USB/IP:
a Peripheral Bus Extension for Device Sharing over IP Network

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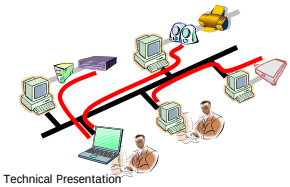
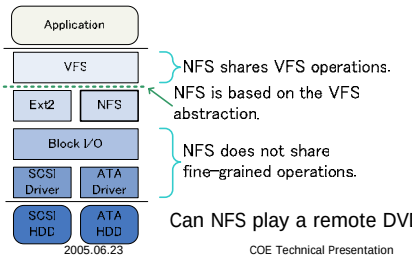
Our Goal

- Seamless Device Sharing
  - Access shared devices using existing drivers and applications.



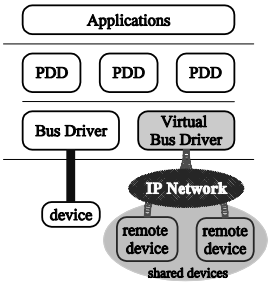
Conventional Device Sharing

- Share only a few high-level operations
- Do not share more fine-grained operations



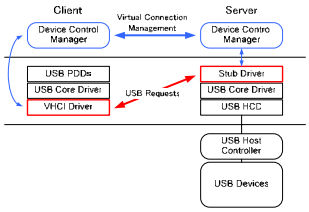
Can NFS play a remote DVD media?

Our Approach



- Existing sophisticated peripheral interfaces
  - USB, IEEE1394
- Virtual bus driver
  - A pseudo bus driver for remote devices

Overview of USB/IP



- **USB** request over **IP**
- **V**irtual **H**ost **C**ontroller **I**nterface
  - is implemented as a USB host controller driver
  - converts a USB request into USB/IP packets
  - conceals all about "over IP" in the lowest layer

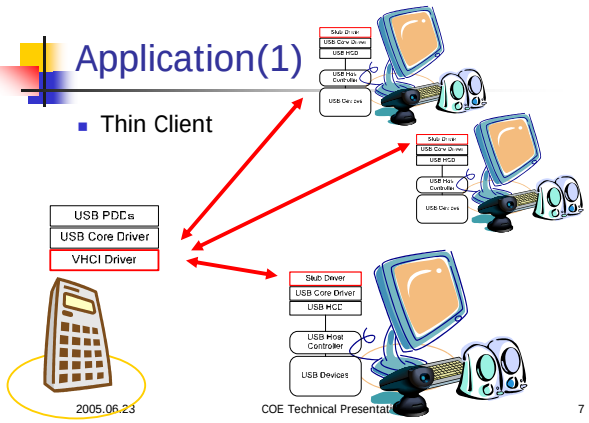
Unmodified drivers and applications can also access remote devices !
Users can play a DVD, format a HDD, watch a webcam, and play the speaker **over networks**, as if these devices were directly attached.

Advantages

- **Full Functionality**
  - the smallest granularity of RPC (USB commands over IP)
  - all the functions of a remote device are accessible
- **Network Transparency**
  - preserve the same semantics as directly-attached devices
  - transparent to applications and most drivers
- **Interoperability**
  - interoperable between different OSs
  - USB commands are independent of OS structure
- **Generality**
  - most devices on a peripheral interface can be shared
  - USB supports various kinds of devices

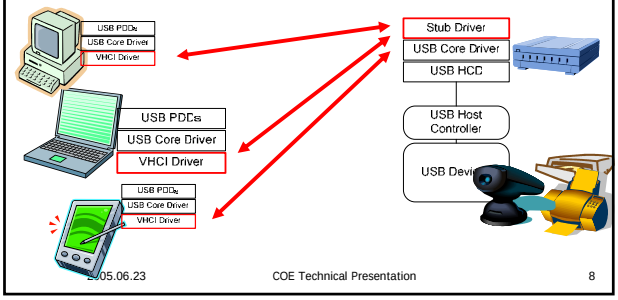
Application(1)

- Thin Client



Application(2)

- Device Server



Issues

- IP network ≠ USB network
  - Bandwidth
  - Packet loss
  - Network delay and jitter
- But, our experiments show
  - Sufficient I/O performance in LAN
  - All the devices are usable over IP network

Implementation

- Prototype implementation
  - VHCI and Stub driver
    - Device drivers in Linux 2.6 series
  - Tiny ruby scripts
    - Negotiate a requested device
  - TCP/IP
    - Set TCP_NODELAY option
- Availability
  - http://usbip.naist.jp/

More Information

The Best Paper Award of FREENIX/Open Source Track: 2005 USENIX Annual Conference !

This paper is also available at http://usbip.naist.jp/.

Demo

USB/IP Server Computer in B206

Performance

- Consumer USB devices
  - A USB HDD
    - 77% of the write throughput obtained by USB under emulated LAN
  - A USB Speaker
    - works fine under less than 5ms network delay
  - A USB keyboard and mouse
    - work fine in LAN.

Related Work

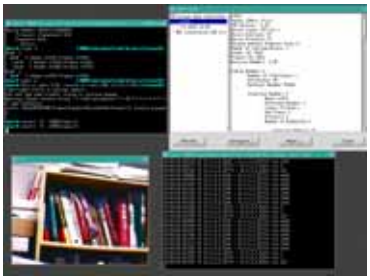
- iSCSI
  - SCSI request over IP network
  - remote access only to storage devices
- Netstation
  - a distributed system composed of processor nodes and network-attached peripherals
  - use IP networks to transfer peripheral's data
  - no compatibility with existing computers
- Anywhere USB
  - Proprietary USB over IP appliance
  - High-Speed (480Mbps) mode and Isochronous type are not supported.

Future Work

- USB over UDP/IP
  - Isochronous Transfer
  - Wireless media
- IPSec
  - Kernel-based security mechanism

Conclusion

- USB/IP: A transparent device sharing technology over IP network
- All the USB devices tested can be shared
- Sufficient I/O performance in our LAN
- Performance optimization criteria
  - Data size of an operation
  - Queuing depth of operations
- http://usbip.naist.jp/



- Q&A slides ....