Distributed Computing

Distributed System Project 2023 - Karaoke App

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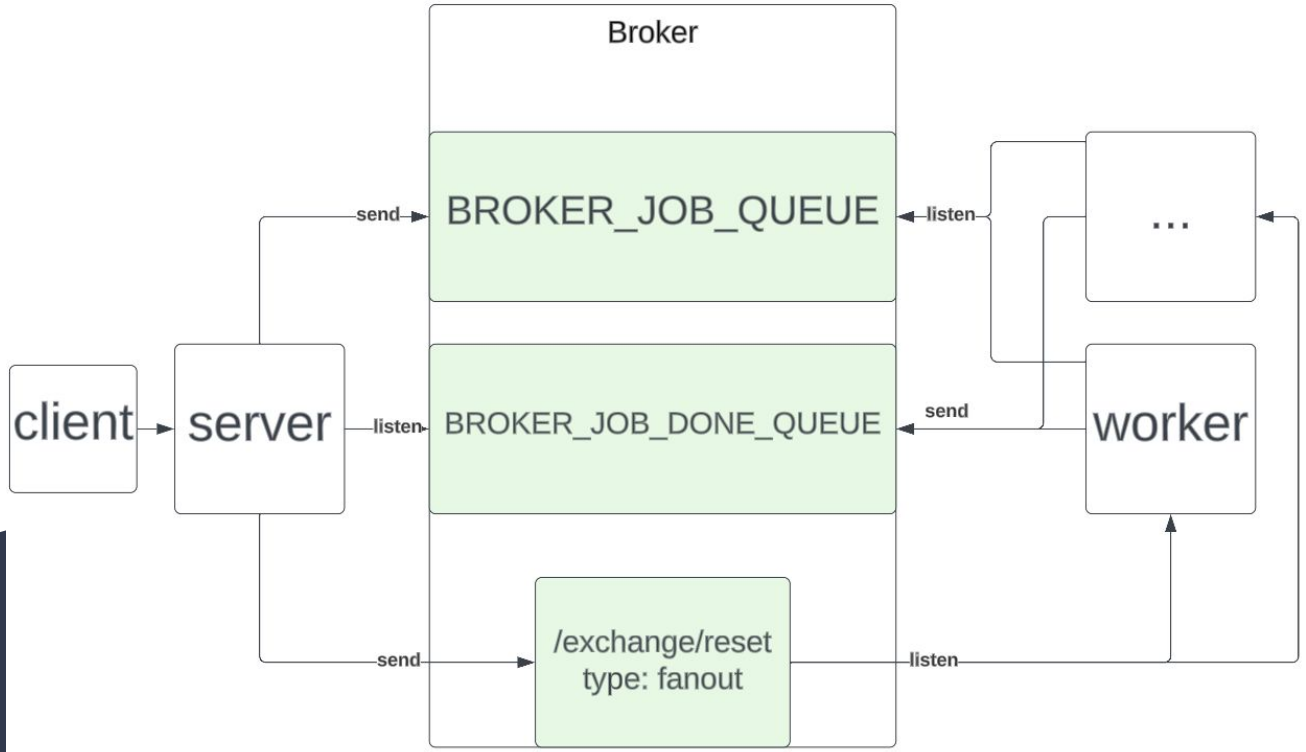
Architecture

- A distributed system containing one server, N workers
- Broker (RabbitMQ) is responsible for the transport of messages
- Server manages messages and client’s UI
- Workers process jobs in parallel

Architecture Diagram



Communication protocols

- The broker uses the **stomp** protocol
  - Simple and widely operable
  - Frame includes *headers* and *body*
- The server communicates with the client using **http** protocol

Fault Tolerance

- Broker is responsible for delivering messages to the destination
- Consumer **heartbeat:**
  - `AUDIO_WORKER_CONN_HEARTBEATS = (15*1000, 15*1000)`
- **ACK** and **NACK** application logic

Fault Tolerance – testing

1.

