CREATING A COMMON SOFTWARE VERBS IMPLEMENTATION

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AGENDA

Overview

• What is rdmaevt and why bother?
• Technical details
• How did we get it into the kernel?
WHAT AND WHY?
PROBLEM

- Quite simple: Code Duplication
PROBLEM

- **ipath, qib, and hfi1 are all based on the same sw verbs**
  - Three drivers for very different hardware
  - Share the same basic software implementation *(for verbs)*
    - QP, PD, CQ, MR, etc is a software construct not involved in putting packets on the wire
    - putting packets on the wire is the job of the HW

- **Code maintenance**
  - Bug in one driver is a bug in all of them
    - has happened, will happen again
  - Improvement for one needs to be made in all
    - has happened, will happen again
    - perhaps not always ported to all drivers

- **There could be other drivers in the future**
  - other HW, other vendors (soft roce?)

- note: *ipath driver has now been removed from the kernel*
rdmavt

- Spawned out of discussion of hfi1 submission to linux-rdma
  - Requirement to move hfi1 out of staging

RDMA Verbs Transport Library

- A new kernel module which implements software verbs
- Handles things like QP, PD, CQ, MR, etc.
- Uses drivers like qib and hfi1 to put packets on the wire
GOALS

- **Remove verbs code duplication where possible**
  - These are high performance devices
    - **Performance comes first!**
    - At times we may need to settle for less than perfect (from sw engineering POV)
- **Can not cause regressions**
  - qib code has been stable for a number of years
- **Be able to support multiple hardware devices**
  - Do nothing that prevents other HW from working with rdmavt
  - Not do the actual work for other HW though
- **Incremental development**
  - Just get it done, make it work, improve it as we go
  - Not fire and forget
- **Develop in the open**
  - Code posted very early to GitHub, announced on linux-rdma
  - Intent is for interested parties to review and weigh-in on design
TECHNICAL OVERVIEW
rdmavt provides

- **Device registration**
  - Drivers register with rdmavt and not with the IB core
- **Data structures and functionality**
  - QP, PD, MR, CQ, etc
- **Almost all verbs functions present in qib and hfi1 (more on this shortly)**
- **Driver overrides**
  - Drivers can choose to implement any of the verbs functions they choose
    - **Performance**
    - **Incompatible hardware**
- **Driver private data structures**
  - Opaque to rdmavt, exp: qp_priv
- **Calls into drivers for HW specific things**
- **API for drivers to call into rdmavt when needed**
• rdmavt does not
  • Move/incorporate code that would take the same number of LOC to make generic
    • exp: modify_device() would take too many call backs into drivers, not worth it
  • Handle MAD processing (yet?)
    • Very different between qib and hfi1
    • Probably some opportunities to incorporate, requires more investigation
  • Address protocol code duplication (yet?)
    • The code is very similar between qib and hfi1 in terms of high level functionality
    • Gotchas and HW specific differences
      • Very risky for the initial version
      • **Performance is top priority**
  • Replace IB core
    • Drivers still use some of the data structures
      • Want to limit of course
      • Why re-invent the wheel?
        » registration
**Device registration**

- Driver fills in a `struct ib_device` and passes to rdmavt
  - rdmavt needs this info, why have another struct for the same thing?
  - Function pointers for the verbs API
    - if NULL then will use rdmavt version of function
      » rdmavt checks for required driver provided function(s)
    - if not NULL then the driver’s version of that function will be used
      » no dependency checks needed
- rdmavt initializes resources
  - locks
  - worker threads
- rdmavt eventually calls `ib_register_device()` on behalf of the driver
• Too many functions to go into each one
• These are just examples of the different ways a verb is implemented
• May vary between drivers
• Reminder: rdmavt checks for any “helper” functions it might need at reg

IB Core
create_qp
alloc_pd
process_mad

rdmavt
rvt_create_qp()
rvt_alloc_pd()

Driver
drv_qp_helper()
drv_proc_mad()
### Outgoing Data
- `rvt_post_send()`
  - Takes a list of work requests
  - Does some checks
  - Queues them for the driver to actually do the send (may kick the driver)
    - Driver handles calling `rdmavt` to add CQ entries
    - Driver handles protocol work
  - Would most likely be a driver specific function if other drivers come along
  - For now it was dead solid duplication so moved

### Incoming Data
- Completely hardware specific (other than `post_recv`)
- Driver handles calling `rdmavt` to add CQ entries
- Driver handles protocol work
open development process

- rdmavt was developed totally in the open
  - The high level overview was submitted to linux-rdma
  - Went right into writing code... just get it done and make it work
  - Another vendor even submitted patches early on

- GitHub
  - Used GitHub repo to make code available early
  - Served as a merged tree
  - Due to the volume of patches provided a point of reference to ensure ordering
  - Set up with 0-day builds
    - Found a few issues

- Git log shows the development history
  - We did not submit a “final” version. Rather a continuous work in progress.
CHALLENGES

- **rdmavt is a new driver**
  - hfi1 is a new driver in drivers/staging
  - qib is a stable driver in drivers/infiniband

- **Problems:**
  - qib can not depend on a driver in staging
  - Different maintainers for staging and linux-rdma
  - **Two trees are not the same!**
    - One reason we used GitHub to have a public tree

- **Solution:**
  - Agreement that linux-rdma maintainer would take over drivers/staging/rdma for 4.5
    - Mostly happened, but there are still patches sent to staging list
  - Have rdmavt ready to go by the start of the 4.6 merge window
    - Not just rdmavt, but hfi1 and qib as well
For 4.6

- Over 300 patches submitted
  - rdmavt driver
  - qib changes for rdmavt
  - hfi1 changes for rdmavt
  - hfi1 style and bug fixes, some new content
  - hfi1 fixes that were sent to staging but were left in limbo during cut over
- A ton of work by a lot of people
  - Too many to list, credit is in the git log

Number of contentious threads on linux-rdma

- Not going to go into further details, it is in the archives though

Accepted and appears in Linus’ tree for 4.6!
NEXT STEPS

What’s next?

• Protocol work
  • Is it feasible given performance requirements?
• Other duplicated, non-verbs code
  • Does it go in rdmavt?
  • Do we need something else?
• Continue to evolve as needed
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