Native Linux KVM Tool

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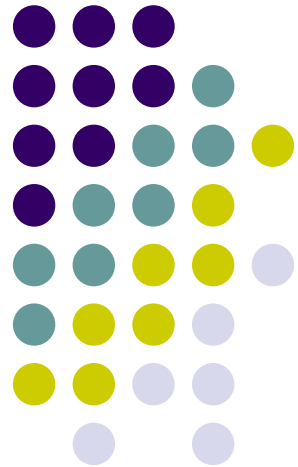
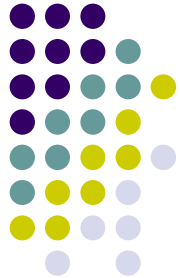
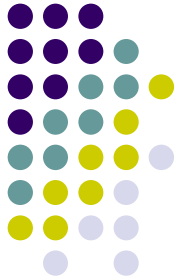


Agenda



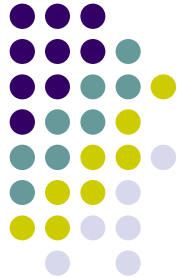
- What is it?
- A brief history
- Who is developing it?
- Features
- Features in the future
- How to use it?
- Demos
- Q&A

What is it? (1/2)



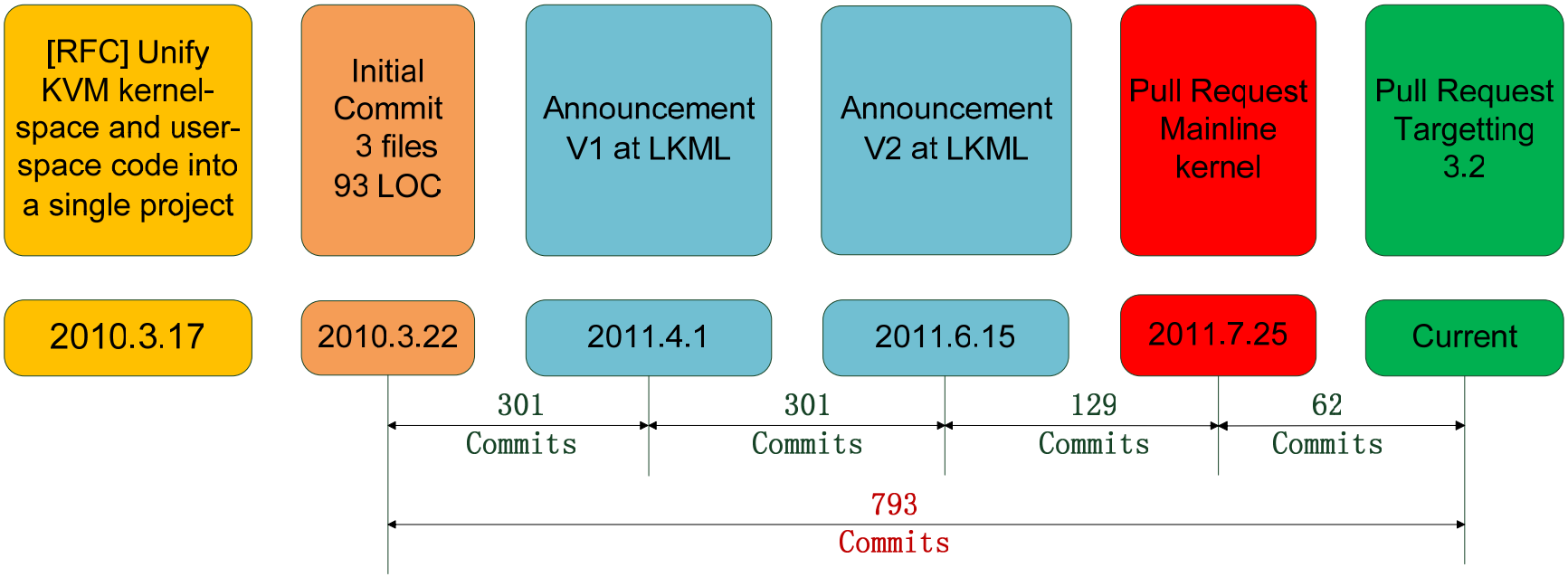
- Native Linux KVM Tool is a clean, from-scratch, lightweight KVM host tool implementation
  - Source Code
    - 15K lines of clean C code
    - From scratch and lightweight
    - Great learning tool
    - Integrate more tightly with the kernel source tree
  - Care about both Desktop and Server users
    - Usability
      - As little configuration as possible
    - Performance
      - Multi-threaded and para-virtualized device model

