



# Migration: One year later

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## Abstract

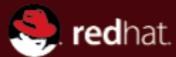
This talk describes current migration status, and ideas for future work.

# Contents

**1 What is the Current State**

**2 Things to do**

**3 Some solutions**



## Section 1

# What is the Current State

## What needs to be moved

- memory

Have I told you that memory nowadays is big? Customer asking already for 8GB guests. Partners for 64-128GB guests.

- disk

And you thought that memory was big. Think again.

- devices

Size don't matter here (insert joke)

But state is spread through a file, not always in a nice place that is trivial to sent.

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## Backward/Forward compatibility

- Old to Old and New to New  
Should be no problem (ha).
- Old → New  
We are in the future, we know what Old sent, should be easy.  
(famous last words).
- New → Old  
We are the future, wanting to sent something to the past, and  
we want the past to understand it. Think NP-complete.  
But we try, of course.

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# Sections, Subsections, Versions

A.K.A. Head hurts ...

- Sections: each device has one.
- Subsections: They are optional. Source decides if they are needed or not.
- Version: Each section has a section number. When we add some fields to a section, we increase the version number, and they are not expected from older versions, but are sent from new versions.

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# Subsections

- Cure cancer
- Get World Peace
- End World Hunger, ....
- Big idea: Why send everything?

We can send only minimal amount of information that is always needed

Send rest of information only when it is used

Source not a subscriber but when it knows that it is needed

Do not have a subscriber, a subscriber

It is not a subscriber, it is not a subscriber

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How to send a file? Don't send it unless it is needed

Do get new records, a different way

How to send a file? Don't send it unless it is needed

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How to send a video? Can we do it when it is needed?

How to send a picture? A document?

How to send a video? A document?

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# Live Migration: When the fun starts

- Memory migration
  - it is big
  - when we fail: memory corruption
  - crash of the machine
- Disk migration
  - you thought memory was big
  - when we fail: disk corruption
  - data loss
  - we will not talk more about disk
- From a 10000 meters view, memory and disk migration are equivalent

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## Live Migration: how it works?

- We have a dirty bitmap with one bit for each page
- We set all the bitmap to “dirty” (A)
- We loop through the bitmap: (B)
  - copy the page
  - clear the bit
- We end the loop when the number of dirty pages is “low enough” (B)
- We stop the machine (C)
- We sent the rest of the pages and all devices (C)
- Stages? What is that?

A: Stage 1

B: Stage 2

C: Stage 3

Send/commit stage 1

Send/commit stage 2 (dirty pages)

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Send/Receive pages

Send/Receive the remaining devices

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## How qemu works?

A.K.A. Why we need threads for migration

- IOthread

```
....  
while(1) {  
    ....  
    qemu_mutex_unlock_iothread();  
    select(...)  
    qemu_mutex_lock_iothread();  
    .... /* We will refer to this part on the next slide */  
}
```

- VCPU's

```
int kvm_cpu_exec(...)  
{  
    ...  
    do {  
        ....  
        qemu_mutex_unlock_iothread();  
        kvm_vcpu_ioctl(..)  
        qemu_mutex_lock_iothread()  
        ....  
    }  
}
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        ....  
    }  
}
```

## What else iothread does?

```
...
QLIST_FOREACH_SAFE(ioh, &io_handlers, next, pioh) {
    if (...FD_ISSET(ioh->fd, readfs), ...)
        ioh->fd_read(ioh->opaque)
    if (...FD_ISSET(ioh->fd, readfs), ...)
        ioh->fd_write(ioh->opaque)
qemu_run_all_timers()
qemu_bh_poll()
```

## How can this ever work?

- Don't this mean that things get “monothread”

- In general no, because

- `lock` is relatively fast

- `lock` threads are out of queue very low times

- `lock` is unpushed

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  - vcpu threads are out of guest very few times
  - Rest of things cheat
    - block layer: some IO
    - network: some IO
  - migration: where the abstraction leaks

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## Buffered file

A.K.A. Another buffer layer will fix any computing problem

- Migration runs in an IOHandler
  - But it can't stop in the middle of a device
  - We add an autogrowing buffer to be able to always finish device state write
  - And we write with a timer that buffer to a FILE \*
  - We wait with select in the FILE \* descriptor
  - We write it with write()
  - And Kernel wants to do its own buffering
  - Enough buffering for you?

