Shimmy: Shared Memory Channels for High Performance Inter-Container Communication

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Crowd Monitoring

https://sequre.world/tag/computer-science/
Crowd Monitoring App in Edge Clouds

Using Berkeley socket with TCP/IP for containers communication

Not utilizing the network resources!

SLOW!
The Problem

If each link has an average of $X$ ms delay:

Making Resized, Objects detected, faces blurred images is going to have $5$ time $X$ ms as average delay.
What if we use shared memory channels for container communications?

- Faster
  - Not going through network stack delays
- Accessible

- What about remote communications?
- Do we have a central control over all the containers host?
- Modifying the Applications
What’s the solution?

- What about remote connections?
  - Remote communication is efficiently supported through synchronizing shared memory regions via RDMA

- Do we have a central control over all the containers host?
  - modern infrastructures we can assume these applications are run within a container orchestration framework, which provides control over:
    - communication interface
    - communication medium
So We proposed ...

- Rethink the **communication model**
- Create **shared memory** channels between containers
- supporting both a **pub/sub** model and **bi-directional streaming** model
- Local communication is made more efficient
- Remote communication is efficiently supported through synchronizing shared memory regions via **RDMA**
- Not only applicable to the **edge clouds** but also beneficial in **core cloud** environments
The Architecture

Shm region

Container 1

Container 2
The Architecture

Shimmy agent

Shm region

Container 1

Container 2
The Architecture

Shimmy agent

Shm region

RDMA Server
Client

Container 1

Container 2

RDMA Client
Server

Container 3

Shimmy agent

Shm region
The Architecture
Prototype
Evaluation

- Setup:
  - two Cloudlab Servers (1x Xeon E5-2450 processor (8 cores, 2.1Ghz), 16GB Memory (4 x 2GB RDIMMs, 1.6Ghz), 1 x Mellanox MX354A Dual port FDR CX3 adapter w/1 x QSA adapter) running Ubuntu 16.04. For our system we have built docker containers for the broker, publisher, and subscriber.

- We compared against Eclipse Mosquitto and Apache Kafka
  - Eclipse Mosquitto is based on pub/sub model which uses TCP/IP underneath
  - Apache Kafka is stream-processing software platform which uses TCP/IP
Local communication – 16 B messages
Remote communication - 16 B messages
Local communication - 100 KB Messages

![Graphs showing throughput and latency for Shimmy, Mosquitto, and Kafka with increasing number of messages.]

- Throughput (Messages/second):
  - Shimmy: Bars increase with number of messages.
  - Mosquitto: Bars show a trend.
  - Kafka: Bars are consistent.

- Latency (seconds):
  - Shimmy: Bars decrease with number of messages.
  - Mosquitto: Bars are relatively stable.
  - Kafka: Bars show a slight decrease.
Conclusion

- A new communication model based on shared memory channels
- Optimizes local communication, but supports remote communication through RDMA
- Developed an Initial prototype which demonstrated
  - 1.78x lower latency than mosquitto for 100KB messages local
  - 2.85x lower latency than Kafka for 100KB messages local
  - 27x lower latency than mosquitto for 16B messages local
  - 82x lower latency than kafka for 16B messages local
  - 21x lower latency than mosquitto for 16B messages remote
  - 66x lower latency than kafka for 16B messages remote
Future work

- Integration with Kubernetes
  - Create a shared memory channel
  - Colocation of containers
  - Security

- Load Balancing
Discussions

What kinds of feedback we are looking to receive?

- how can we improve our communication models and infrastructure to provide a complete low latency/high throughput platform for edge/cloud computing.
- What critical functionality is missing in our current proposal?
- What are other platforms that we should compare our platform with?
- Are there other technologies that we could leverage to improve our proposal?
- Are there other communication models or paradigms (other than pub/sub and streaming) that we should provide?
Discussions (2)

The open issues the paper does not addressed

- Applications would need to be modified to take advantage of Shimmy’s architecture, but we hope that the performance benefits will make it worth.
Thank you!