Megasas megasas

An efficient SCSI HBA emulation for KVM/Qemu

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Qemu device emulation goals

- Emulate existing hardware
- Emulate common drivers
- Device multiplication
  - Network drivers
  - Storage drivers
- Supports various platforms

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KVM device emulation goals

- Efficient emulation on Linux
- Paravirtualisation: virtio
- One device only, but efficient
- Main focus on x86 platform
- (Alex Graf it ported to PPC and S/390 :-)

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SCSI device emulation

- Two types: scsi-disk, scsi-generic
- Scsi-disk emulates disk access
  - Translates every command
  - Using bounce-buffers to transfer data
  - Using bdrv_XXX functions to access backing device
- Scsi-generic for everything else
  - No command translation
  - SG_IO to pass commands to backing device

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SCSI HBA emulation

- Emulates NCR/LSI 53c8xx
- SCSI parallel HBA
- All devices are emulated as SCSI parallel devices
- Emulates on HBA level:
  - Scripts engine
  - SCSI parallel protocol quirks
- Prone to breakage

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The search for an HBA

HBA emulation goals

- Should be a SCSI driver
  - I want to use all the nifty sg_XX tools
- Existing driver / hardware
  - Emulate only one side, use existing driver for the guest
- Simple driver / HBA interface
  - Efficient implementation, less coding
- Protocol independent interface
  - All type of devices should be passed/emulated
  - Full protocol handling cumbersome

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Protocol independent interface

- Excludes protocol-specific drivers
  - SAS/FC HBA
- Possible HBA types:
  - LSI MPT driver
  - I2O driver
  - RAID driver

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Simple HBA interface

- LSI MPT interface rather complex, so not doing it
- I2O … well
- RAID driver:
  - Aacraid: Can't stand Adaptec …
  - Hpsa: new development, not readily available
  - Megaraid: Old interface horrible
  - 3Ware: SATA mainly, not really multiprotocol
- Megaraid_SAS has a pretty simple interface
  - Protocol independent
  - Simple structure

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Updating KVM/Qemu

Qemu/KVM SCSI implementation

- Very old style:
  - Requests are opaque, access via 'tag'
  - Sequential processing
  - Call ->send_command() to evaluate CDB
  - Receive completion on tag
  - Call ->read_data() / ->write_data() to fill buffer
  - Receive completion
  - Access the buffer via ->get_buf()
  - Finish command
  - Sense data has to be requested separately

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Megasas cmd handling

- Receive command
  - Two type of commands: SCSI Passthrough and direct I/O (Read/Write) commands
  - Data is passed via SGLs
- Handle command
  - Process command
  - Process I/O
  - Handle exceptions
- Send back status & sense code

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First try: Rewrite SCSI stack

- Expose the SCSI request to SCSI driver
- Allow driver to pass scatter-gather list to the block driver
- Allow the driver to access sense data directly
- Update existing driver to the new interface
- Quite intrusive ...

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Scatter-gather list passing

Scatter-gather list handling

- Scatter-gather list is received by the HBA
- Convert and pass down to backing device
- File-backed:
  - Using aio to write data / sgl to disk
- Device-backed:
  - Using SG_IO to write data/sgl to device
- SG list might be misaligned
- No definite indication for this
  - A priori checking required

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Misaligned sg lists

- Request queues on host and guest might have different parameter
- Passing misaligned sg list results in I/O error
- Ideally: queue parameter are aligned
  - No guarantee
- Pass host queue parameter up to the guest
  - megaraid_sas reads parameter off the hba, so we can be passing the information

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HBA – disk mapping

- Request queue reflects the HBA settings
- Connecting devices from different HBAs to megasas emulation will not work
- Disallow, have a 1:1 (host)disk / (guest) HBA mapping initially

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Developing the driver

Linux driver as template

- Quite complete interface description in megaraid_sas.h
- Implement target side to match linux driver expectations
- Simple frame interface:
  - Driver allocates ring buffer and passes location of head and tail pointer to HBA
  - Driver writes frames, updates head pointer, and notifies HBA via mmio
  - HBA processes frames, updates tail pointer, and notifies driver via doorbell register & interrupt

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Windows booting

- HBA detection failed; frame analysis didn't reveal anything
- Analyse qemu traces: driver checks for the number of available frames and aborts??
- Disassemble windows driver:
  - Driver reads the number of frames from the driver
  - If this number is <u>not</u> 1000 → abort
- (How stupid can one get …)
- Fix frame number to 1000
- Windows boots :-)

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Management interface

- Most of the protocol given to management functions
- Stand-alone management CLI 'MegaCLI'
- Implement rudimentary functions to make CLI work
- ¼ of calls undocumented
- 'Educated guesswork' to implement missing functions
- CLI now runs without errors
- (without functionality, too)

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Initial results

I/O performance

- Bonnie run on LSI:

```
Writing with putc()...         done:     33 MB/s  51.3 %CPU
Rewriting...                   done:     27 MB/s   3.4 %CPU
Writing intelligently...       done:     23 MB/s   4.1 %CPU
Reading with getc()...         done:     30 MB/s  45.8 %CPU
Reading intelligently...       done:   1063 MB/s  62.3 %CPU
```

- Bonnie run on Megasas:

```
Writing with putc()...         done:     28 MB/s  45.1 %CPU
Rewriting...                   done:     27 MB/s   3.2 %CPU
Writing intelligently...       done:     34 MB/s   5.5 %CPU
Reading with getc()...         done:     51 MB/s  67.0 %CPU
Reading intelligently...       done:   1220 MB/s  81.0 %CPU
```

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I/O performance (contd.)

