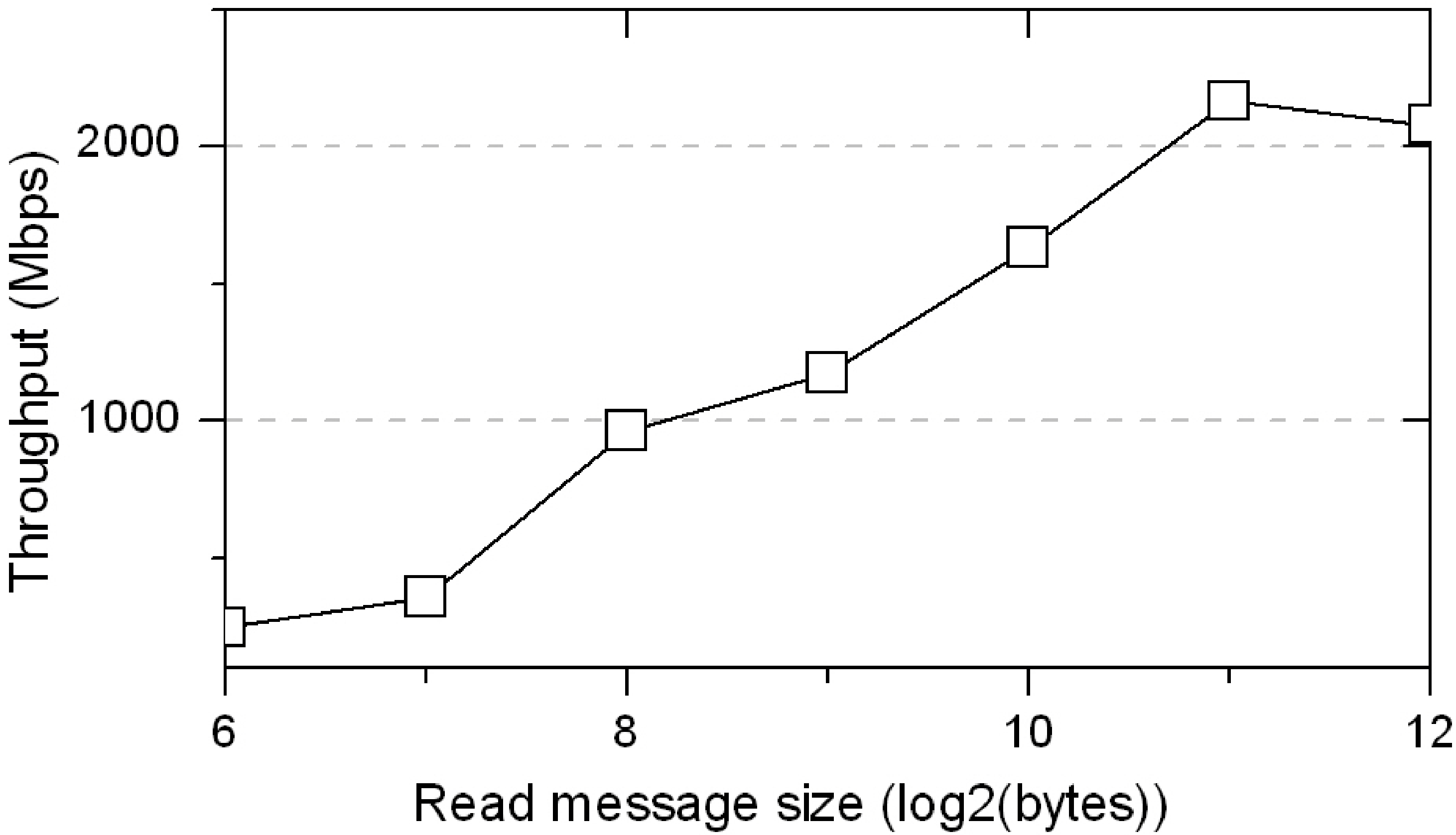
Experimental results

- **Throughput VS. message size**
  - In Xenrelay, reading message size = writing message size



