Architecture and Usages of Accelio

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What is Accelio in a Nutshell

High-performance, Transport independent, Simple to use Reliable Messaging and RPC Library for Accelerating applications

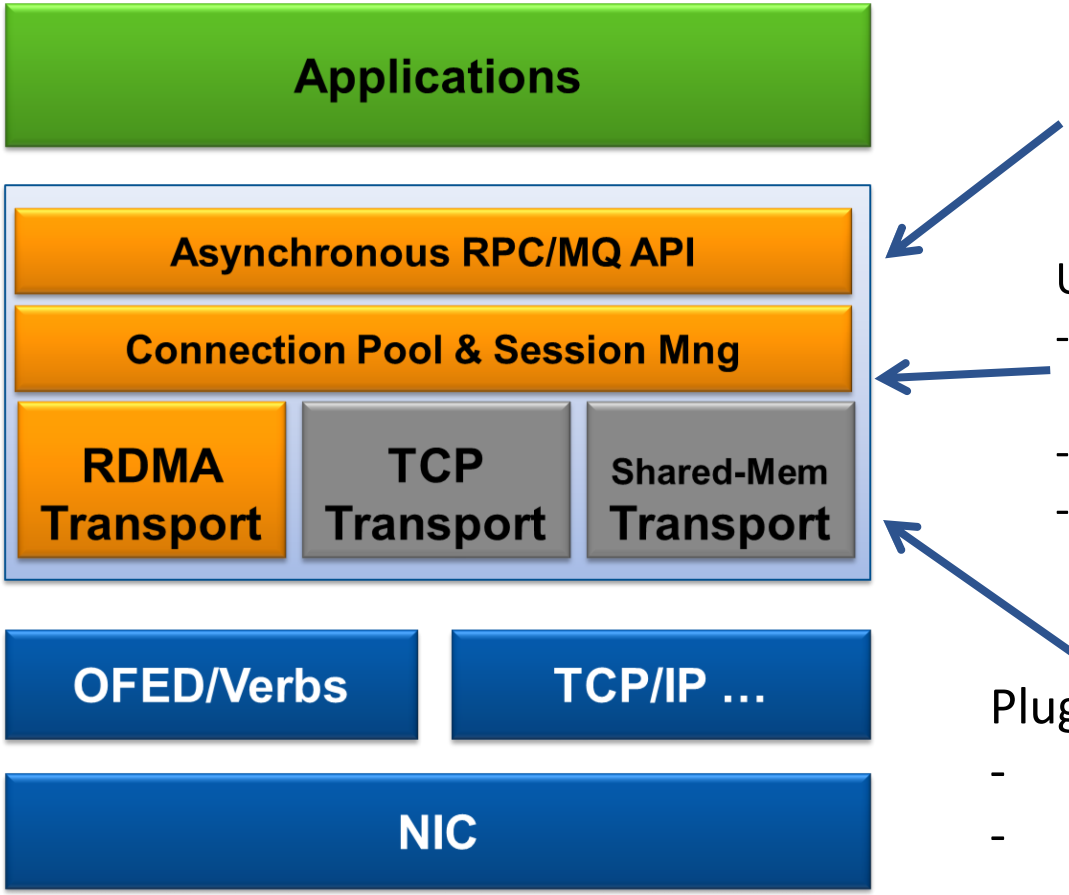
- Support User space, **Kernel**, C/C++, Java, Python (Future) bindings
- Optimal usage of CPU and Network hardware resources
- Built in fault-tolerance, transaction reliability, and load-balancing
- Integrated into OpenSource (e.g. HDFS, Ceph), and Commercial Storage/DB products in-order to accelerate its transport with minimal development/integration effort
- OpenSource Community project from the ground up:
  - Site: http://accelio.org
  - Code in: http://github.com/accelio
  - Project/Bug tracking: http://launchpad.net/accelio

Accelio Goal

- **Goal:** Provide an easy to use, reliable, scalable, and high performance data/message delivery middleware that maximize efficiency of modern CPU and NIC hardware

- **Key features:**
  - Focus on high-performance asynchronous APIs
  - Reliable message delivery (end to end)
  - Request/Response (Transaction) or Send/Receive models
  - Provide connection and resource abstraction to max scalability and availability
  - Maximize multi-threaded application performance with dedicated HW resources per thread
  - Designed to maximize the benefits of RDMA, hardware offloads, and Multi-core CPUs
  - Will support multiple transport options (RDMA, TCP, ..)
  - Native support for service and storage clustering/scale-out
  - Small message combining
  - Simple and abstract API