What is it? (2/2)

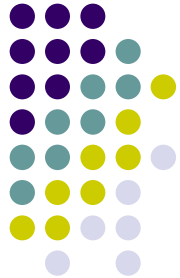


- Young, only 1 year and 5 months old
- Still under heavy development
- Already have some cool features
  - SMP
    - Up to 254 VCPUs per VM
  - Devices
    - Minimal legacy devices emulation
    - Rely heavily on virtio devices
    - Disk, Network, Serial, Mouse and Keyboard, RTC, VESA, SDL and VNC support
- More features and improve usability & performance

A brief history



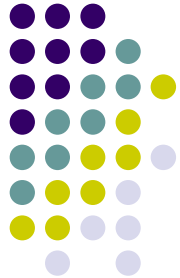
Who is developing it? (1/2)



- Developers (17 people)
  - **Pekka Enberg** (326)
  - Sasha Levin (153)
  - Asias He (120)
  - Cyrill Gorcunov (110)
  - Prasad Joshi (29)
  - Aneesh Kumar K.V (18)
  - Ingo Molnar (11)
  - Liming Wang (7)
  - John Floren (6)
  - Amos Kong (4)
  - Amerigo Wang (2)
  - Giuseppe Calderaro (2)
  - Anton Vorontsov (1)
  - David Ahern (1)
  - Emil Renner Berthing (1)
  - Konstantin Khlebnikov (1)
  - Paul Bolle (1)

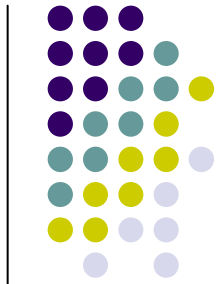
- Special thanks to
  - Avi Kivity
    - KVM internal
  - Ingo Molnar
    - All around support
    - Encouragement

Who is developing it? (2/2)



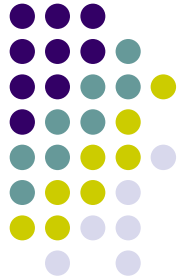
- Mail List
  - kvm@vger.kernel.org
- IRC
  - #pvm @ freenode
- Git Repo
  - git://github.com/penberg/linux-kvm.git
- We need you!
  - Patches and ideas are more than welcome ;-)

Features (1/12)



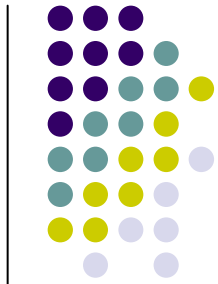
- User Interface support
  - Command line user interface
    - Very similar CLI interface like git and perf.
  - Text Console
    - Serial console
    - Virtio console
  - GUI Framebuffer
    - SDL
    - VNC

Features (2/12)



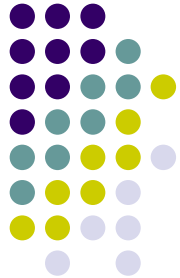
- SMP support
  - Up to 254 VCPUS per VM
    - KVM_CAP_NR_VCPUS 64
    - KVM_CAP_MAX_VCPUS 254
      - [PATCH] x86: Raise the hard VCPU count limit by Sasha Levin
  - Implement MPtable specification
    - Easier than ACPI specification
    - Implement the minimum needed for smp

Features (3/12)



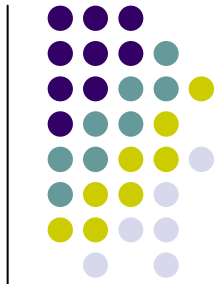
- Disk support
  - Disk image support
    - Raw disk images
    - QCOW/QCOW2 disk images (experimental)
    - Raw block devices (e.g. /dev/sdb7)
  - Boot a directory as a root filesystem.
    - Plain directory which contains root filesystem

Features (4/12)



