KVM and CPU feature enablement

Eduardo Habkost <ehabkost@redhat.com>
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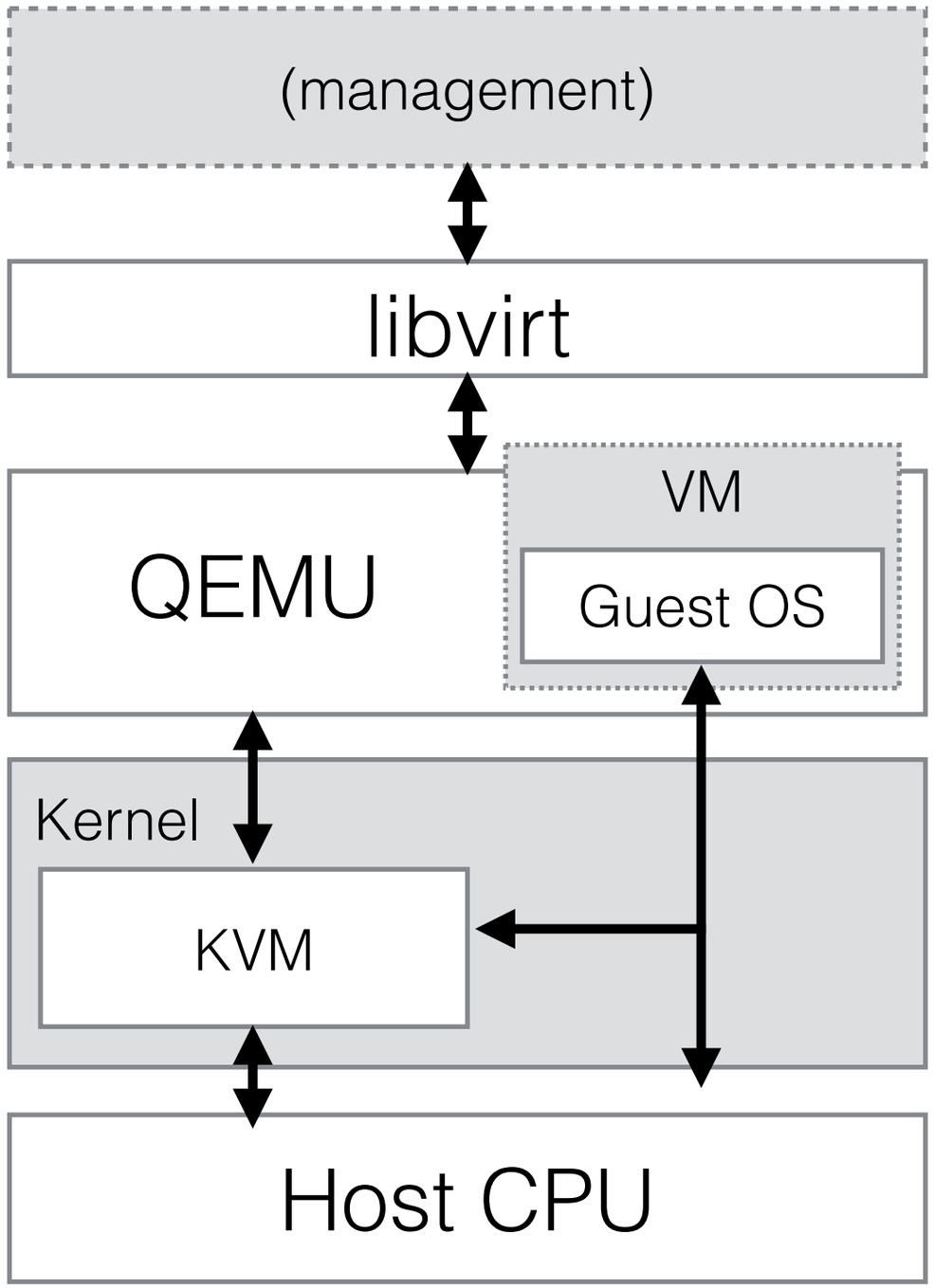
Agenda