Accelio Architecture



Abstract, Easy to use API

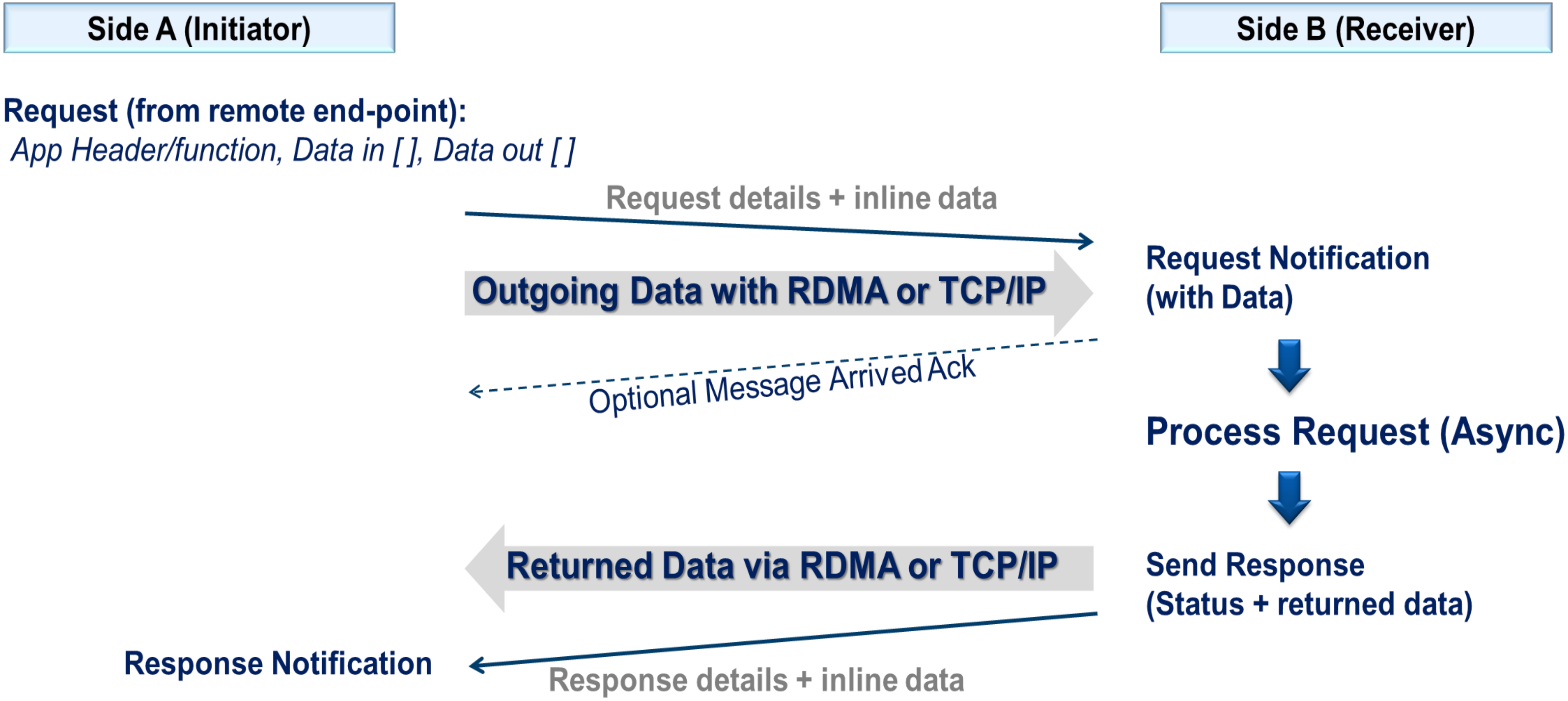
Use multiple connections per session:

- maximize CPU core usage/parallelism
- High-availability & Migration
- Scale network bandwidth

Pluggable Transports:

- Code once for multiple HW options
- Seamlessly use RDMA

High Level Transaction Flow



Side A (Initiator)

Side B (Receiver)

Request (from remote end-point):
App Header/function, Data in [ ], Data out [ ]

Request details + inline data

Outgoing Data with RDMA or TCP/IP

Request Notification
(with Data)

Optional Message Arrived Ack

Process Request (Async)

Returned Data via RDMA or TCP/IP

Send Response
(Status + returned data)

Response Notification

Response details + inline data

Next Request …..