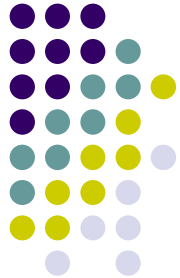
- Network support
  - TAP Mode
    - NAT
    - Bridge
    - Special privilege (CAP_NET_ADMIN)
    - Setup
  - UIP Mode (User mode TCP/IP)
    - No special privilege
    - From scratch and no ancient slirp code
      - *qemu.git$ cat slirp/*.{c,h} net/slirp.{c,h} | wc -l* -> **11790 LOC -> 11.7 KLOC**
      - *tools/kvm$ cat net/uip/*.{c,h} include/kvm/uip.h | wc -l* -> **1588 LOC -> 1.5 KLOC**
      - 1588 / 11790 = 13.5%
    - Protocols
      - ARP, ICMP, IP, TCP, UDP DHCP
      - Up layer: HTTP, FTP, SSH, DNS
    - Zero configuration network
      - Built-in DHCP server
      - No setup in host side
    - Multi-threaded
      - UDP thread
      - Per Connect TCP thread
    - Performance
      - Almost achieves the the same TCP and UDP performance as in host

Features (5/12)



- Device emulation
  - Two type of devices
    - Virtio devices
    - Legacy devices
  - Device emulation infrastructures
    - PIO and MMIO
      - KVM_EXIT
      - KVM_IOEVENTFD
    - Interrupt
      - KVM_IRQ_LINE

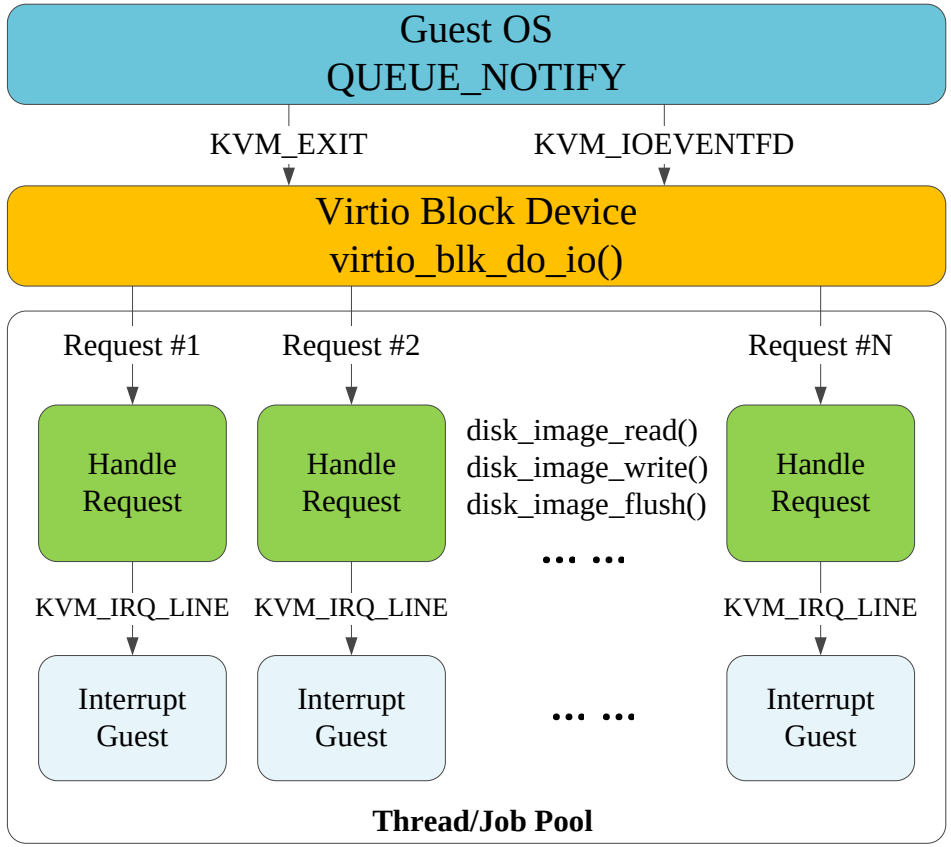
Features (6/12)