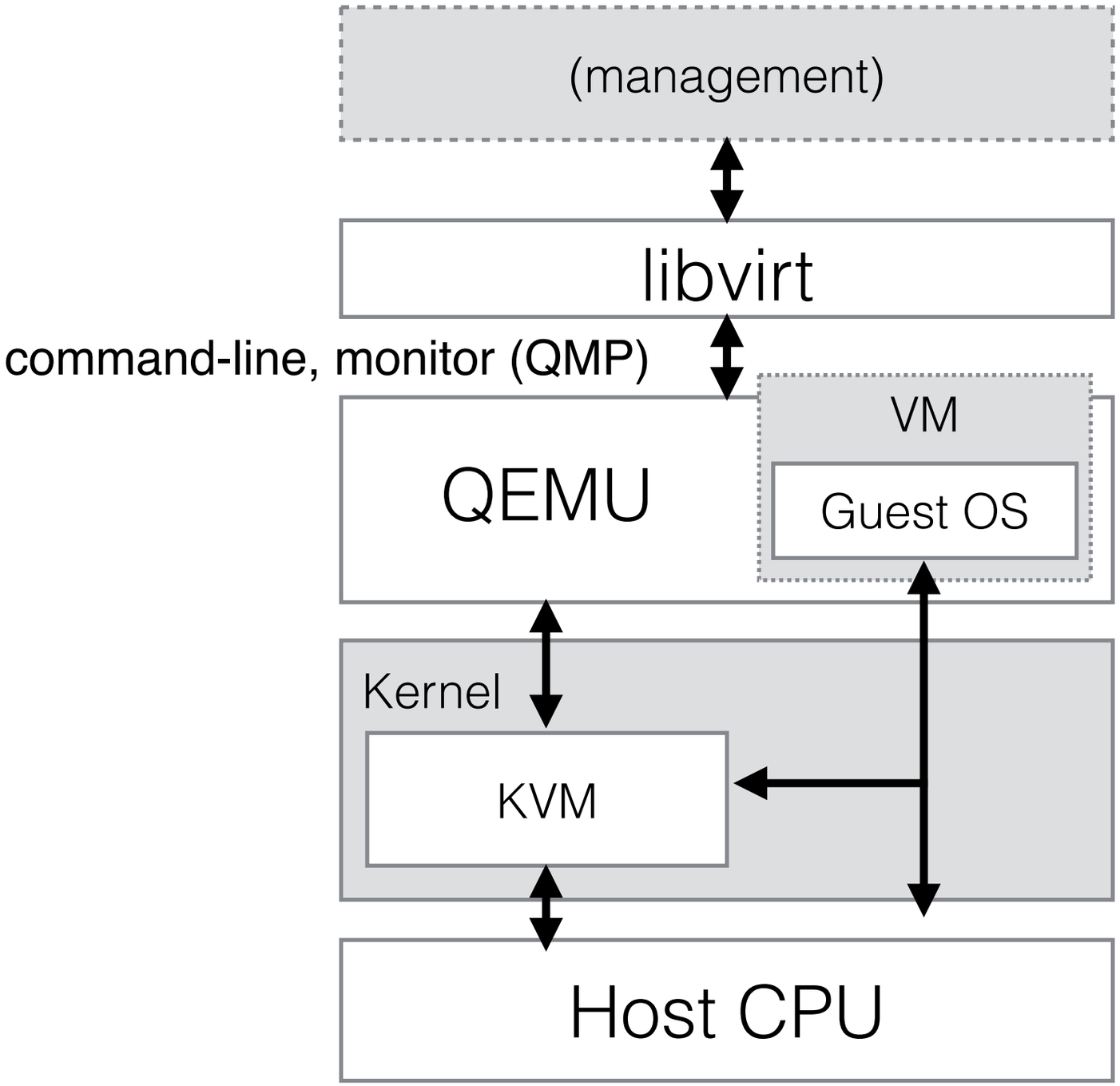
- Basic concepts
- Existing mechanisms and current challenges
- Current work and future plans

Basics

Introduction: Basics



Introduction: Basics



Introduction: Stable guest ABI

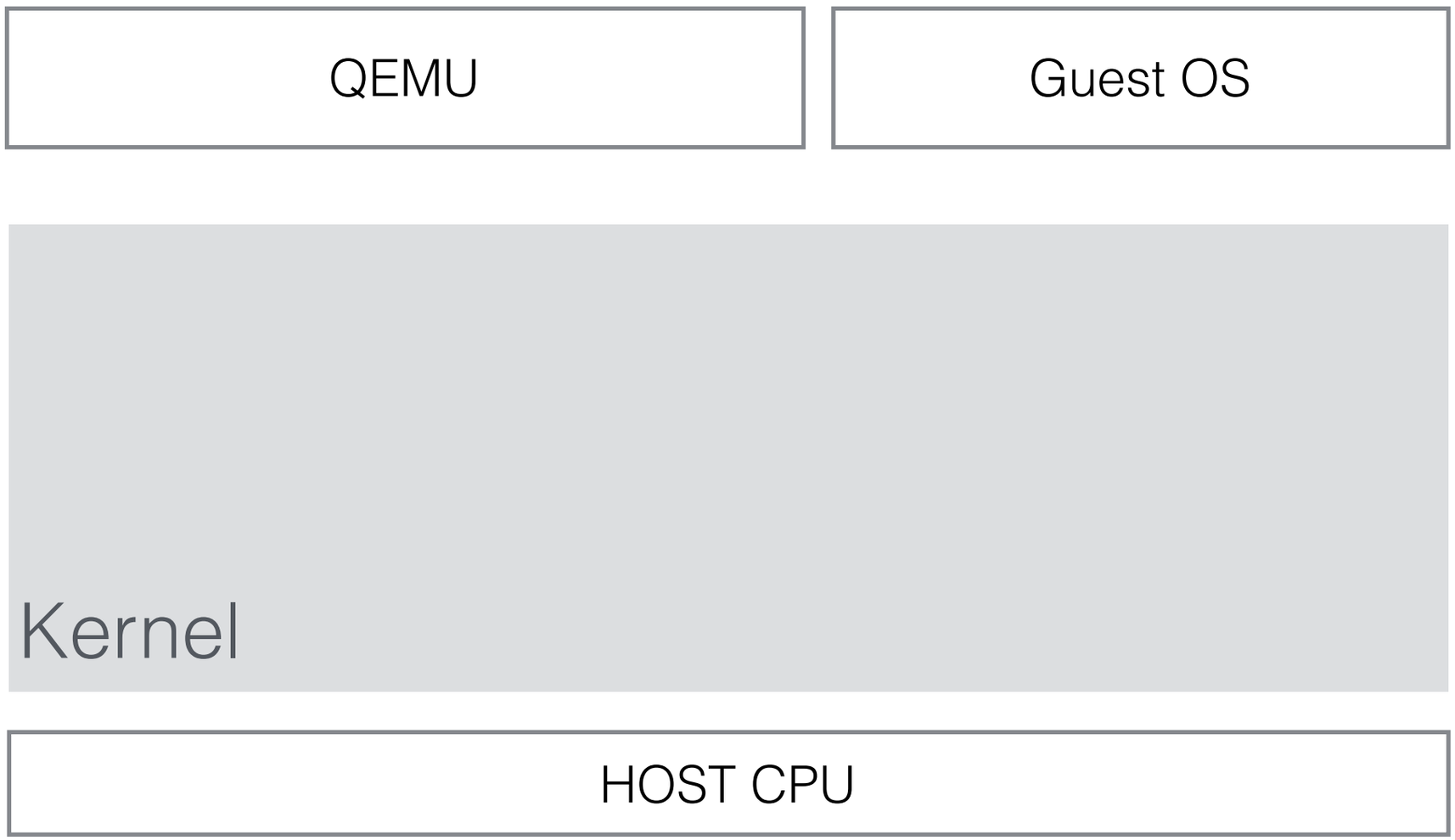
- Guest OS should see the “same” machine, even if the host system has changed
- Hard requirement for live migration
- Soft requirement for non-live migration
- **Host system may change a lot, but VM should look the same**

