12th ANNUAL WORKSHOP 2016

RDMA RESET SUPPORT

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[April 4th, 2016]

INTRODUCTION

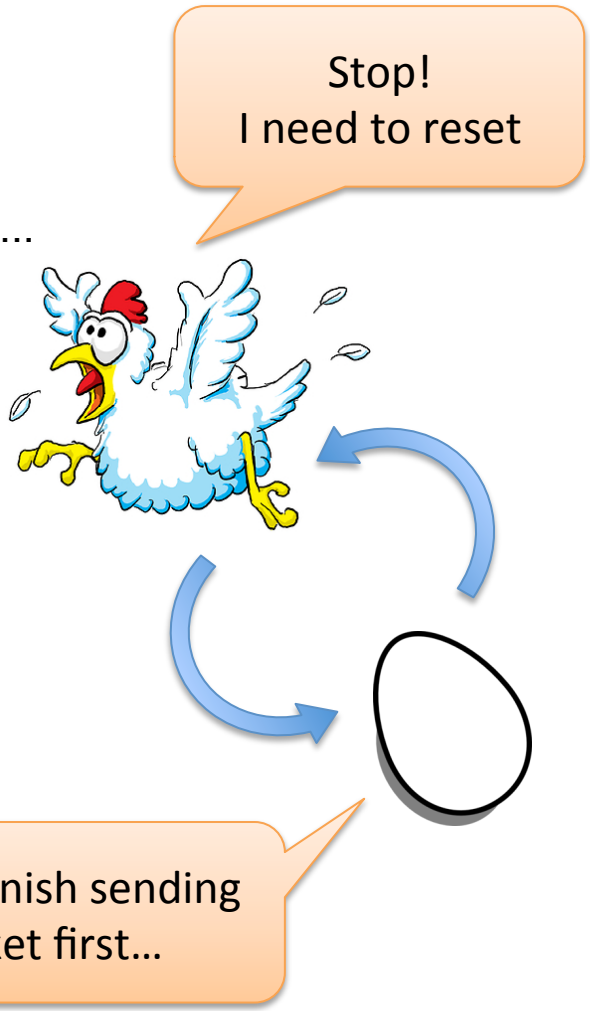
- **Several events may require re-initializing/suspending the operation of a device**
  - PCI errors
  - Device errors
  - Unresponsive device
  - Device isolation
  - Hot unplug (e.g., VM migration)
  - Driver restart

- **In such cases, device resets are required to**
  - Idle the device
  - Bring the device into a known state

- **Example**
  - tx_timeout() handler when an Ethernet interface doesn't complete transmissions

RESET DESIRABLES

- **Avoid dependencies on device consumers**
- **Complete in a timely manner**
  - Often, a timeout is what brought us here in the first place...
- **Minimize affects to consumers**
  - Recover automatically
  - “Invisible” to system operation
- **Disable device as a last resort**
  - E.g., if normal operation cannot be resumed
  - Ensure that device is idle



RDMA CHALLENGES

- **Device is stateful**
  - Resources, connection state, in-flight WRs
  - During a reset, this state may be lost
- **Applications and ULPs manipulate HW resources directly**
  - Maximum efficiency, minimum abstraction
  - Resets are observable
- **User-space holds device references**
  - Direct via uverbs, Indirect via ucma
  - Cannot be trusted to release them in a timely manner

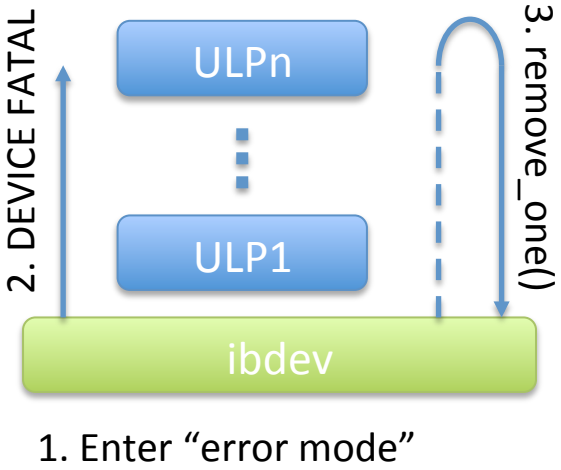
RDMA CHALLENGES (CONT.)

- **Multi-layer dependency**
  - For example:
    - **iSER**→CMA→CM→**MAD**→QP→ib_dev
    - **iSER**→QP→ib_dev
  - Which layer do you tear down first?
    - iSER depends on MADs, so iSER should go down first
    - How can the MAD layer complete operations if the device is not working?