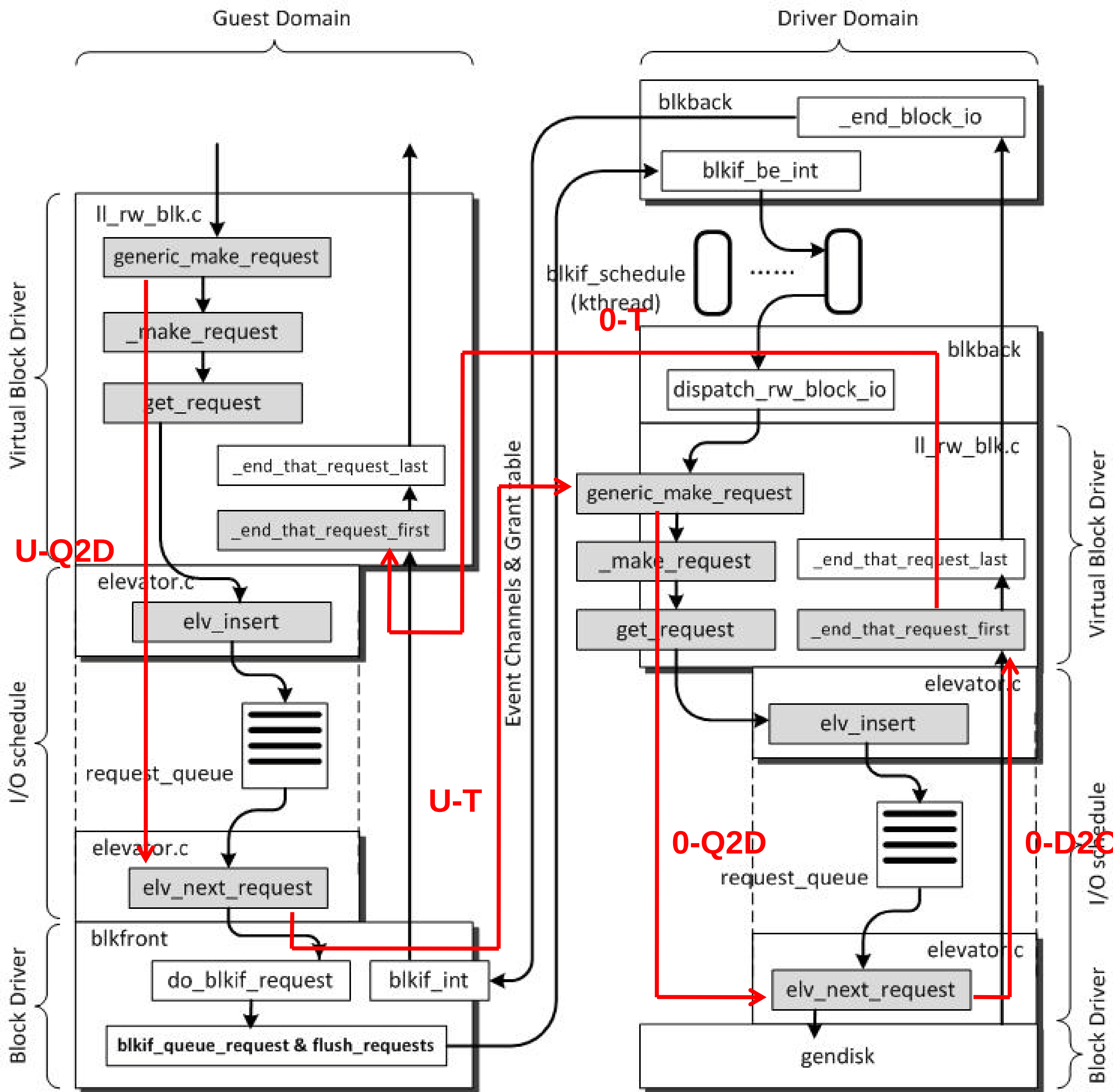
Experimental results

- **Throughput VS. reading message size**
  - writing message size = 2^6 bytes
  - reading message size >= writing message size