x86 CPUID instruction

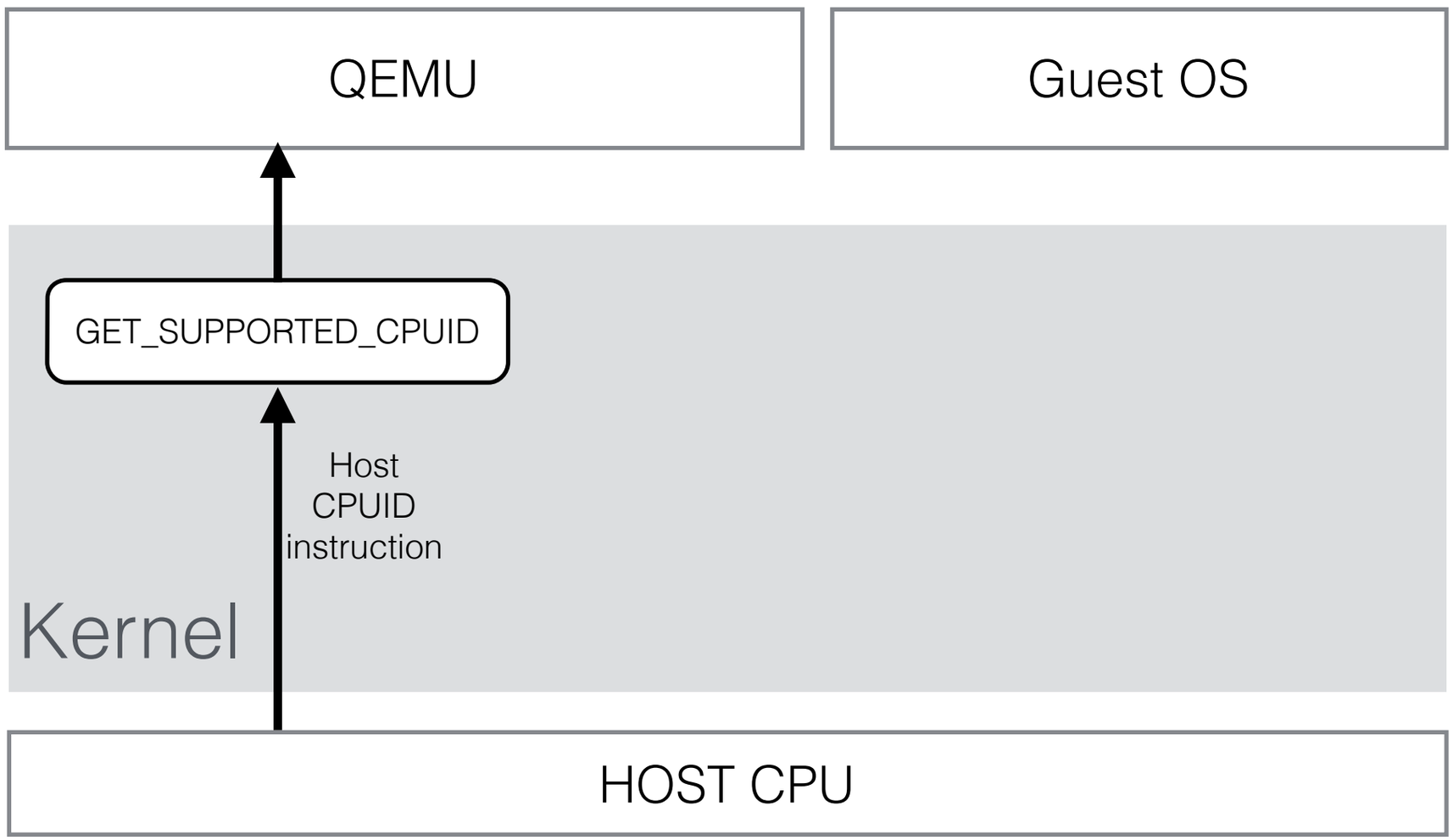
- Returns information about the running CPU
  - Most information shown on `/proc/cpuinfo`
- Feature flags indicating a feature is present
- Other more complex data
  - e.g.: cache and topology information
- **CPUID data is part of guest ABI**

