USB Cloud Storage
Gateway
Intelligent Storage for Stupid Things

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Agenda

• Project Introduction
• Ceph
• USB Storage
• Demo!
• Azure Blob Storage
• Linux I/O Target in Userspace
• Future
Hack Week

• What to hack on?
  - ARM board gathering dust
  - Learn something new
  - Storage is my day job

• 🌟 I know...
Project Idea
Goals

• Access cloud storage from anything
  - Stereos, TVs, Phones, etc.

• Boot from cloud backed disk images
  - Ceph
  - Azure

• Encryption

• Simple device configuration
Ceph

- Aggregate, manage and share storage resources
- Highly available
  - No single point of failure
- Self managing and self healing
- Scalable
Ceph

**LIBRADOS**
A library allowing apps to directly access RADOS, with support for C, C++, Java, Python, Ruby, and PHP

**RADOSGW**
A bucket-based REST gateway, compatible with S3 and Swift

**RBD**
A reliable and fully-distributed block device, with a Linux kernel client and a QEMU/KVM driver

**CEPHFS**
A POSIX-compliant distributed file system, with a Linux kernel client and support for FUSE

**RADOS**
A reliable, autonomous, distributed object store comprised of self-healing, self-managing, intelligent storage nodes.
Ceph RADOS Block Device

- Block device backed by RADOS objects
- Thin provisioned
- Resizeable
- Supports snapshots and clones
- Linux kernel and user-space clients
Hardware
Hardware

• Mainline kernel support
  - sunxi community
• openSUSE Tumbleweed port
• Relatively performant
  - Multi-core ~1GHz CPU
  - 512MB-2GB RAM
  - USB2 and 100Mb-1Gb Ethernet
• Inexpensive
USB Storage

• SCSI transport
  - Bulk-Only transport (BOT)
  - USB Attached SCSI (UAS)
    - Faster: high-speed and super-speed specs

• Linux kernel USB gadget support
  - f_mass_storage.ko
  - f_tcm.ko
    - Support for BOT and UAS
USB Gateway

• Linux kernel does everything
  - Ceph RBD client
  - USB device mode support
  - Block device encryption (dm-crypt)

• Only need to handle configuration
  - Ceph credentials and image details
  - dm-crypt key
  - Perform RBD mapping and crypt setup once configured
USB Gateway

Plug-in → Boot Linux → Provision Conf-FS → Await Eject → Connect Network → Map RBD Image

Fast Path

Encryption?

Yes → Open LUKS Device

No → Expose Via USB

rbd-usb.conf
ceph.conf
Ceph Keyring
LUKS key
Demo!
Azure Blob Storage

• Public cloud storage
  - RESTful protocol
  - Pay for what you use

• Page Blobs and Block Blobs
  - Page Blobs ideal for disk images
    - Sparse object
    - Accept 512-byte aligned I/Os at arbitrary offsets
  - Premium accounts with QoS constraints
• Linux I/O Target (LIO)

  • In-kernel SCSI target
    - Pluggable transport and storage engine layers
    - Transports: FC, iSCSI, loopback, USB, etc.
    - Storage engines: file, block device, tcm-user (TCMU)

  • TCMU
    - LIO storage engine in user-space
    - SCSI pass-through
• TCMU with Azure

• Elasto Cloud project
  - Azure Page Blob client written in C
  - Also supports Azure File Service and Amazon S3 protocols
  - POSIX like API

• TCMU Elasto handler
  - Maps SCSI I/O to Azure Page Blob REST requests
  - Page Blobs accessible as regular block devices
    - Via supported LIO transports
• Linux I/O Target with Azure

Diagram:
- **Microsoft Azure**
- **HTTP(S)**
- **Elasto Client Library**
- **TCMU**
- **Linux I/O Target**
- **USB Gadget**

*SCSI* and *USB* connections are depicted.

Filesystem

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Testing

- *dummy_hcd* on Linux
  - Re-route USB device traffic back to the local system
  - USB high-speed and super-speed connection simulation
Future Challenges

• Concurrent image access
  - Currently must be manually avoided

• Use locking and snapshots?
  - Snapshot and lock on connect
  - Subsequent connects expose snapshot
  - Reference counting for cleanup
Future Challenges

• Power
  - Battery to reduce reliance on USB supply

• f_tcm
  - Works in VM (loopback) but fails on board
  - Needs super-speed support?

• Caching
  - Utilise on-board NAND
Future Challenges

• Performance
  - Boot time critical
    - Perform fast-path mapping in initramfs
  - USB3+ and GbE/802.11ac
    - Price trade-off
    - Not a priority for “stupid” devices
Conclusion

• Ceph is great
  - Client availability limits adoption

• USB storage is accepted everywhere
  - A USB gateway can expose cloud storage to the masses
  - Gateway encryption makes cloud storage use safer

• Cheap and portable hardware makes this viable
  - Mainline Linux support is a huge benefit
Questions?

Thank you.
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