* API is asynchronous, multiple requests can be submitted in parallel, and across multiple links & connections

Accelio Example - Hello Client

```
int main(int argc, char *argv[])
{
   struct …

   /* open one thread context set the polling timeout */
   ctx = xio_context_create(NULL, 0);

   /* create a session and connect to server */
   session = xio_session_create(XIO_SESSION_CLIENT,  &attr, url, 0, 0,
                                &session_data);

   session_data.conn = xio_connect(session, ctx, 0, NULL, &session_data);
   …
   xio_send_request(session_data.conn, session_data.req);

   /* run the default xio main loop */
   xio_context_run_loop(ctx, XIO_INFINITE);

   /* normal exit phase */
   xio_context_destroy(ctx);

   return 0;
}
```

Accelio Example - Hello Client

```
int on_session_event(struct xio_session *session, struct xio_session_event_data *event_data,
                      void *cb_user_context)
{
   switch (event_data->event) {
     case XIO_SESSION_CONNECTION_TEARDOWN_EVENT:
             xio_connection_destroy(event_data->conn);
     break;
     case XIO_SESSION_TEARDOWN_EVENT:
             xio_session_destroy(session);
     break;
    }
    return 0;
}
```

```
int on_response(struct xio_session *session, struct xio_msg *rsp, int more_in_batch,
               void *cb_prv_data)
{
    struct …

    process_response(rsp); /* process the incoming message, send a new one */

    xio_release_response(rsp); /* acknowledge xio that response resources can be recycled */
    …
    xio_send_request(session_data.conn, session_data.req);

    return 0;
}
```

Accelio Example - Hello Server

```
int main(int argc, char *argv[])
{
   struct …


   /* create thread context for the server */
   ctx    = xio_context_create(NULL, 0);

   /* bind a listener server to a portal/url */
   server = xio_bind(ctx, &server_ops, url, NULL, 0, &server_data);

   xio_context_run_loop(ctx, XIO_INFINITE);

   /* normal exit phase */
   xio_unbind(server);
   xio_context_destroy(ctx);

   return 0;
}
```

Accelio Example - Hello Server

```
static int on_new_session(struct xio_session *session, struct xio_new_session_req
                           *req, void *cb_prv_data)
{
    /* accept new connection request */
    xio_accept(session, NULL, 0, NULL, 0);

    return 0;
}
```

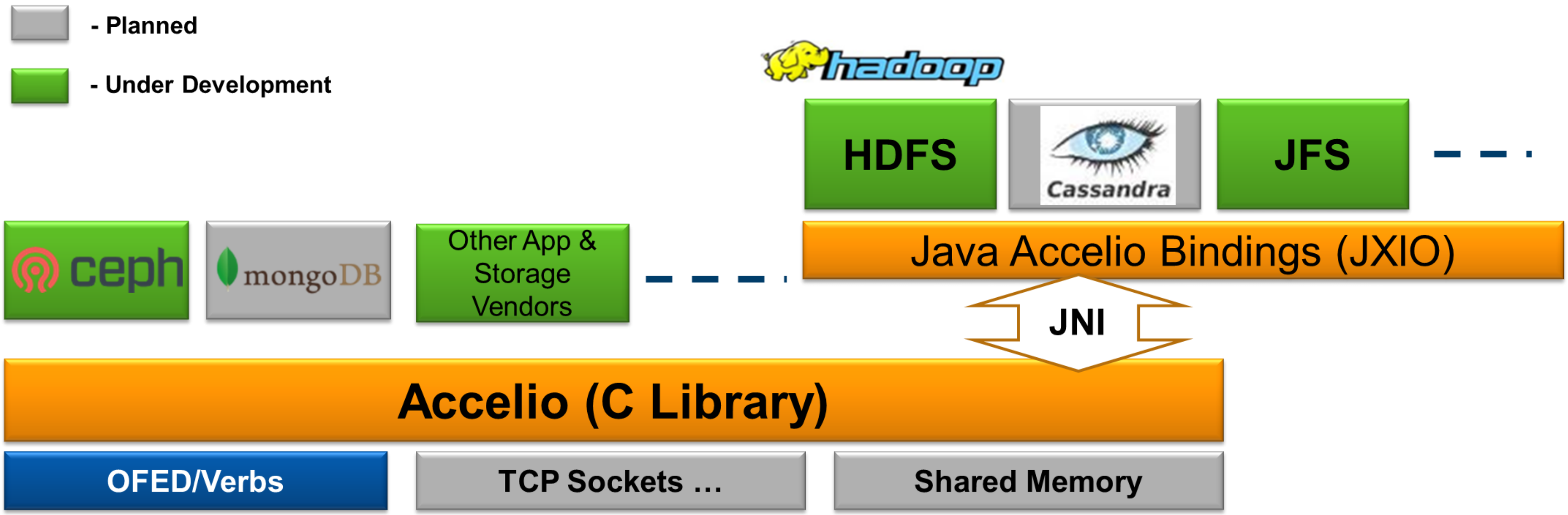
```
static int on_new_request(struct xio_session *session, struct xio_msg *req, int more_in_batch,
                          void *cb_prv_data)
{
    struct …

    /* process request and send a response */
    process_request(req);
    /* attach the original request to response and send it */
    response->request = req;

    xio_send_response(response);

    return 0;
}
```