- Bonnie run on virtio:

```
• Writing with putc()...          done:     54 MB/s  80.6 %CPU
• Rewriting...                    done:     47 MB/s   5.3 %CPU
• Writing intelligently...        done:     52 MB/s   8.8 %CPU
• Reading with getc()...          done:     58 MB/s  74.8 %CPU
• Reading intelligently...        done:   1318 MB/s  66.9 %CPU
```

- Bonnie run on Megasas:

```
• Writing with putc()...          done:     28 MB/s  45.1 %CPU
• Rewriting...                    done:     27 MB/s   3.2 %CPU
• Writing intelligently...        done:     34 MB/s   5.5 %CPU
• Reading with getc()...          done:     51 MB/s  67.0 %CPU
• Reading intelligently...        done:   1220 MB/s  81.0 %CPU
•
```

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Smartd weirdness

- Log during boot:

```
Starting SSH daemon                                                  done
Starting cupsd                                                       done
Starting irqbalance                                                  unused
Starting Name Service Cache Daemon                                   done
Starting mail service (Postfix)                                      done
Starting CRON daemon                                                 done
Starting smartd megasas: xfer length mismatch, frame 512 cdb 256
                                                                     unused
Master Resource Control: runlevel 3 has been                         reached
Skipped services in runlevel 3:            nfs smbfs irq_balancer smartd
```

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LSI legalese

- Got in touch with LSI to get legal clearance
- Legal review at LSI
- Rejected in the sense that LSI will not endorse any HBA virtualisation
- “This would allow you to run LSI driver on a non-LSI hardware” … well, yes … that was the whole point...
- Discussions ongoing.

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Multipath testing

- 'Real' SCSI HBA, no problems with multipath setup
- Using LIO-target to emulate disks
- Testing and implementing advanced multipath scenarios:
  - Dynamic ALUA
  - Multipath with Referrals

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Upstreaming it

- Fighting with Qemu community
- Main points of contention:
  - SG list mismatch
  - Limited I/O size
- Original LSI HBA emulation transfers data in chunks of 128k, thus allowing for (in theory) unlimited data size
- SGL lists are limited by the hardware / HBA emulation, thus the total I/O size is limited, too.
- But the OS will only allow I/O which matches to hardware limits, hence quite a pointless argument

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Next try: Updating existing stack

- Rearrange patchset to send 'real' enhancements first
  - Sense code handling
  - INQUIRY fixes
  - Use SCSIRequest directly instead of referencing it via 'tag'
  - Add possibility to pass in SG Lists
  - Rewrite megasas emulation to match the updated interface
- Leaving existing drivers intact, thus objections should be resolved
- Sending it upstream shortly

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TEAL **RGB** **50 118 109**	GREEN RGB **98 158 31**	YELLOW **RGB** **255 221 0**
DK GRAY RGB **60 60 65**	MD GRAY RGB **90 90 100**	LT GRAY RGB **204 204 205**

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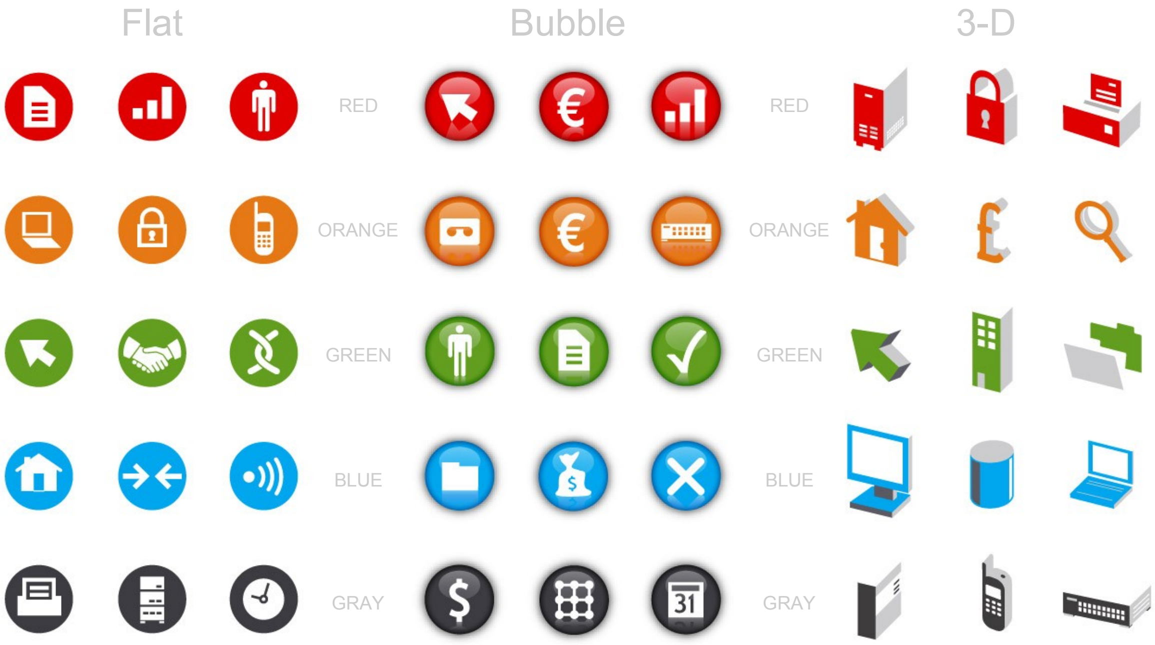

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