14th ANNUAL WORKSHOP 2018

MULTI-PROCESS SHARING OF RDMA RESOURCES

Alex Rosenbaum
Mellanox Technologies

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WHY?

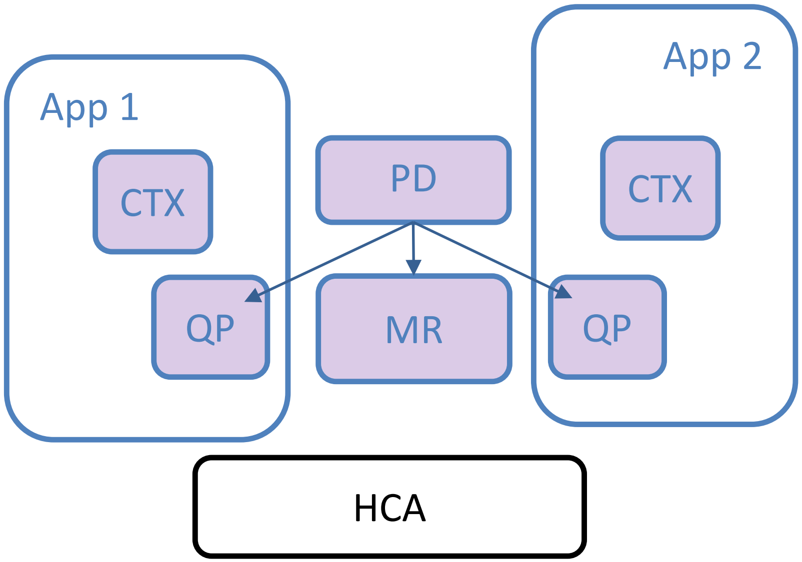
- **Why Multi-<u>Process</u> RDMA access?**

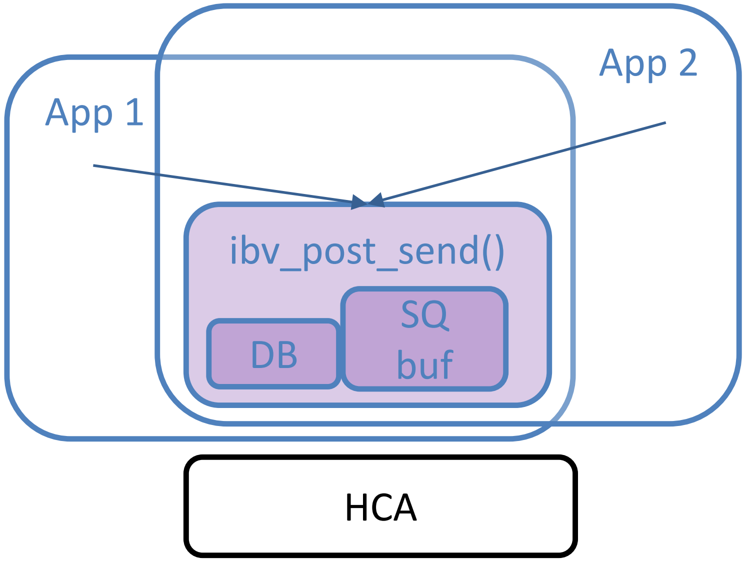
- **Multi-<u>Thread</u> can do just as good!**
  REALY?

  or is there anything missing?

AGENDA

- **Motivation**
- **Different Solutions**
- **Examples and use cases**
- **Problems and limitations**





MOTIVATION

- **Existing fork() based applications and frameworks**
  - Replace socket() and need to be on par
  - NGINX, Big Data, Hadoop
- **TELCO Grade Resiliency**
  - Allow design in a high availability based requirement
- **Application update without breaking connections**
- **Treat Processes as you would Thread**
- **Extended debuggability**
  - Attach to existing process and read values