Accelio Integration With Other Applications/Projects



▨ - Planned

🟩 - Under Development

hadoop

HDFS

Cassandra

JFS

ceph

mongoDB

Other App & Storage Vendors

Java Accelio Bindings (JXIO)

JNI

Accelio (C Library)

OFED/Verbs

TCP Sockets …

Shared Memory

- Accelio is adopted as the high-performance, low-latency, Reliable Messaging/RPC library for variety Open-Source and Commercial products, customer projects
- Support multiple bindings (Kernel C, User Space C/C++, Java, Python (future))

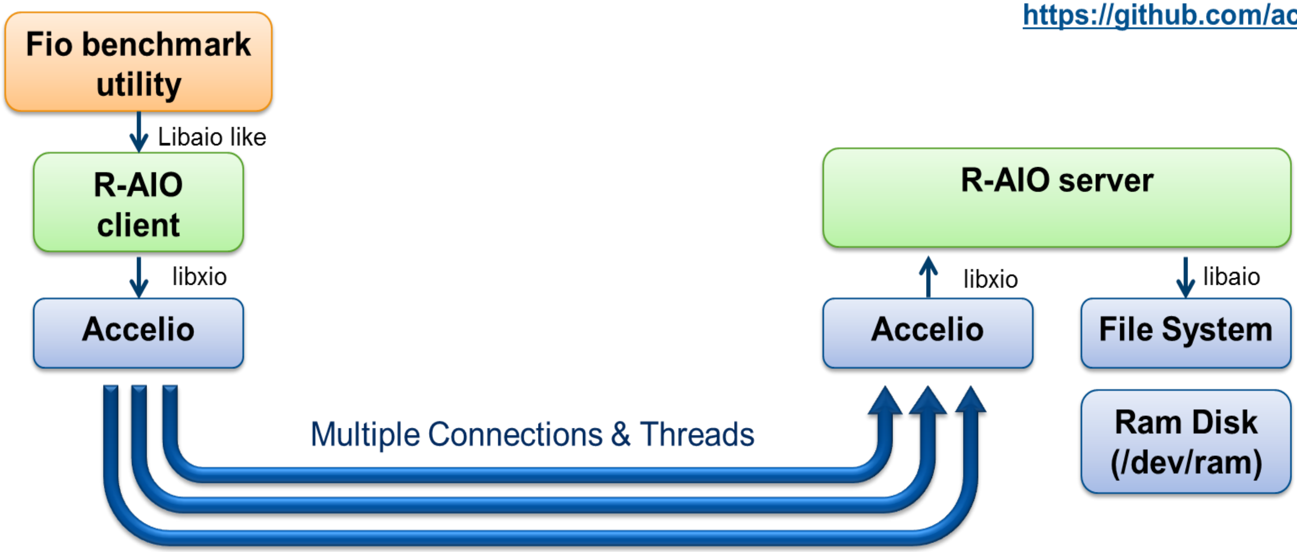
Use case 1: XNBD

Accelio based network block device

- Multi-queue implementation in the block layer for high performance
- Utilizes Accelio's facilities and features:
  - Hardware acceleration for RDMA
  - Zero data copy
  - Lockless design
  - Optimal CPU usage
  - Reliable message delivery
- IO operation translation to libaio submit operations to remote device.
- OpenSource Community project from the ground up:
  - Code in: http://github.com/accelio/xnbd
- Prerequisites:
  - Accelio 1.1 version and above.
  - Kernel version 3.13.1 and above.