Applications of Xenrelay (1)

- **Use Xenrelay to create a block trace toolkit**
  - In guest domain kernel, traces I/O events and uses Xenrelay to transfer it
  - In privileged domain kernel, traces I/O events and uses relayfs to transfer it
- **Trace point**
- **Trace data**
  - device number, the event time stamp, the start sector number, the number of handle block, the event type and the operation type



U-Q2D: *generic_make_request to elv_next_request*

U-T: *elv_next_request to generic_make_request in dom0*

0-Q2D: *generic_make_request in dom0 to elv_next_request*

0-D2C: *block device handling request*

0-T: *blkback returning blkfront*

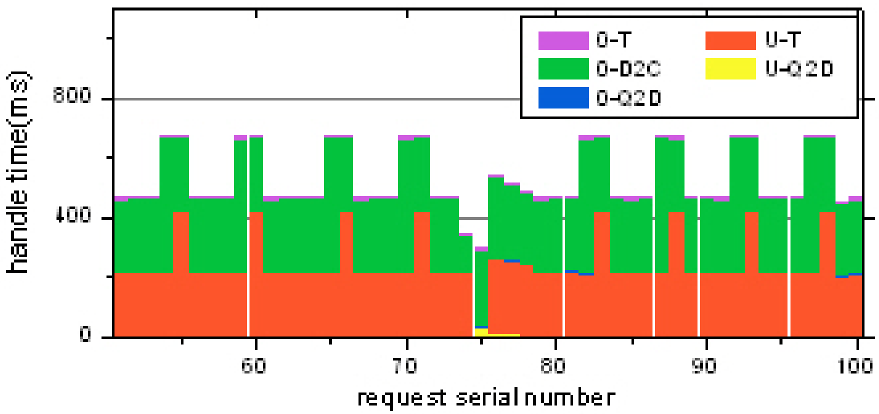
Applications of Xenrelay (2)

- evaluate typical combinations of the I/O schedulers
  - Guest Domain Schedule Test
    - ✓ Change guest domain's Schedule
    - ✓ Fix driver domain's Schedule and use Noop schedule
  - Driver Domain Schedule Test
    - ✓ Change driver domain's Schedule
    - ✓ Fix guest domain's Schedule and use Noop schedule
- A single 100MB file was read

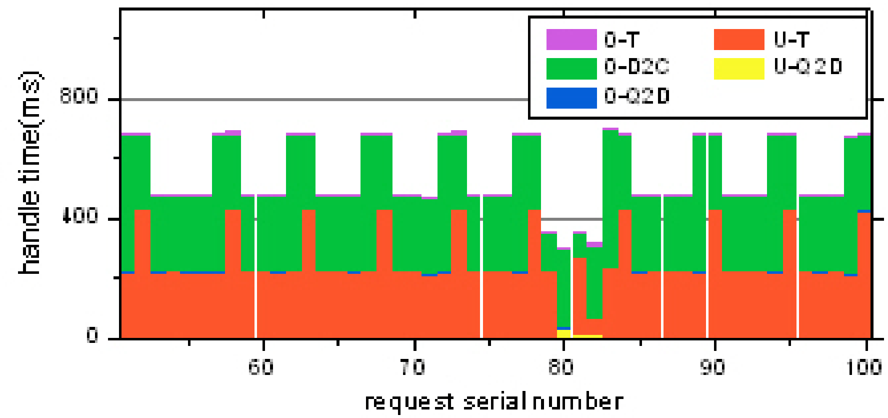
Applications of Xenrelay (3)