Existing Mechanisms

CPUID handling



CPUID handling



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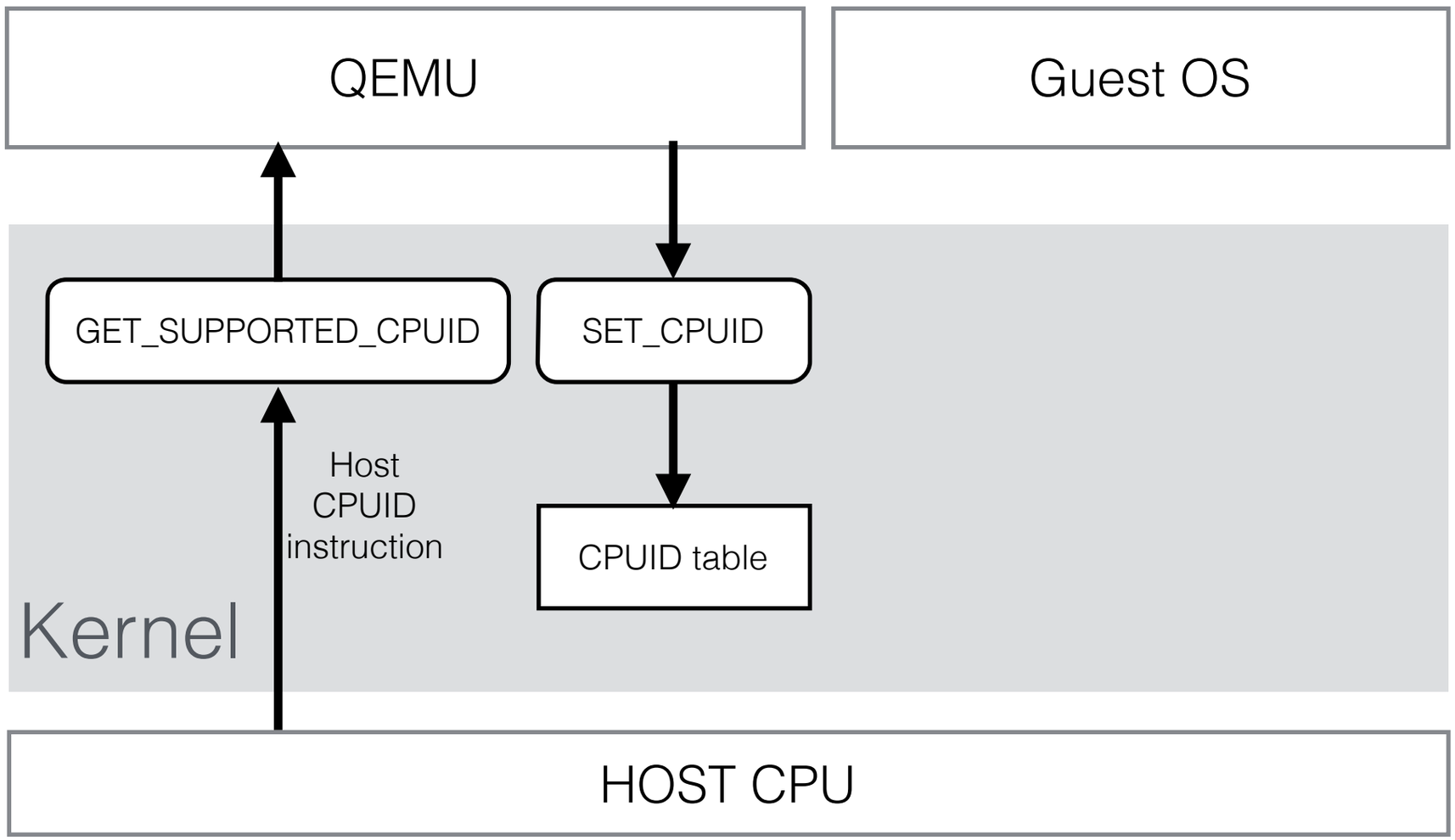
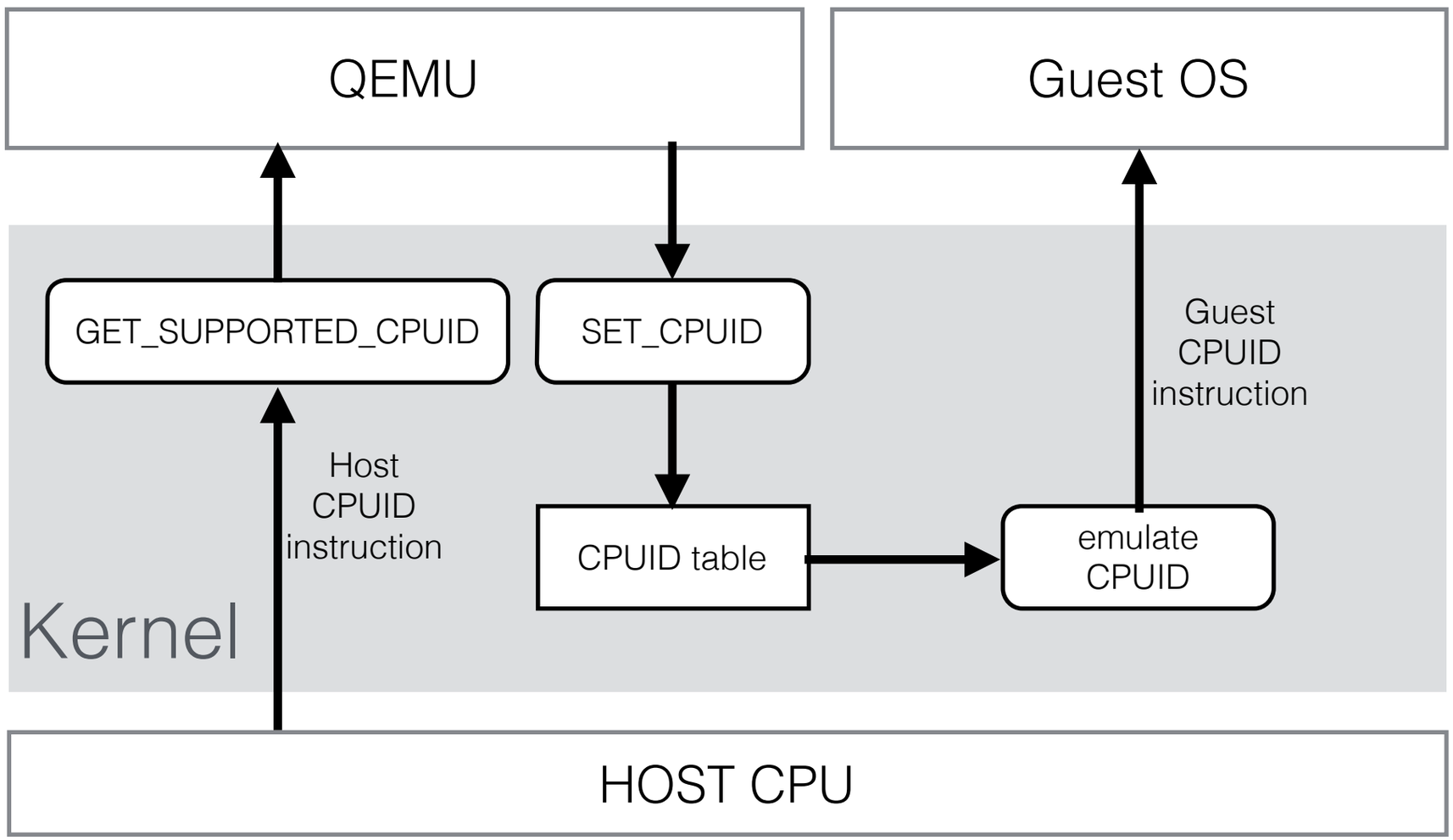