Use case 2: R-AIO Remote File Access Application Example

https://github.com/accelio/accelio/tree/master/examples/usr/raio



Performance

Max IOPs	2.5M
IO Latency	5us
Bandwidth	6GB/s

- Provide access to a remote file system by redirecting libaio (async file IO) commands to a remote server (which will issue the IO and return the results to the client)
- Deliver extraordinary performance to remote ram file (/dev/ram)
  - Using 4 CPUs & HW QPs for parallelism
  - Similar performance to local ram file access (i.e. minimal degradation due to communication)

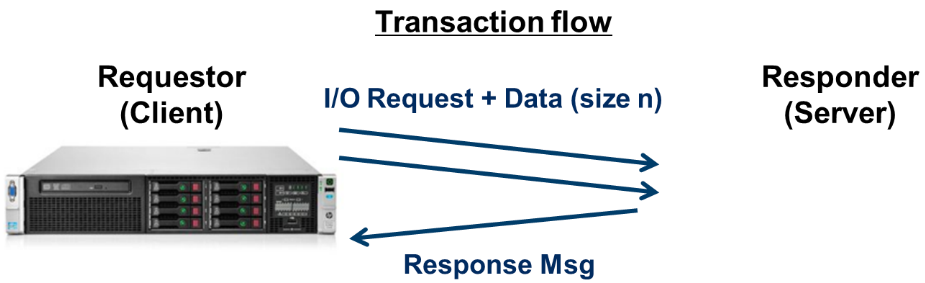
Use case 3: JXIO

JXIO provides the first RDMA API in JAVA

- JXIO is a Java wrapper of Accelio library
- Open source project: https://github.com/accelio/JXIO
- Preserves Accelio's zero copy and performance all the way
- Every C struct in Accelio is represented by a matching Java class
- Provides 1.5M transactions per second (in Java)
- Reliable message delivery
- Low memory footprint
- Essential component in Mellanox's HDFS RDMA acceleration solution

Test Configuration

- Server
  - HP ProLiant DL380p Gen8
  - 2 x Intel(R) Xeon(R) CPU E5-2650 0 @ 2.00GHz
  - 64 GB Memory
- Adapters
  - ConnectX3-Pro VPI (IB FDR or 40GbE)
  - ConnectIB 16x PCIe
  - OFED 2.1
- OS
  - RedHat EL 6.4
  - Kernel: 2.6.32-358.el6.x86_64
- Test
  - Accelio I/O test utility in C, User space
  - Request/Responce transactions (RPC)
  - Over 1 or 2 ports, using auto
    load balancing based on threads



Transaction flow

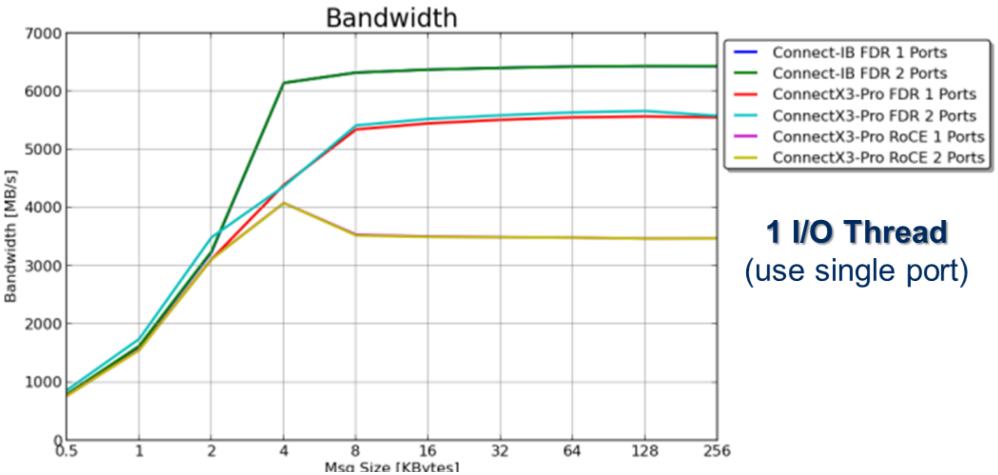
Requestor (Client)