- virtio pci
  - Simple PCI controller
  - PCI configuration space
    - PCI_CONFIG_ADDRESS 0xcf8
    - PCI_CONFIG_DATA 0xcfc
  - PCI discovery/configuration
    - VENDOR_ID
      - PCI_VENDOR_ID_REDHAT_QUMRANET 0x1af4
    - DEVICE_ID
      - PCI_DEVICE_ID_VIRTIO_NET 0x1000
      - PCI_DEVICE_ID_VIRTIO_BLK 0x1001
      - PCI_DEVICE_ID_VIRTIO_CONSOLE 0x1003
      - PCI_DEVICE_ID_VIRTIO_RNG 0x1004
      - PCI_DEVICE_ID_VIRTIO_BLN 0x1005
      - PCI_DEVICE_ID_VIRTIO_9P 0x1009
    - SUBSYSTEM_ID
      - VIRTIO_ID_NET 1
      - VIRTIO_ID_BLOCK 2
      - VIRTIO_ID_CONSOLE 3
      - VIRTIO_ID_RNG 4
      - VIRTIO_ID_BALLOON 5
      - VIRTIO_ID_9P 9
    - BAR[0]
      - IO space
      - Virtio configuration

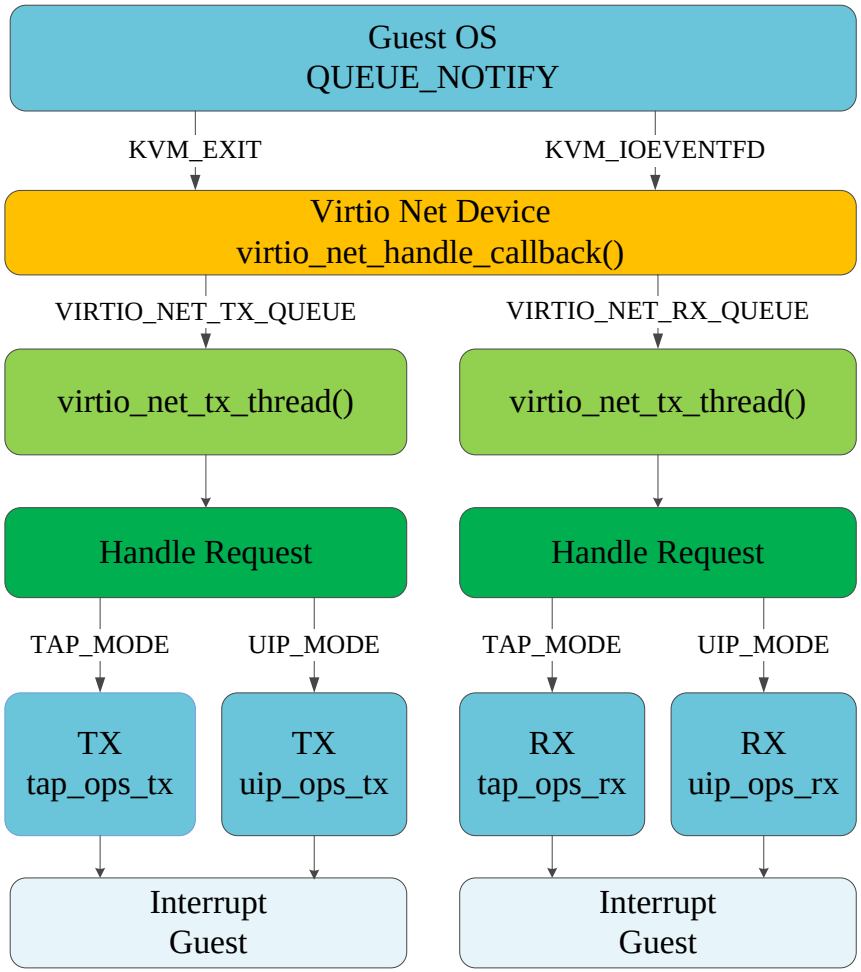
Features (7/12)

- virtio blk
  - Process multiple virtio-blk *requests* in parallel
  - Process multiple virtio-blk *devices* in parallel
  - Backends
    - Raw block device
    - Raw disk image
    - QCOW image
    - QCOW2 image

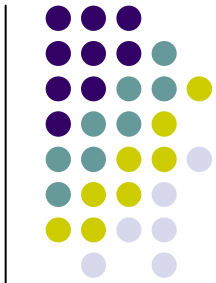


Features (8/12)

- virtio net
  - Multi-thread
    - TX thread
    - RX thread
  - Backends
    - TAP Mode
    - UIP Mode

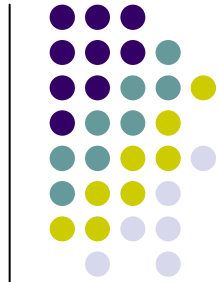


Features (9/12)