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## Measurements: who needs that?

- We have two knobs
  - `migrate_speed`: in MB  
Yes, I mean that, we measure speed in Megabytes, think about it.
  - `max_downtime`: in ms
- And we try to make sense of them.
- When migration don't converge, we don't know for how much

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## migration speed

- Remember the buffered file
- Remember that we measure speed in megabytes?
- migration handler interesting part is:

```
while (number_bytes_sent < max_speed) {  
    sent_another_page()  
}
```

- What can be wrong with this?

• We are measuring how fast we can write to a FILE \* buffer

• We don't measure how fast fread() is the opposite

• We have a FILE \* object that has a buffer of 1000000 bytes

• If we have lots of blank pages we spend a lot of time to write

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• We don't measure how fast we read from the buffer

• We don't measure how fast we can read from the buffer

• We don't measure how fast we can write to the buffer

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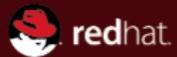
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## Section 2

# Things to do

## VMState: Finish the work

- Virtio devices: old code exists. Problem is that we have list of requests, and we have no good idea how to represent lists on VMState.
- Rest of CPU's: no real problem, just code that needs to be written. (sections are quite big).
- slirp: eats puppies. Slirp code is a mess, It is lists of lists of lists. Code needs fixing independently of VMState.
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- Detection of subsection is wrong, only looks at the 1st byte
- Needs to look at the whole header, and see if len + name makes sense
- It requires the equivalent of `ungetc()` to work for 10-20 chars. And it has to work in the middle of two packets.
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- move to 3 bitmaps: 70 percent size reduction
- who produces dirty pages: kvm, mmio
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- add avi, shake well, and .... **idea**
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### A.K.A. More size reduction

- We have a ram list of ramblocks
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- -M pc-0.14 lies, and uses the same devices that v14
- but it uses the versions of v0.15.
- We need a way to tell a device: boot with version foo
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- And then we can use that for migration.
- People continue asking that we fix that at migration level, but solution needs to be at qdev level. Otherwise, we are trying to boot a device with feature foo, and now magically, migration have to migration **without** feature foo.
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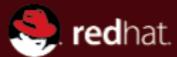
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## Section 3

# Some solutions

## Change the migration format

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- Suggestion: move to XML
- .....
- That helps describing the data in the wire, but helps with the other problems how?

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{
    int32_t *v = pv;
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static void put_xml_int32(QEMUFile *f, void *pv, size_t size)
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## One device gets split in 2 devices

A.K.A. Anthony, I am looking at you

```
struct OldState {
    int foo;
    int bar;
}
struct FooState {
    int foo;
}
struct BarState {
    int bar;
}
```

## One device gets split in 2 devices (II)

```
struct OldState {  
    int foo;  
    int bar;  
    struct FooState *foo;  
}  
struct FooState {  
    int foo;  
}
```

## One device gets split in 2 devices (III)

```
static int old_state_post_load(void *opaque, int version_id)
{
    OldState *s = opaque;
    s->foo->foo = s->foo;
    return 0;
}

static const VMStateDescription vmstate_foo = {
    .name = "old_state",
    .post_load = old_state_post_load,
    .fields = (VMStateField []) {
        VMSTATE_INT32(foo, OldState),
        VMSTATE_INT32(bar, OldState),
        VMSTATE_END_OF_LIST()
    }
}
```

# Postcopy

- Networking vs CPU/RAM
  - we have a new failure case
  - but .... we only have to copy each page only once
  - guest performance varies
  - should be possible to do using current infrastructure

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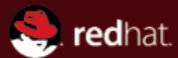
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# Questions?



# The end.

Thanks for listening.