Result of tracing

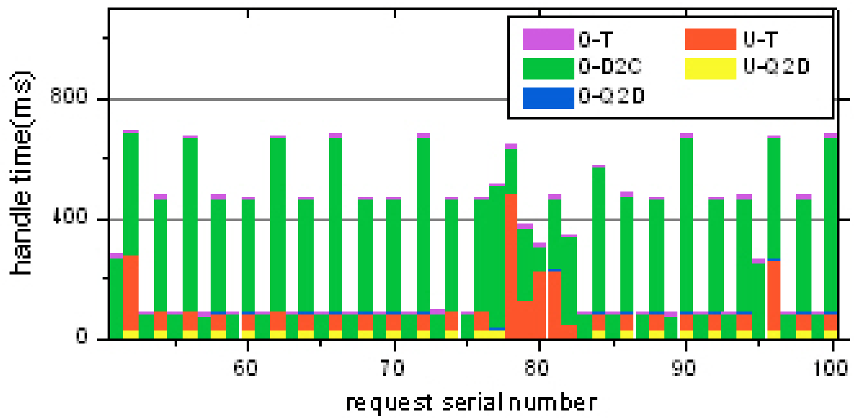
- Guest domain schedule test



Noop schedule



AS schedule



CFQ schedule

***U-Q2D**: generic_make_request to elv_next_request*

***U-T**: elv_next_request to generic_make_request in dom0*

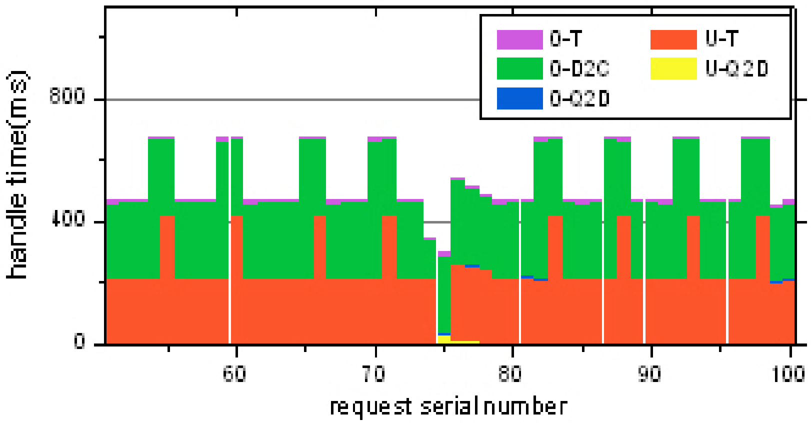
***0-Q2D**: generic_make_request in dom0 to elv_next_request*

***0-D2C**: block device handling request*

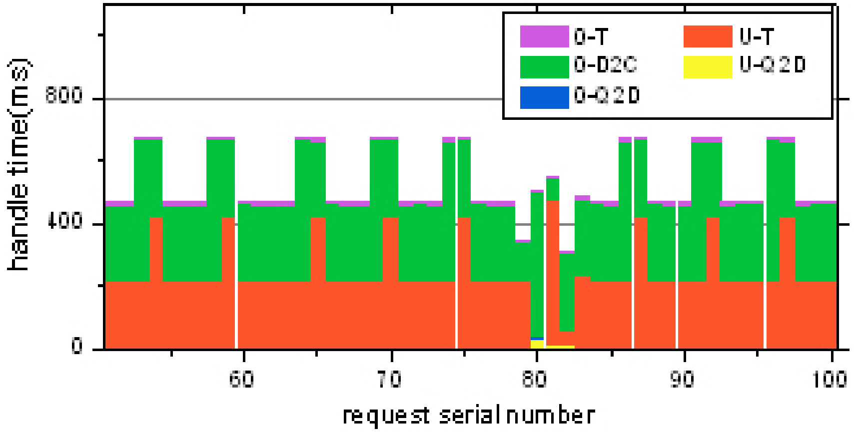
***0-T**: blkback returning blkfront*

Applications of Xenrelay (4)