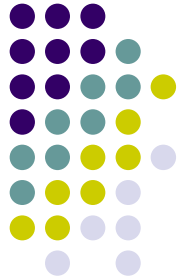
- virtio 9p
  - 9p: Plan 9 Filesystem Protocol
    - Transport: Named pipe, TCP connection, File descriptor, RDMA channel, virito
    - No network setup is needed
  - Share files between host and guest
    - *kvm run -k ./bzImage -d ./disk.img -9p ./dir_to_share*
    - *mount -t 9p -otrans=virtio -oversion=9p2000.u kvm_9p /mnt*
  - Boot a directory as a guest root filesystem using 9p
    - *kvm run -k ./bzImage -d ./guest_rootfs*

Features (10/12)



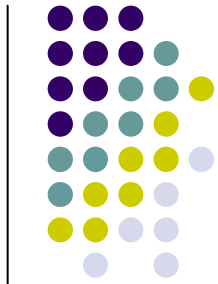
- virtio console
  - /dev/hvc0
- virtio rng
  - /dev/urandom
  - /dev/hwrng
- virtio balloon
  - kvm balloon inflate/deflate size instance

Features (11/12)



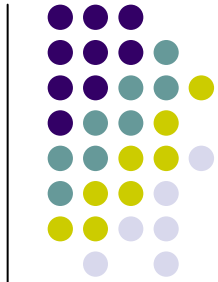
- Legacy device emulation
  - Serial device 16550
    - Guest console
  - PS/2 Keyboard and Mouse i8042
    - SDL and VNC
  - VESA
    - SDL and VNC
  - RTC
    - Real time clock

Features (12/12)



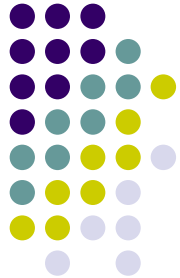
- BIOS emulation
  - Very tiny and lightweight BIOS layer
  - No external BIOS dependency
  - Functions
    - e820 memory map
    - real-mode interrupt vector table
    - mptable

Features in the future(1/2)



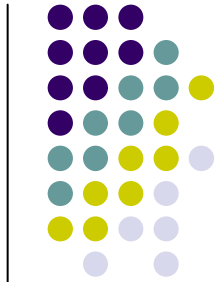
- Vhost net/blk
- Macvtap Mode
- Virtio-scsi virtio-based SCSI HBA
- IO bandwidth limits
- More disk image format support (e.g. vmdk, vdi, etc.)
- 9p + overlayfs for COW filesystem layer for guest
- Boot disk images without external linux kernel image.
- Grub support
- External BIOS support (e.g. Seabios)

Features in the future(2/2)



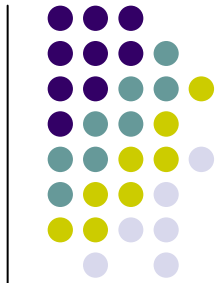
- Non-Linux OS support
- QXL paravirtual graphic card
- Integrate with *perf* for profiling and tracing
- Integrate with *gdb* for debugging
- Libvirt support
- Live migration

How to use it (1/6)



- Command line interface
  - kvm run/stop
  - kvm pause/resume
  - kvm list
  - kvm balloon
  - kvm debug
  - kvm help
  - kvm version

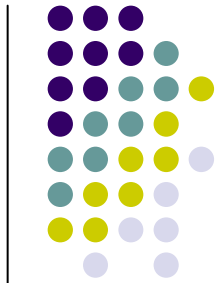
How to use it (2/6)



- Details for ‘kvm run’

```
Basic options:
        --name <guest name>
                              A name for the guest
    -c, --cpus <n>            Number of CPUs
    -m, --mem <n>             Virtual machine memory size in MiB.
    -d, --disk <image or rootfs_dir>
                              Disk image or rootfs directory
        --balloon             Enable virtio balloon
        --vnc                 Enable VNC framebuffer
        --sdl                 Enable SDL framebuffer
        --rng                 Enable virtio Random Number Generator
        --9p <dir_to_share,tag_name>
                              Enable virtio 9p to share files
                               between host and guest
        --console <serial or virtio>
                              Console to use
        --dev <device_file>
                              KVM device file
```