Fault Tolerance

- This system is resillient to worker crashes, please see the `WORKERS_UNHEALTHY` parameter to simulate the crash after `WORKER_SIMULATE_CRASH_AFTER` time.

Configurations

- in `src/config.py` you can find a number of parameters to be adjusted, e.g.:

```
### User Conf ###
BROKER_HOST = 'localhost'           # broker IP
WORKERS_HEALTHY = 10                # Amount of workers that do not crash
WORKERS_UNHEALTHY = 2               # Amount of workers that crash (their process terminates)
WORKER_SIMULATE_CRASH_AFTER = 20    # After this amount of seconds.
### User Conf ###
```

Fault Tolerance – scenario

1. Server sends one job for every worker (`WORKERS_UNHEALTHY` + `WORKERS_HEALTHY`)
2. Every worker receives one job, and processes for 2-3minutes
3. A number of workers crash (`WORKERS_UNHEALTHY`)
4. Broker detects there is no heartbeat within given time
   a. Worker's message is NACKed
5. A message is consumed by the first free worker

Fault Tolerance – log

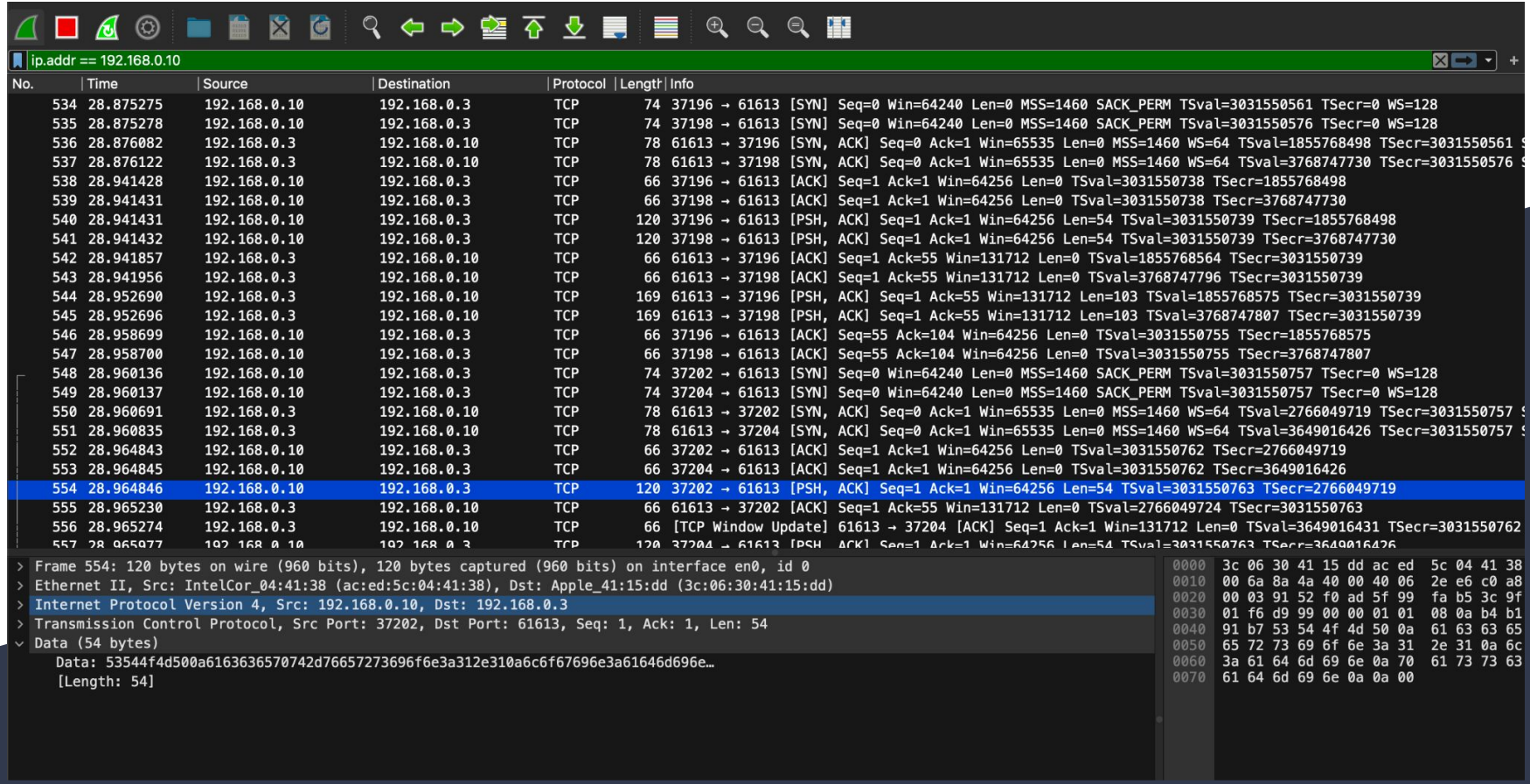
```
~/Doc/MG/sem /C/pr/cd2023-proj-103411-112169 main !5 ?1 ❯ make server
source venv/bin/activate && python src/main.py
2023-06-05 17:25:20 - INFO - Server startup.
2023-06-05 17:25:20 - WARNING - Storage cleaned.
2023-06-05 17:25:23 - INFO - Splitting audio to chunks...
2023-06-05 17:25:28 - INFO - MusicService: Music[1]: Sending 8 jobs
2023-06-05 17:27:51 - INFO - Server: Music[1] - Progress: 12%.
2023-06-05 17:27:51 - INFO - Server: JobDoneMsg[8] - ACK - job time: 137.18[s]
2023-06-05 17:28:16 - INFO - Server: Music[1] - Progress: 25%.
2023-06-05 17:28:16 - INFO - Server: JobDoneMsg[4] - ACK - job time: 163.86[s]
2023-06-05 17:28:18 - INFO - Server: Music[1] - Progress: 37%.
2023-06-05 17:28:18 - INFO - Server: JobDoneMsg[6] - ACK - job time: 165.17[s]
2023-06-05 17:28:19 - INFO - Server: Music[1] - Progress: 50%.
2023-06-05 17:28:19 - INFO - Server: JobDoneMsg[3] - ACK - job time: 166.81[s]
2023-06-05 17:28:23 - INFO - Server: Music[1] - Progress: 62%.
2023-06-05 17:28:23 - INFO - Server: JobDoneMsg[5] - ACK - job time: 168.84[s]
2023-06-05 17:28:24 - INFO - Server: Music[1] - Progress: 75%.