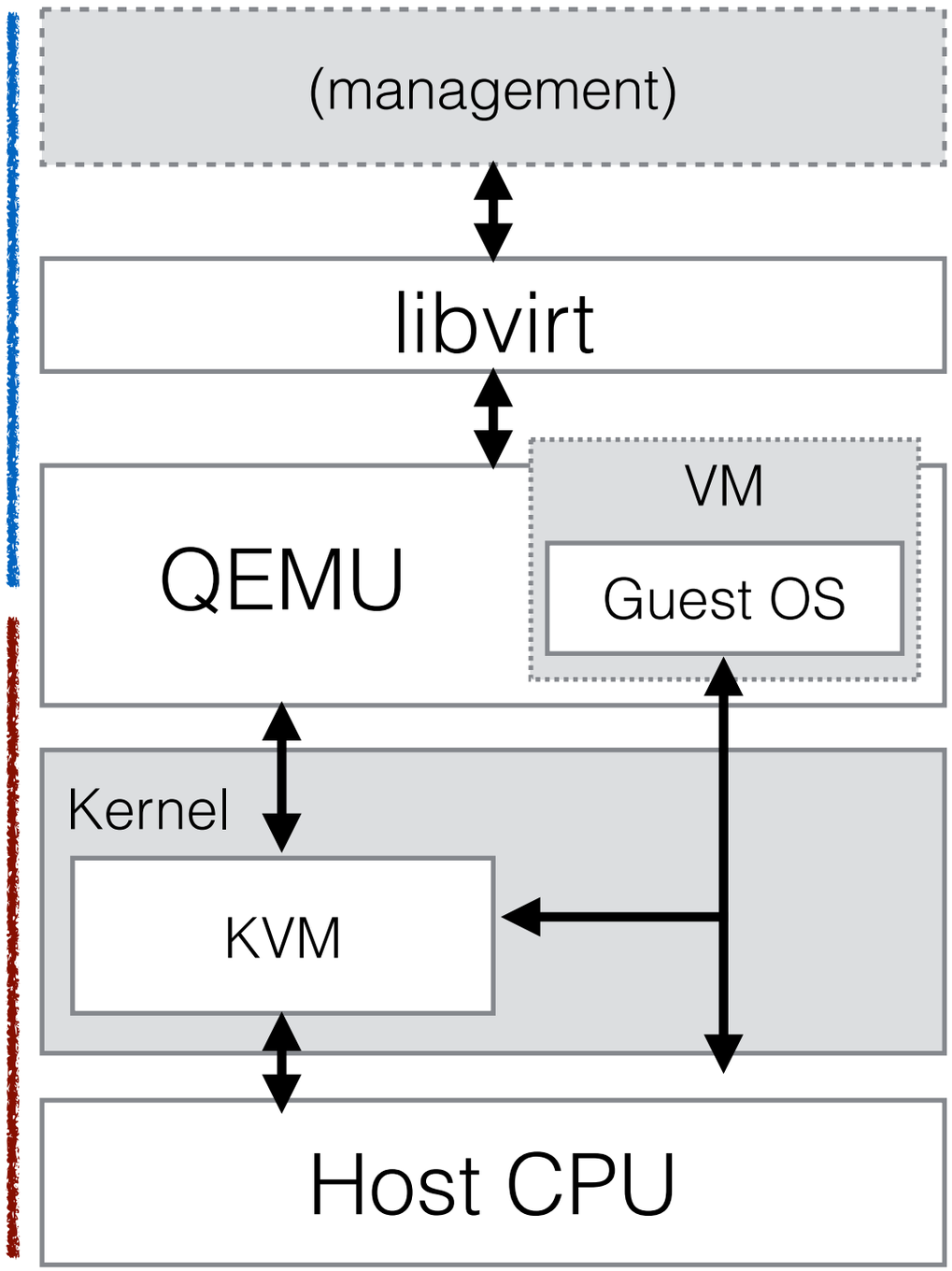
CPUID handling



The Stack

Decision to enable a feature (should be) taken in the upper layers

Lower layers affect the **ability** to enable a feature



Enabling new features

- We can't silently enable or disable a feature:
  - It breaks guest ABI
  - May unexpectedly prevent migration to other (less powerful) hosts

CPU models

- **CPU model table**, different CPUID data on each entry
  - `qemu-system-x86_64 -cpu SandyBridge`
  - `qemu-system-x86_64 -cpu Haswell`
- Controlling individual features. e.g.: `-cpu Nehalem,+aes`
- CPU model entries may change, **machine-types** keep compatibility