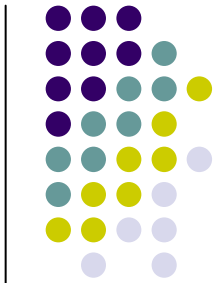
How to use it (3/6)



- Details for ‘kvm run’

```
Kernel options:
    -k, --kernel <kernel>
                            Kernel to boot in virtual machine
    -i, --initrd <initrd>
                            Initial RAM disk image
    -p, --params <params>
                            Kernel command line arguments
```

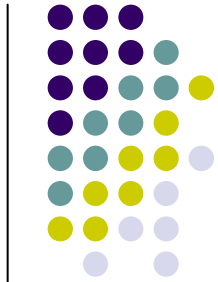
How to use it (4/6)



- Details for ‘kvm run’

```
Networking options:
 -n, --network <user, tap, none>
                Network to use
     --host-ip <a.b.c.d>
                Assign this address to the host side networking
     --guest-ip <a.b.c.d>
                Assign this address to the guest side networking
     --host-mac <aa:bb:cc:dd:ee:ff>
                Assign this address to the host side NIC
     --guest-mac <aa:bb:cc:dd:ee:ff>
                Assign this address to the guest side NIC
     --tapscript <Script path>
                Assign a script to process created tap device
```

How to use it (5/6)



- Details for ‘kvm run’

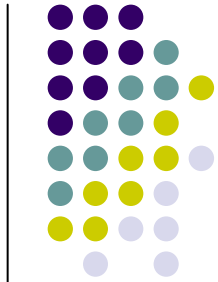
```
BIOS options:
        --vidmode <n>     Video mode

Debug options:
        --debug                 Enable debug messages
        --debug-single-step     Enable single stepping
        --debug-ioport          Enable ioport debugging
        --debug-iodelay <n>     Delay IO by millisecond
```

How to use it (6/6)

- Details for ‘kvm debug’

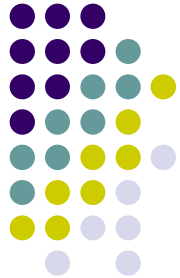
```
Registers:
----------
rip: 00000000c1035061   rsp: 00000000c199ffb8 flags: 0000000000000246
rax: 0000000000000000   rbx: 00000000c19fa1e4   rcx: 00000000d78027d0
rdx: 0000000000000003   rsi: 0000000000000000   rdi: 00000000c19a0000
rbp: 00000000c199ffb8    r8: 0000000000000000    r9: 0000000000000000
r10: 0000000000000000   r11: 0000000000000000   r12: 0000000000000000
r13: 0000000000000000   r14: 0000000000000000   r15: 0000000000000000
cr0: 0000000080050033   cr2: 00000000085907c8   cr3: 0000000016ec0000
cr4: 00000000000006d0   cr8: 0000000000000000

Segment registers:
------------------
register  selector  base              limit     type  p dpl db s l g avl
cs        0060      0000000000000000  ffffffff  0b    1 0   1  1 0 1 0
ss        0068      0000000000000000  ffffffff  03    1 0   1  1 0 1 0
ds        007b      0000000000000000  ffffffff  03    1 3   1  1 0 1 0
es        007b      0000000000000000  ffffffff  03    1 3   1  1 0 1 0
fs        00d8      0000000015d9d000  ffffffff  03    1 0   0  1 0 1 0
gs        0000      0000000000000000  ffffffff  00    0 0   0  0 0 0 0
tr        0080      00000000d7803480  0000206b  0b    1 0   0  0 0 0 0
ldt       0000      0000000000000000  ffffffff  00    0 0   0  0 0 0 0
gdt                 00000000d7800000  000000ff
idt                 00000000c19a0000  000007ff

APIC:
-----
efer: 0000000000000000  apic base: 00000000fee00900  nmi: enabled

Interrupt bitmap:
-----------------
0000000000000000 0000000000000000 0000000000000000 0000000000000000

Code:
-----
rip: [<00000000c1035061>] <unknown>
```

Demos



- 1.demo.sdl.sh
- 2.demo.vnc.sh
- 3.demo.serial.console.sh
- 4.demo.virtio.console.sh
- 5.demo.dir.as.rootfs.sh
- 6.demo.dir.to.share.sh
- 7.demo.64vcpus.sh

Q&A



Questions?