ALTERNATIVE SOLUTIONS

- **Shared IB Object**
- **fork()**
- **Shared Memory**

SHARED IB OBJECT SOLUTION

SHARED IB OBJECT SOLUTION

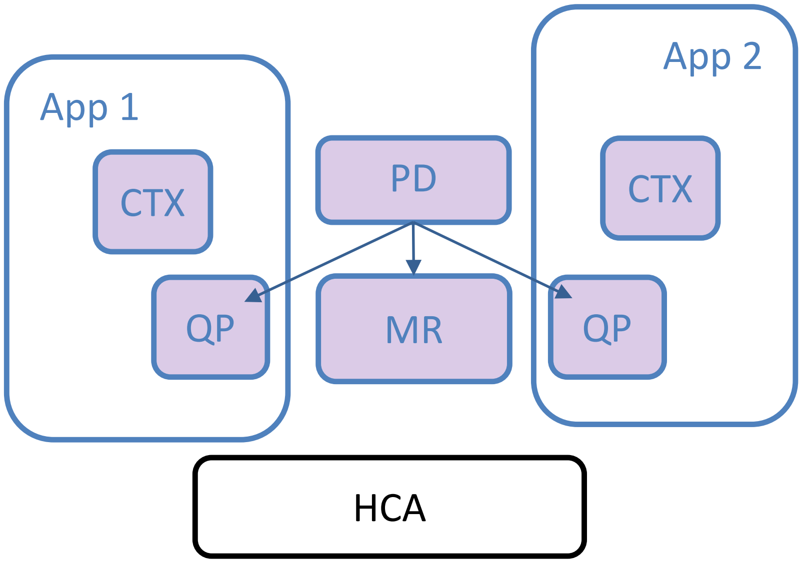
- **High Level:**
  - Each process holds a reference to the same Kernel/HW object value
  - Sharing the same ib_obj through different ib_uobj and different ib_ucontext

- **Design:**
  - Open RDMA resource from user space
  - Create a Share FD or use the existing ibv_context fd
  - Associate IB object with Shared FD
  - Pass Shared FD to other process
  - Other process to open shared resource based on shared FD
  - Kernel to track resource open from all processes

- **Application has to:**
  - Pass the Shared FD between processes
  - Pass the shared objects' handles between processes to be opened

SHARED IB OBJECT EXAMPLE

- **Example:**
  - Primary processes allocates and registers huge memory blocks
  - Each secondary processes open the MR's as with Shared FD into their own PD
  - Each secondary processes does RDMA operation on segments of memory which is shared and mapped once
  - Single LKey will result in higher performance



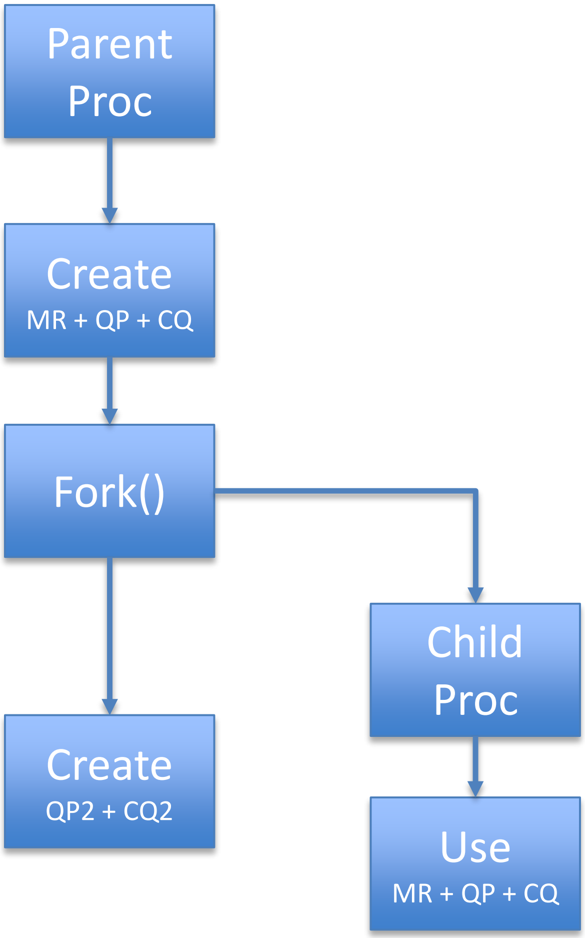
SHARED IB OBJECT LIMITATION

- **Good for stateless objects: PD, MR, XRC**
  - But how do we transfer state full objects: QC, CQ, cmd_id’s

