Effectively using Amazon Web Services

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Message latency of SQS (Simple Queue Service)

Optimizing upload performance to S3
Simple Queue Service

- Highly reliable and scalable distributed queue system for web service applications.
- A buffer between the component sending data and the component receiving the data for processing.

From “Building Scalable, Reliable Amazon EC2 Applications with Amazon SQS.”
Good for interactive applications?

• Vague fears about potential very high send-to-receive latency.
  – Many concerns on Amazon SQS forum with latencies more than 60 seconds.
• Let’s do some measurement!
First measurement - As Fast As Possible

• Send/receive/delete messages as fast as possible.

SQS performance measurement architecture
Huge latencies... really?

- 30 seconds of sporadic latencies
- After 5 hours, latencies increased sharply and the measurement client became unresponsive...
After inspecting logs, it turned out...

• Lots of duplicated messages.
  – Due to deleter being slower than receiver, messages kept reappearing after the 30-sec invisibility time window.

• Delete queue became too big and consumed all RAM.

• Need Rate control!
Rate-controlled measurement

AWS SQS

Sender

- send msg
- send rate control to keep SQS size no bigger than 10

Receiver

- recv msgs
- Receiver makes a request only when there is a message in SQS
- msg map to keep track of sent msgs and duplicated msgs

Deleter

- delete msg
- Delete queue. The oldest msg - the one with the earliest sent time - will be popped first.
- send rate control to keep the oldest msg in the delete queue no older than 15 seconds

SQS performance measurement architecture
Huge latencies are gone!

- \( \text{avg} < 100 \text{ ms}, \max < 3 \text{ s} \)
- Some big latencies turned out to be from duplicated messages. Message handling should be idempotent!
Performance by region/zone

Send-to-receive latency by zone (bezier smoothed 10-sec running average)
Message latency of SQS (Simple Queue Service)

Optimizing upload performance to S3
There are various S3 upload tools...

- AWS web interface
  - s3cmd: command line S3 client
- CyberDuck
  - Amazon Java APIs
    - Low level API: AmazonS3Client.putObject()
    - High level API: TransferManager.upload()
...with different performances

- # of connections: S3cmd 1, putObject 1, CyberDuck 5, and TransferManager 10.
Multi-part upload of small files?

• TransferManager, with default configuration, does multi-part upload when file size > 16MB and chunk size >= 5MB

• S3 server does not allow it with smaller files...

16:06:42.438 [s3-transfer-manager-worker-4] DEBUG com.amazonaws.services.s3.transfer.internal.UploadMonitor.call(UploadMonitor.java:159) - Status Code: 0, AWS Request ID: 3784CB129EBAEF41, AWS Error Code: EntityTooSmall, AWS Error Message: Your proposed upload is smaller than the minimum allowed size, S3 Extended Request ID: 7cymUI2eF7Ui9nTv3TsI59JwPzWMdXI+K4R4Pb0rNmzJ/cC5Xzxo7UT6NMICket6
A closer look at TransferManager

```java
Thread pool manager

s3-transfer-manager-worker-1

s3-transfer-manager-worker-2

s3-transfer-manager-worker-3

tx = new TransferManager
--> ...
    --> createDefaultExecutorService()
    --> newFixedThreadPool(10, threadFactory)
    ...
    --> new CCnmgr()
--> setMaxTotal(50)

TX.upload()
--> ...
    --> new UploadMonitor()
    --> submit to thread pool

UploadMonitor.call()
    --> upload()
        --> multipartUploadCallable.call()
        --> shouldUseMultipartUpload()
        --> uploadInParts()
        --> getMaxOptimalPartSize()
        --> initiateMultipartUpload()
        --> new UploadPartRequestFactory()
            each req has its offset and size
        --> uploadPartsInParallel()
            --> while (reqFactory.hasMoreReq())
                threadPool.submit()
        ...
        --> reschedule() in 5 sec

AmazonS3Client.uploadPart()
--> invoke()
    --> AmazonHttpClient.execute()
    --> executeHelper()
    --> execute(httpRequest)

tx.shutdownNow()

possible enhancement
modifications to increase parallelism

poll transfer status
or provide a progressListener
and have it report

thread pool manager executes a submitted task

main
```
With more threads and connections...

• Connection manager puts a limit on the # of connections - 50 connections.
  – to **200 connections**.

• A pool of fixed # of worker threads - 10 threads.
  – with `CachedThreadPool`, which creates threads as needed and reuse ones when they are available.
... got 20% performance gain

Upload performance by # of connections

• from 5.20 MB/s with 10 connections, which is the max # of conn. With unmodified code,
• to 6.21 MB/s with 14 connections,
• but it start to decrease... because of HDD?
Data from RAM disk

Upload performance by # of connections from RAM disk

• Scaled up to 22.32 MB/s, which is 3.6 x more gain.
• Now the bottleneck is... CPU?
• CPU saturates around 20 threads.
  – On Macbook Pro 4,1. Core2 Duo 2.6GHz.

• On a better machine?
On a better machine

Upload performance by # of connections on a better client machine

- 30.69 MB/s from 22.32 MB/s, which is 38% more gain.
- Switched to Xeon Quad Core 2.8 GHz, 12 GB of DDR3 RAM, 7200 rpm HDD
- from Core 2 Duo 2.6 GHz, 4 GB of DDR2 RAM, 5400 rpm HDD
Merging parts

Merge time by # of parts

- < 1 sec. Good scalability.
Lessons learned

• With minimal modifications to TransferManager and by detecting and eliminating bottlenecks one by one, high throughput can be achieved.
  – Unmodified code (5.20 MB/s)
  – More connections and threads (6.21 MB/s)
  – Data from RAM disk (22.32 MB/s)
  – With a better client (30.69 MB/s)
More throughput?

• Network may not be a bottleneck.
  – iperf from the client machine to a large EC2 instance showed 1 Gb/s with 120 connections.

• More throughput could have been achieved with either
  – more # of parts (with a bigger file) or
  – with multiple instances of TransferManagers.
Thank you!!

Comments or Questions?