I/O Request + Data (size n)

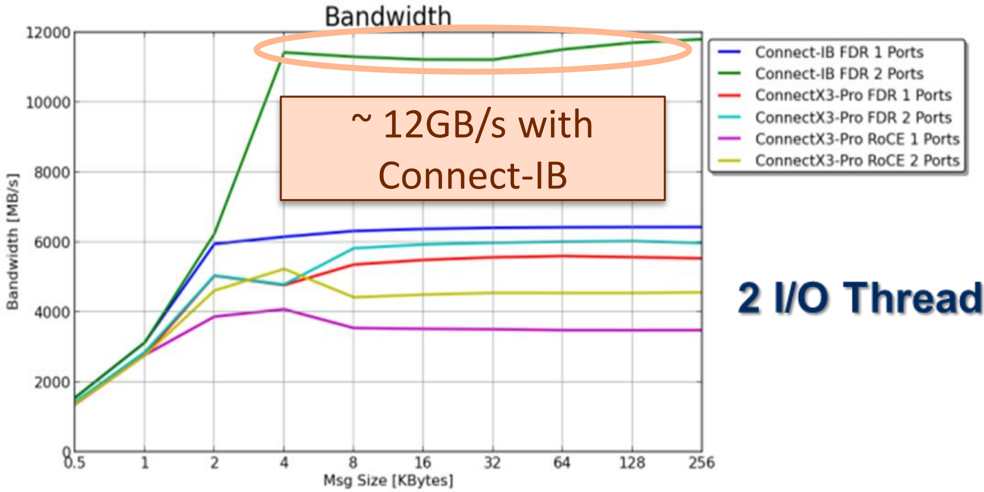
Responder (Server)

Response Msg

Bandwidth Results



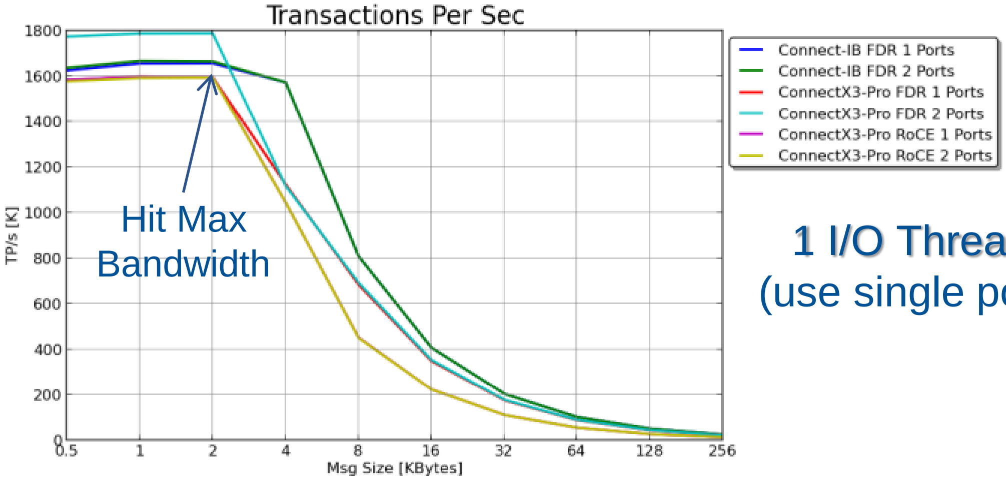
1 I/O Thread
(use single port)