  - `qemu-system-x86_64 -machine pc-1.6 -cpu SandyBridge`
  - `qemu-system-x86_64 -machine pc-1.7 -cpu SandyBridge`
- **enforce** flag. e.g.: `-cpu SandyBridge,enforce`
  - **Required** to ensure predictable results

CPU models

- Special CPU model: **-cpu host**

- Will enable everything that's supported by the host

- No stable guest ABI

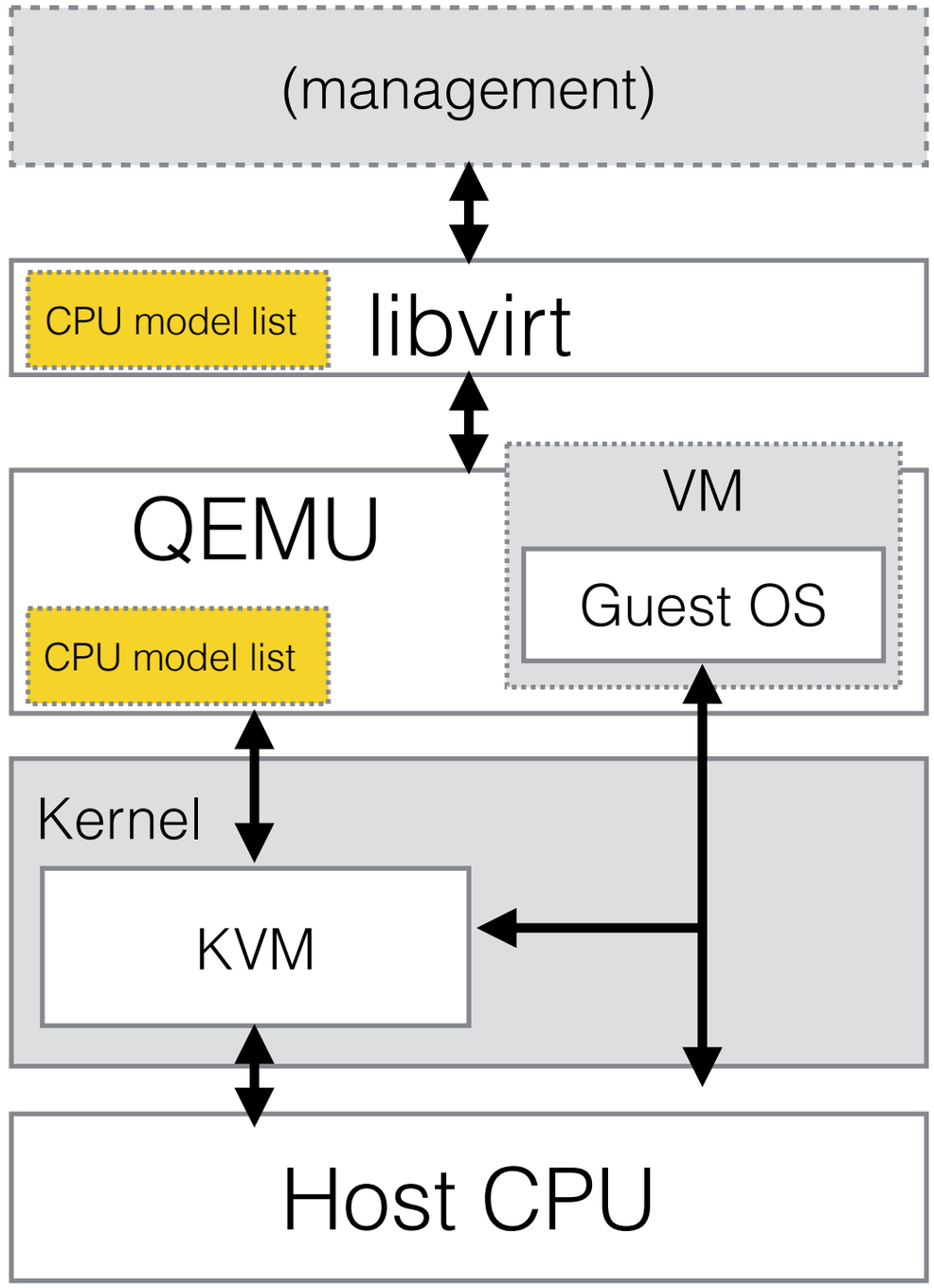
Management requirements

- Ensuring that the resulting CPUID data is what was asked for
- Knowing which CPU models can be enabled in a host
- Knowing which features are available in a host
- Knowing to which hosts a VM can be migrated