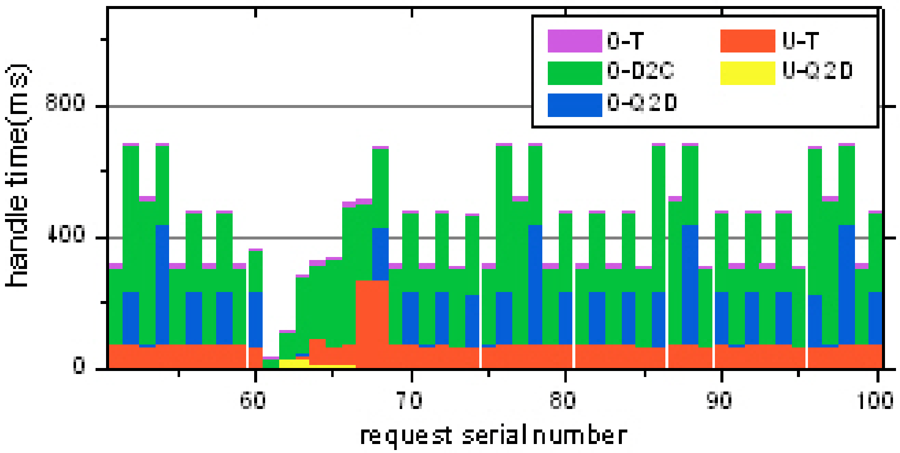
- **Result of tracing**
  - Driver domain schedule test



Noop schedule



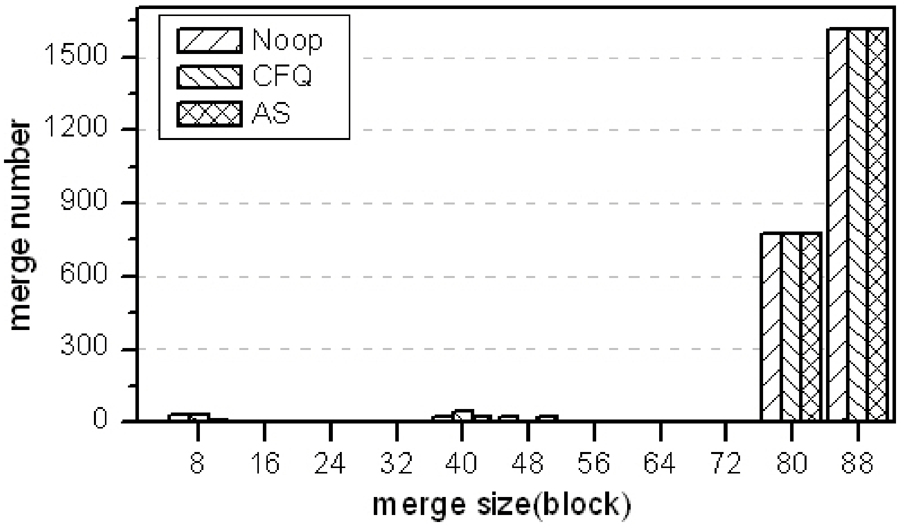
AS schedule

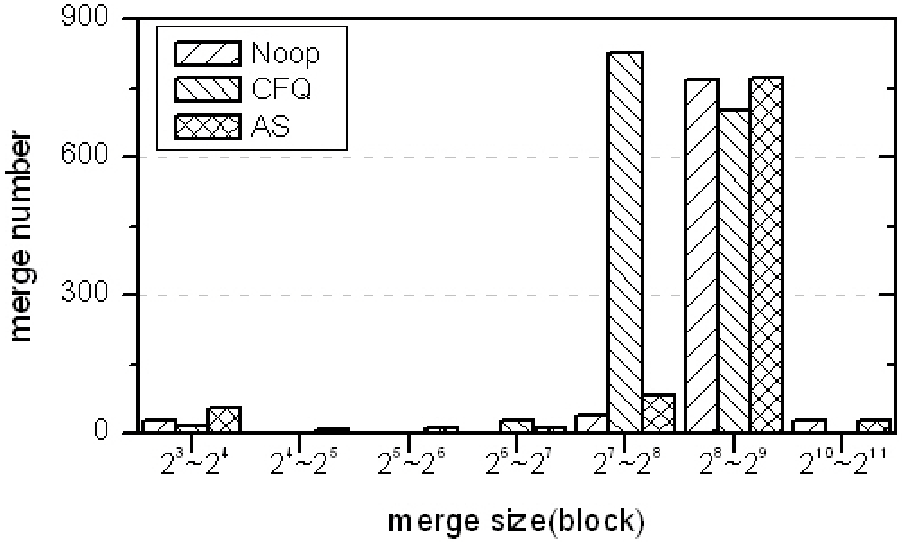


CFQ schedule

Applications of Xenrelay (5)