2023-06-05 17:28:24 - INFO - Server: JobDoneMsg[1] - ACK - job time: 168.88[s]
2023-06-05 17:28:25 - INFO - Server: Music[1] - Progress: 87%.
2023-06-05 17:28:25 - INFO - Server: JobDoneMsg[7] - ACK - job time: 168.67[s]
2023-06-05 17:29:10 - INFO - Server: Music[1] - Progress: 99%.
2023-06-05 17:29:10 - INFO - Server: Merging chunks...
2023-06-05 17:29:30 - INFO - Server: Music[1] - merge time: 20.77[s]
2023-06-05 17:29:35 - INFO - Server: Music[1] - total time: 98.82[s]
2023-06-05 17:29:35 - INFO - Server: Music[1] - cleaning workspace.
2023-06-05 17:29:35 - INFO - Server: JobDoneMsg[2] - ACK - job time: 78.05[s]
```

```
~/Doc/MG/sem /C/pr/cd2023-proj-103411-112169 main !5 ?1 ❯ make workers
source venv/bin/activate && python src/audio_worker/client.py
2023-06-05 17:25:22 - INFO - 1 workers started listening for jobs.
2023-06-05 17:25:22 - INFO - 7 workers started listening for jobs.
2023-06-05 17:25:28 - INFO - Worker[5d52b7f] started Job[2].
2023-06-05 17:25:28 - INFO - Worker[2866087] started Job[1].
2023-06-05 17:25:28 - INFO - Worker[e372bd2] started Job[3].
2023-06-05 17:25:28 - INFO - Worker[ca7dfbe] started Job[7].
2023-06-05 17:25:28 - INFO - Worker[7c48f8d] started Job[4].
2023-06-05 17:25:28 - INFO - Worker[a86d4c6] started Job[5].
2023-06-05 17:25:28 - INFO - Worker[6fda6bc] started Job[6].
2023-06-05 17:25:28 - INFO - Worker[d6ed28a] started Job[8].
2023-06-05 17:25:50 - WARNING - Simulating workers crash. Killing 1 workers.
2023-06-05 17:27:48 - INFO - Worker[d6ed28a]: Job[8] - JobDoneMsg - ACK
2023-06-05 17:27:49 - INFO - Worker[d6ed28a] started Job[2].
2023-06-05 17:28:14 - INFO - Worker[7c48f8d]: Job[4] - JobDoneMsg - ACK
2023-06-05 17:28:16 - INFO - Worker[6fda6bc]: Job[6] - JobDoneMsg - ACK
2023-06-05 17:28:17 - INFO - Worker[e372bd2]: Job[3] - JobDoneMsg - ACK
2023-06-05 17:28:21 - INFO - Worker[a86d4c6]: Job[5] - JobDoneMsg - ACK
2023-06-05 17:28:21 - INFO - Worker[ca7dfbe]: Job[7] - JobDoneMsg - ACK
2023-06-05 17:28:21 - INFO - Worker[2866087]: Job[1] - JobDoneMsg - ACK
2023-06-05 17:29:08 - INFO - Worker[d6ed28a]: Job[2] - JobDoneMsg - ACK
```