~ 12GB/s with Connect-IB

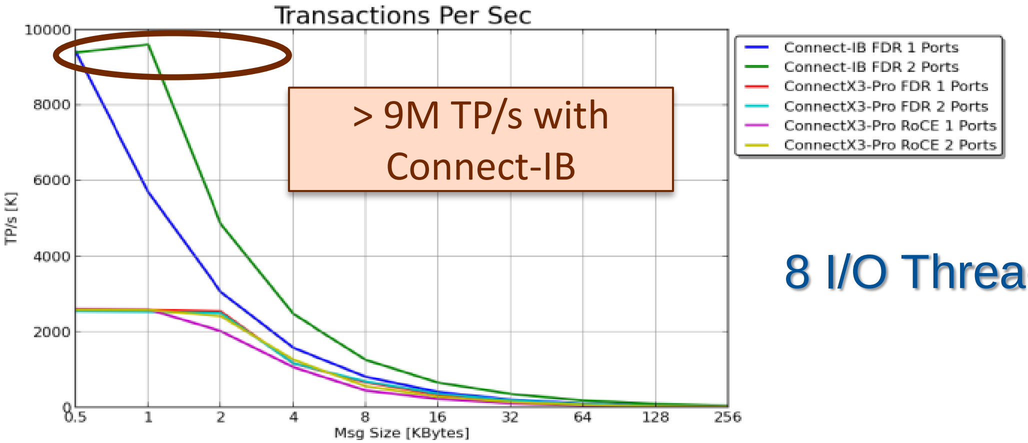
2 I/O Threads

Transaction Per Second (IOP/s) Results



Hit Max Bandwidth

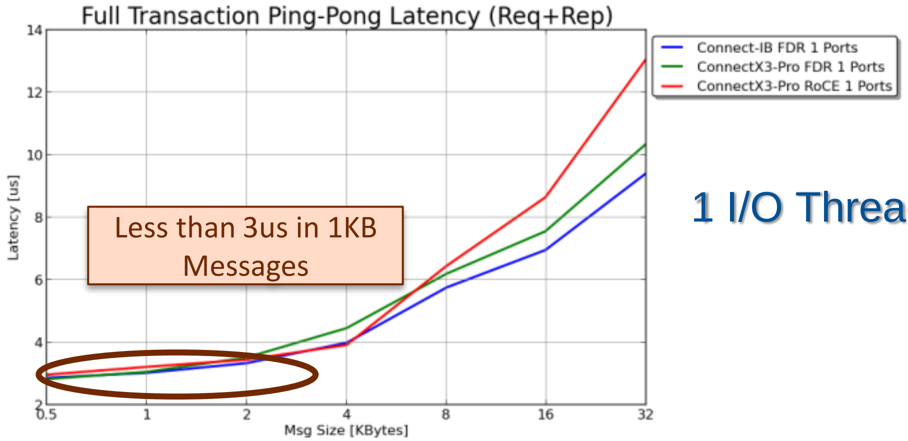
1 I/O Thread
(use single port)