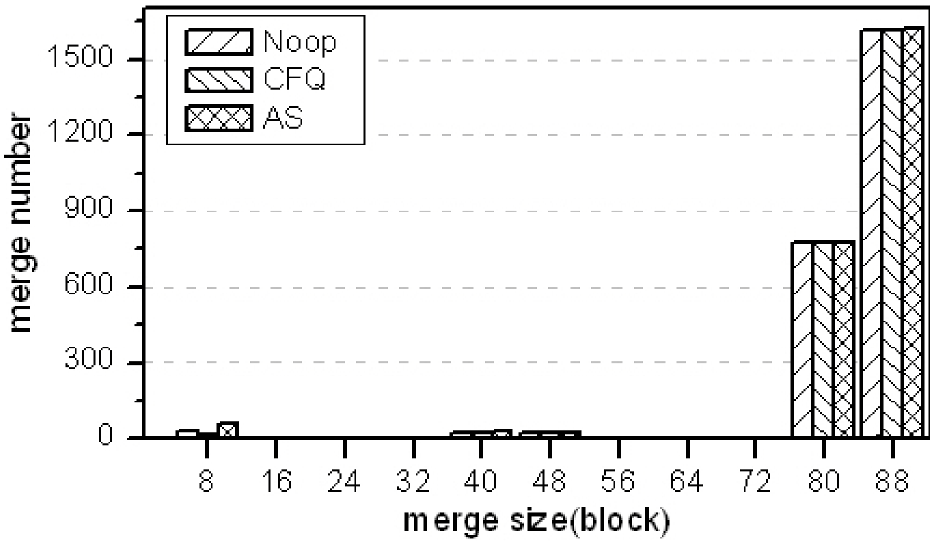
- Merge block number and size
  - Guest domain schedule test

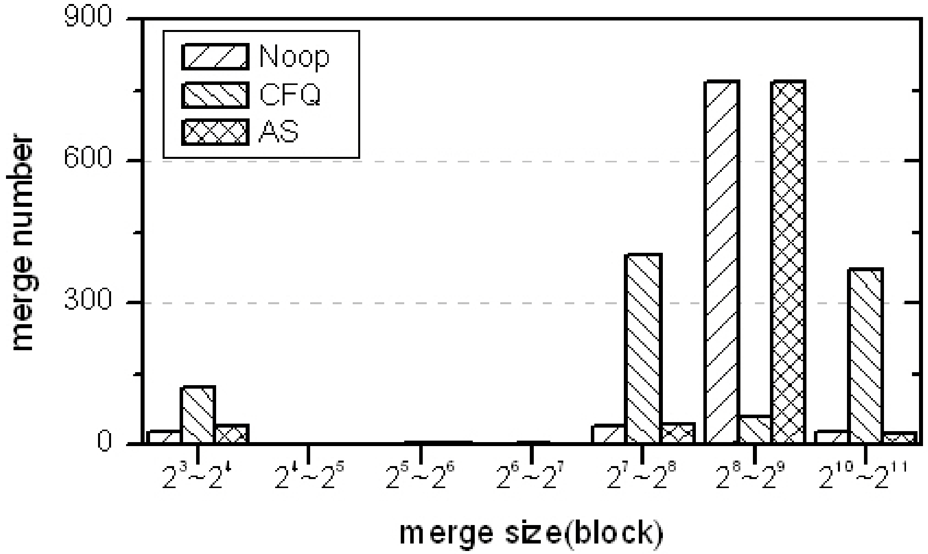




Applications of Xenrelay (6)

- Merge block number and size
  - Driver domain schedule test





Conclusion

- Xenrelay is a unified, efficient, and simple mechanism for transferring data
- Xenrelay provides supports for users who trace subsystems to record and relay data

Thank you!

Questions ?