FORK SOLUTION

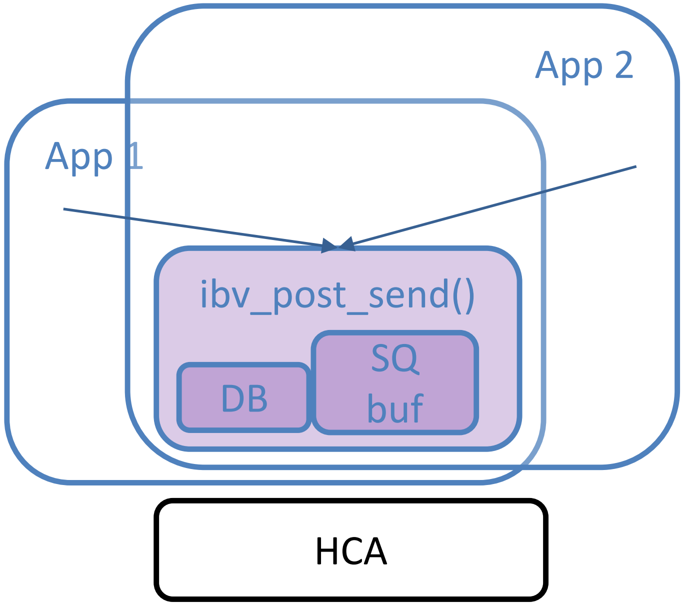
FORK() BASED SOLUTION

- **High Level:**
  - All IB/RDMA resources are created as shared fd/memory/locks
  - On fork(), all shared objects are exposed also to child
  - Kernel holds single ib_ucontext and ib_uobj instances for both processes
  - User space, parent & child, share only resources created in it's history
  - User needs to sync processes just as it has to sync threads:
    - Pass and sync ibv/cma handles to resources each processes should handle.
    - Protect critical sections from multi-thread access, or from destroy races.



FORK() BASED SOLUTION

- **Created ‘SHARED’ `ibv_context`**
- **All created IBV objects are allocated as shared**
- **Upon fork all are shared**




```
struct ibv_context *ibv_open_device_ex(
                    struct ibv_device *device,
                    struct ibv_context_attr *attr);

struct ibv_context_attr {
    uint32_t flags;
};

enum ibv_context_flags {
    IBV_CONTEXT_FLAGS_SHARED  = 1 << 0
};
```

FORK() EXAMPLE

- **RDMA server with fork()-ed children processes handling the traffic request/responce**

```
server_main() {

	server_create_device_shared(); /* with IBV_CONTEXT_FLAGS_SHARED */

	rdma_listen(listen_id, 0);

	while (!exit) {
		/* wait for RDMA_CM new connection requests */
		rdma_get_request(listen_id, &id);

		/* create QP + CQ */
		server_create_resources(id);

		/* accept connection */
		rdma_accept(id, NULL);

		if (fork())
			continue; /* server process */
		else
			server_connection_processing(); /*  child process */
	}
}
```

FORK() SOLUTION LIMITATION

- **Single Binary**
  - Upgrade/Replace of binary is impossible
  - Need to replace entire processes and release all RDMA resources

- **Adding object which is not shared to an already shared object**
  - New ‘private’ QP with shared CQ: old child will not recognize new qp_num

- **Atomicity of parent/child crash doesn’t guaranty RDMA resource usability**

SHARED MEMORY SOLUTION

APPLICATION SHARED MEMORY SOLUTION

- **High Level Design:**
  - Application to manage the shared memory
    - rdma-core allocates resource with application callback: shared_malloc()
  - Application to allow additional processes to attach to same virtual address offset in the shared memory
  - All processes modify the same shared memory DB and access the same HW mapped resource

- **Allows Application logic / binary to be updated**
  - Compared to fork() in which we have single binary
  - Must keep rdma-core identical

APPLICATION SHARED MEMORY EXAMPLE

- **RDMA Server: On RDMA_CM new connection requests**
  - Create RC QP + CQ
  - Accept + Handle connection in thread
- **Launch upgrade process which attached to shared memory and takes ownership over connection and resource until ‘old’ processes can exit**

APPLICATION SHARED MEMORY SOLUTION

- **Each new `ibv_context` will request application to allocate Shared Memory**
- **Application manages attach to shared block**
- **Application uses IPC to pass ibv_obj pointers between threads in different processes**

```
struct ibv_context *ibv_open_device_ex(
                     struct ibv_device *device,
                     struct ibv_context_attr *attr);

struct ibv_context_attr {
     uint32_t flags;
     struct ibv_context_memallocators *memallocators;
};

struct ibv_context_memallocators {
     void *(*alloc)(size_t size, void *priv_data);
     void (*free)(void *ptr, void *priv_data);
     void *priv_data;
};
```

APPLICATION SHARED MEMORY LIMITATION

- **Align virtual Address:**
  - Requires Disabling Address-Space Layout Randomization (ASLR) (vs fork())
- **Guarantying rdma-core binary compatibility**
  - Change in data struct will break
- **Atomicity of processes actions during process crash doesn’t guaranty RDMA resource usability**

ATOMICITY PROBLEM

- **How do we protect for atomicity of multi-process failures/crashes?**
  - Process crashes with new WC
  - Failure in post_send

- **Can 'other' process recover the application state and continue managing the connection?**

OPENFABRICS ALLIANCE

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THANK YOU

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