Wireshark – broker / workers communication

- Server, Broker: **192.168.0.3**
- Machine with workers: **192.168.0.10**
- Broker is on the same machine as the server

Wireshark – server / workers communication



ip.addr == 192.168.0.10

No.	Time	Source	Destination	Protocol	Length	Info
534	28.875275	192.168.0.10	192.168.0.3	TCP	74	37196 → 61613 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM TSval=3031550561 TSecr=0 WS=128
535	28.875278	192.168.0.10	192.168.0.3	TCP	74	37198 → 61613 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM TSval=3031550576 TSecr=0 WS=128
536	28.876082	192.168.0.3	192.168.0.10	TCP	78	61613 → 37196 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 WS=64 TSval=1855768498 TSecr=3031550561 S
537	28.876122	192.168.0.3	192.168.0.10	TCP	78	61613 → 37198 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 WS=64 TSval=3768747730 TSecr=3031550576 S
538	28.941428	192.168.0.10	192.168.0.3	TCP	66	37196 → 61613 [ACK] Seq=1 Ack=1 Win=64256 Len=0 TSval=3031550738 TSecr=1855768498
539	28.941431	192.168.0.10	192.168.0.3	TCP	66	37198 → 61613 [ACK] Seq=1 Ack=1 Win=64256 Len=0 TSval=3031550738 TSecr=3768747730
540	28.941431	192.168.0.10	192.168.0.3	TCP	120	37196 → 61613 [PSH, ACK] Seq=1 Ack=1 Win=64256 Len=54 TSval=3031550739 TSecr=1855768498
541	28.941432	192.168.0.10	192.168.0.3	TCP	120	37198 → 61613 [PSH, ACK] Seq=1 Ack=1 Win=64256 Len=54 TSval=3031550739 TSecr=3768747730
542	28.941857	192.168.0.3	192.168.0.10	TCP	66	61613 → 37196 [ACK] Seq=1 Ack=55 Win=131712 Len=0 TSval=1855768564 TSecr=3031550739
543	28.941956	192.168.0.3	192.168.0.10	TCP	66	61613 → 37198 [ACK] Seq=1 Ack=55 Win=131712 Len=0 TSval=3768747796 TSecr=3031550739
544	28.952690	192.168.0.3	192.168.0.10	TCP	169	61613 → 37196 [PSH, ACK] Seq=1 Ack=55 Win=131712 Len=103 TSval=1855768575 TSecr=3031550739
545	28.952696	192.168.0.3	192.168.0.10	TCP	169	61613 → 37198 [PSH, ACK] Seq=1 Ack=55 Win=131712 Len=103 TSval=3768747807 TSecr=3031550739
546	28.958699	192.168.0.10	192.168.0.3	TCP	66	37196 → 61613 [ACK] Seq=55 Ack=104 Win=64256 Len=0 TSval=3031550755 TSecr=1855768575
547	28.958700	192.168.0.10	192.168.0.3	TCP	66	37198 → 61613 [ACK] Seq=55 Ack=104 Win=64256 Len=0 TSval=3031550755 TSecr=3768747807