Issues

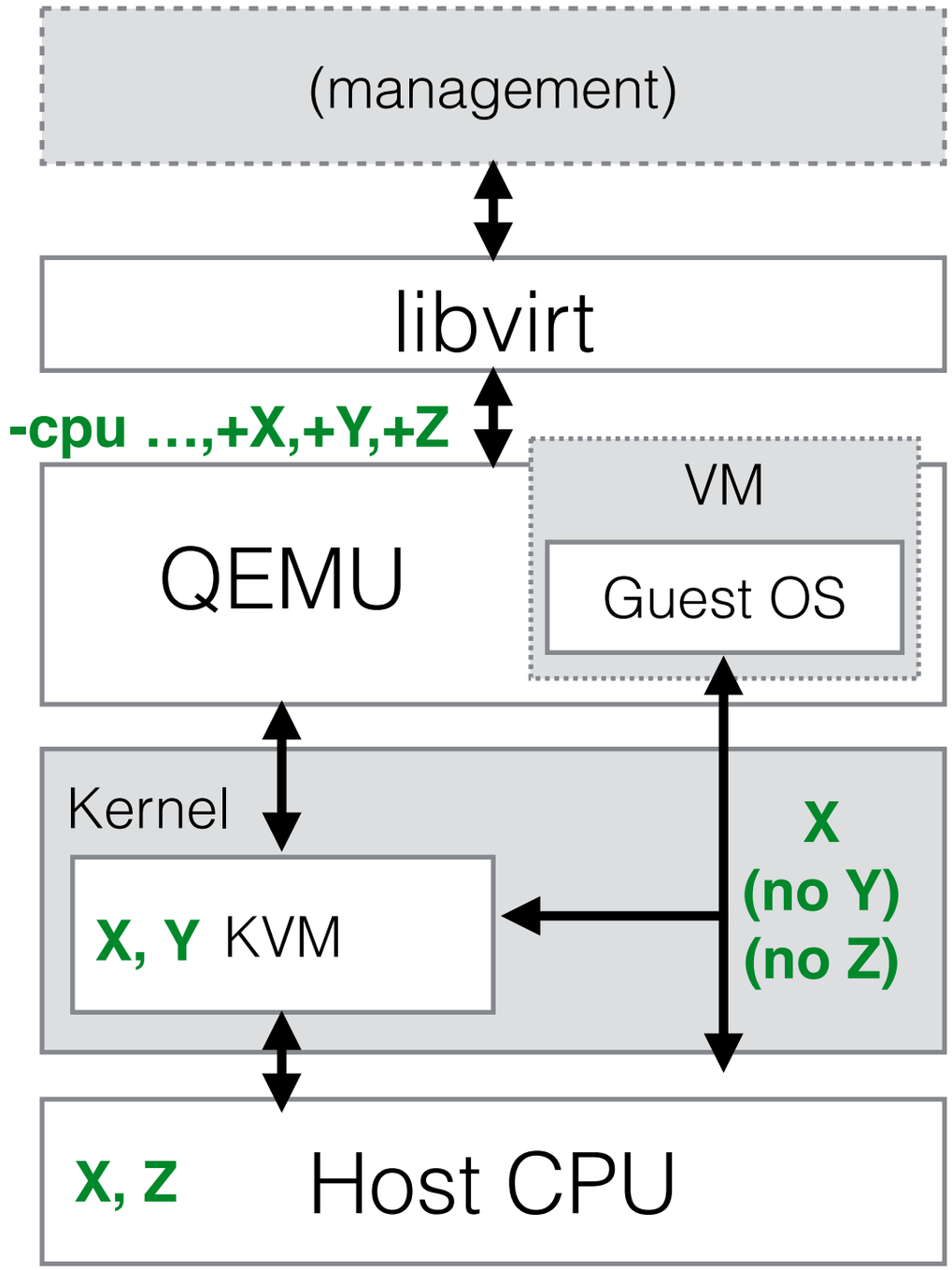
Problem: querying CPU model information

- libvirt has its own list of CPU models
- libvirt doesn't know QEMU CPU models can change over time
- QEMU's fault, there's no good API for that (yet!)