KERNEL RESET SUPPORT

- **Reset = *abortive* shutdown + reinit**
  - Leverage normal dependency order of remove/add ()
  - Adding another asynchronous state is complex

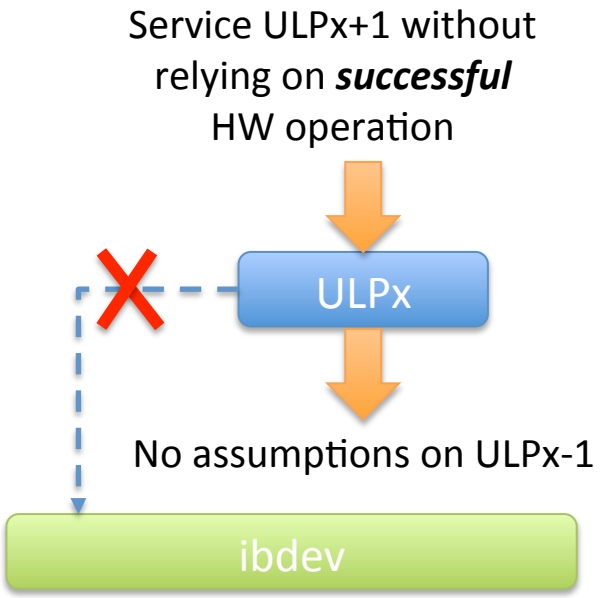
- **Abortive shutdown**
  - Place device in "***error mode***"
  - Raise IB_EVENT_DEVICE_FATAL event
  - Unregister device
    - Triggers remove() sequence



- **Device "error mode"**
  - Complete in error all in-flight + new WRs
    - Alternatively, return immediate error for new Post_Send/Recv()'s
  - Successfully *"complete"* all Verbs that close resources
    - Otherwise, ULPs will hang or risk memory corruption!!!
  - Return immediate errors for all remaining Verbs

ULP ASSUMPTIONS

- **Upon receiving DEVICE_FATAL event**
  - Assume that underlying device is in “error” mode
  - Service API calls in a ***timely*** manner
    - Do not condition on successful control or data path device operation
    - Optionally return immediate errors (optimization)
  - Optionally avoid internal reset sequences (optimization)
    - E.g., attempt reopening a QP following a completion in error
- **Upon receiving remove()**
  - Close all directly held device resources
  - Free logical instance…



ISOLATING USER-SPACE

- **HW resources must be dereferenced prior to closing a device**
  - Kernel ULPs may be trusted to do so
- **Some (non-)options for user-space applications**
  - Let the application hold the kernel hostage
  - Force the application to release resources! Well, not really….
  - Kill the application!
- **Solution: *zombify* open device instances**
  - Zombie: a SW implementation of a device in “error mode”
    - Doesn’t hold any reference to HW
  - Zombies persists until the last reference is dropped
  - Application may attempt to reopen the same device

SPAWNING A ZOMBIE

- **uverbs**
  - Disassociate HW from existing uverbs context
    - Free all resources in IDR trees
    - Call provider **disassociate_ucontext()** entry point
      - Redirect memory mappings, free resources, etc.
  - Return EIO for all system calls
- **ucma**
  - Destroy underlying RDMA IDs
  - Mark ucma_context as closed
    - Avoid duplicate closing when App releases RDMA ID
  - Return EIO for all other system calls
- **No change required in umad/ucm**

PROVIDER RESET SUPPORT

- **Kernel driver**
  - Implement “error mode”
  - Implement disassociate_ucontext()
    - For example
      - Remove MMIO mappings to device
      - Free related resources
      - Notify user-space driver

- **User-space driver**
  - Implement “error mode”

UPSTREAM STATUS

- **Linux 4.3**
  - Reset flow framework
    - ib_uverbs, ib_ucma
  - ConnectX-3 complete kernel driver support
- **Linux 4.4**
  - ConnectX-4 PCI reset support
- **Ongoing work**
  - ConnectX-4 complete kernel driver support

FUTURE WORK

- **ib_uverbs**
  - Graceful abort
    - Allow grace period for apps to close their references
- **librdmacm**
  - Respond to RDMA_CM_EVENT_DEVICE_REMOVAL
    - Refresh device list
- **Maintain ULP context and SW state during reset**
  - Introduce new IB client ops:
    - **stop**() – release all references to HW resources
    - **start**() – re-create HW resources
  - Fallback to remove()/add () if not implemented
- **Persistent names**
  - Kernel and udev support for renaming RDMA devices based on Node GUIDs

OPENFABRICS
ALLIANCE

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THANK YOU