548	28.960136	192.168.0.10	192.168.0.3	TCP	74	37202 → 61613 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM TSval=3031550757 TSecr=0 WS=128
549	28.960137	192.168.0.10	192.168.0.3	TCP	74	37204 → 61613 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM TSval=3031550757 TSecr=0 WS=128
550	28.960691	192.168.0.3	192.168.0.10	TCP	78	61613 → 37202 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 WS=64 TSval=2766049719 TSecr=3031550757 S
551	28.960835	192.168.0.3	192.168.0.10	TCP	78	61613 → 37204 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1460 WS=64 TSval=3649016426 TSecr=3031550757 S
552	28.964843	192.168.0.10	192.168.0.3	TCP	66	37202 → 61613 [ACK] Seq=1 Ack=1 Win=64256 Len=0 TSval=3031550762 TSecr=2766049719
553	28.964845	192.168.0.10	192.168.0.3	TCP	66	37204 → 61613 [ACK] Seq=1 Ack=1 Win=64256 Len=0 TSval=3031550762 TSecr=3649016426
554	28.964846	192.168.0.10	192.168.0.3	TCP	120	37202 → 61613 [PSH, ACK] Seq=1 Ack=1 Win=64256 Len=54 TSval=3031550763 TSecr=2766049719
555	28.965230	192.168.0.3	192.168.0.10	TCP	66	61613 → 37202 [ACK] Seq=1 Ack=55 Win=131712 Len=0 TSval=2766049724 TSecr=3031550763
556	28.965274	192.168.0.3	192.168.0.10	TCP	66	[TCP Window Update] 61613 → 37204 [ACK] Seq=1 Ack=1 Win=131712 Len=0 TSval=3649016431 TSecr=3031550762
557	28.965977	192.168.0.10	192.168.0.3	TCP	120	37204 → 61613 [PSH, ACK] Seq=1 Ack=1 Win=64256 Len=54 TSval=3031550763 TSecr=3649016426

```
> Frame 554: 120 bytes on wire (960 bits), 120 bytes captured (960 bits) on interface en0, id 0
> Ethernet II, Src: IntelCor_04:41:38 (ac:ed:5c:04:41:38), Dst: Apple_41:15:dd (3c:06:30:41:15:dd)
> Internet Protocol Version 4, Src: 192.168.0.10, Dst: 192.168.0.3
> Transmission Control Protocol, Src Port: 37202, Dst Port: 61613, Seq: 1, Ack: 1, Len: 54
v Data (54 bytes)
    Data: 53544f4d500a6163636570742d76657273696f6e3a312e310a6c6f67696e3a61646d696e…
    [Length: 54]
```

```
0000  3c 06 30 41 15 dd ac ed  5c 04 41 38
0010  00 6a 8a 4a 40 00 40 06  2e e6 c0 a8
0020  00 03 91 52 f0 ad 5f 99  fa b5 3c 9f
0030  01 f6 d9 99 00 00 01 01  08 0a b4 b1
0040  91 b7 53 54 4f 4d 50 0a  61 63 63 65
0050  65 72 73 69 6f 6e 3a 31  2e 31 0a 6c
0060  3a 61 64 6d 69 6e 0a 70  61 73 73 63
0070  61 64 6d 69 6e 0a 0a 00
```