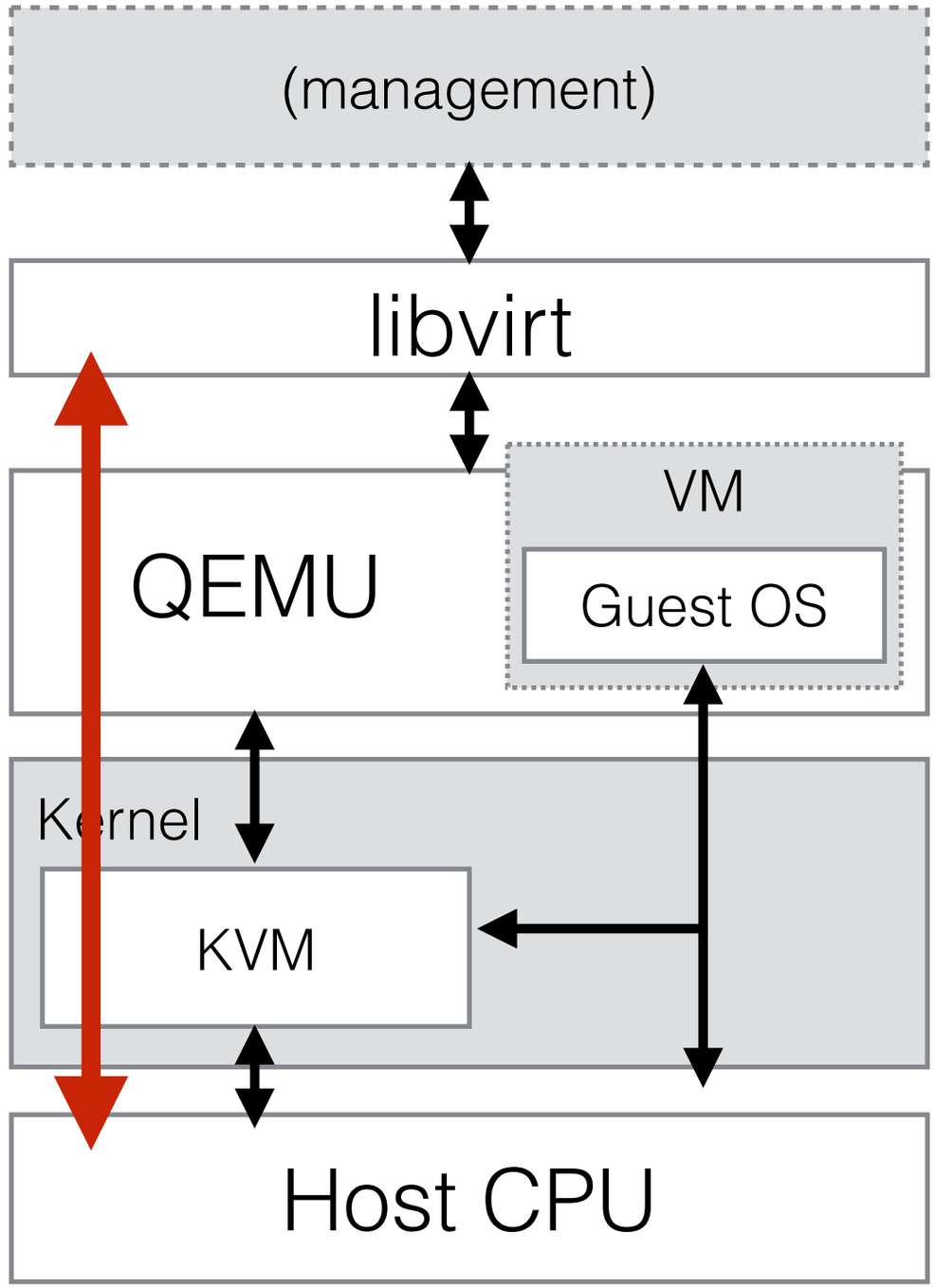
Problem: no “enforce” mode

- libvirt doesn’t use the `enforce` flag
- Error reporting not machine-friendly
- Most serious issue so far
- Fix involves implementing CPU model and host capability APIs



Problem: querying host capabilities

- libvirt queries host CPU features directly using CPUID instruction
- Ignores KVM capabilities
- Ignores QEMU capabilities
- Ignores features that require extra CPU capabilities
- QEMU's fault, there's no good API for that (yet!)



Solutions

Solutions

- Existing interfaces: CPU-specific options and commands
  - `-cpu`, `cpu-add`, `query-cpu-definitions`
- New interfaces: based on common infrastructure (QDev, QOM)

QDev

- QDev = QEMU Device Model
- QOM = QEMU Object Model
- QDev devices are QOM objects
- `-device` command-line option
- QMP commands:
  - Adding devices/objects (`device_add`, `object-add`)
  - Removing devices/objects (`device_del`, `object-del`)
  - Getting/setting devices properties (`qom-get`, `qom-set`)
  - Listing objects and object classes (`qom-list`, `qom-list-types`)

QDev-based solution

- CPUs are QDev devices (done)
  - CPU devices and its properties visible through QMP
- `feature-words` property (done)
  - Query CPU model info
  - Query host capabilities (“host” CPU model)
  - Incomplete: no machine-type-specific data
- `filtered-features` property (done)
  - Used to emulate “enforce" mode with better error reporting
- Not used by libvirt yet

What's missing (1/2)

- Querying CPU model information without re-running QEMU
  - Solution: separate QOM types for each CPU model
- Exposing machine-type-specific data
  - No defined solution yet
- Use QOM properties to control all feature flags
- Changing libvirt to use the new stuff

What's missing (2/2)

- Long term plans:
  - Deprecate `-cpu`, `cpu-add` and use only QDev commands (`-device`, `device_add`)
  - Better interfaces to specify CPU topology (NUMA nodes, sockets, cores, threads)

Future

- Reporting capabilities reliably ⇒ smarter management systems
  - Usability (automatically choosing good defaults)
  - Smarter VM scheduling
- May require extending libvirt API

Thanks

Feedback:

http://devconf.cz/f/34

Additional info / pointers:

http://wiki.qemu.org/Features/CPUModels

ehabkost@redhat.com

Questions?