> 9M TP/s with Connect-IB

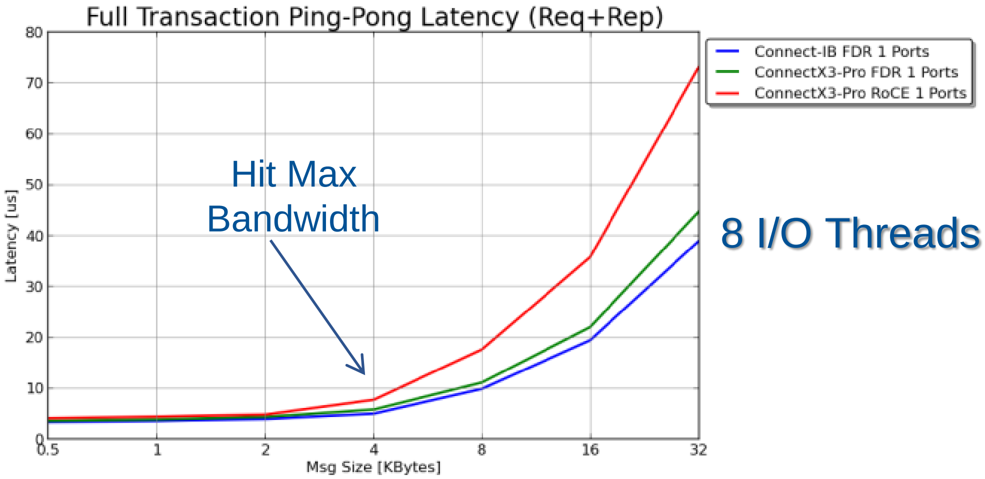
8 I/O Threads

Round Trip Latency (Request & Response) Results



Less than 3us in 1KB Messages

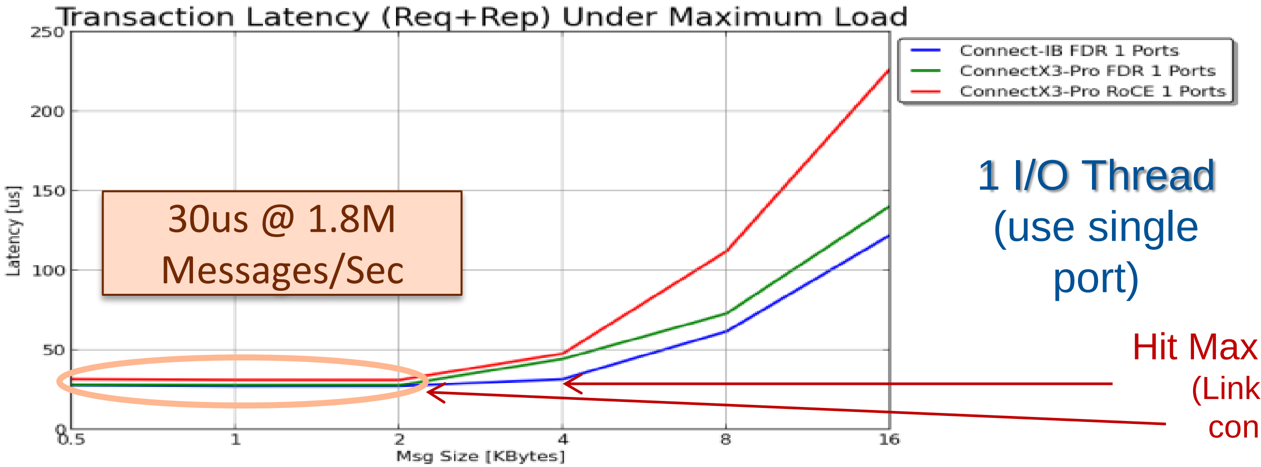
1 I/O Thread



Hit Max Bandwidth

8 I/O Threads

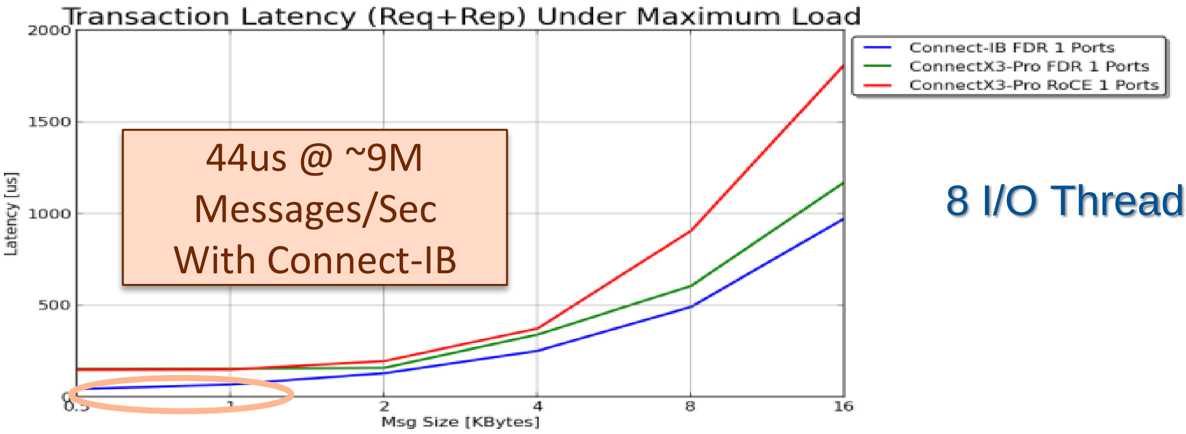
Latency Under Maximum Load (Millions of Messages/Sec)



30us @ 1.8M Messages/Sec

1 I/O Thread (use single port)

Hit Max Bandwidth (Link become congested)



44us @ ~9M Messages/Sec With Connect-IB

8 I/O Threads

Open source project

- Initiated by Mellanox
- Partnership
- Companies and Individuals are welcome to join the project and contribute

- Web site: http://accelio.org
- Code in: http://github.com/accelio
- Project/Bug tracking: http://launchpad.net/accelio
- Email: info@accelio.org
- License: Dual BSD/GPLv2

Accelio

Thank You

OPENFABRICS
ALLIANCE

10TH
ANNUAL
INTERNATIONAL
DEVELOPER
WORKSHOP