

Demo:

100 users' authentication success messages on the server logs.

```
daisy@LAPTOP-488RQ82M:~/MutexMutualBank$ ./server
[12:11:06] Mutex Bank Server Starting...
[12:11:06] Shared memory initialized
[12:11:06] Listening on port 8888
[12:11:06] Waiting for clients...
[12:11:08] [AUTH] User user3 connected, account=3
[12:11:08] [AUTH] User user11 connected, account=11
[12:11:08] [AUTH] User user12 connected, account=12
[12:11:08] [AUTH] User user10 connected, account=10
[12:11:08] [AUTH] User user4 connected, account=4
[12:11:08] [AUTH] User user5 connected, account=5
[12:11:08] [AUTH] User user7 connected, account=7
[12:11:08] [AUTH] User user8 connected, account=8
[12:11:08] [AUTH] User user1 connected, account=1
[12:11:08] [AUTH] User user2 connected, account=2
[12:11:08] [AUTH] User user6 connected, account=6
[12:11:08] [AUTH] User user0 connected, account=0
[12:11:08] [AUTH] User user14 connected, account=14
[12:11:08] [AUTH] User user9 connected, account=9
[12:11:08] [AUTH] User user13 connected, account=13
[12:11:08] [AUTH] User user16 connected, account=16
[12:11:08] [AUTH] User user17 connected, account=17
[12:11:08] [AUTH] User user15 connected, account=15
[12:11:08] [AUTH] User user18 connected, account=18
[12:11:08] [AUTH] User user19 connected, account=19
[12:11:08] [AUTH] User user22 connected, account=22
[12:11:08] [AUTH] User user23 connected, account=23
[12:11:08] [AUTH] User user21 connected, account=21
[12:11:08] [AUTH] User user26 connected, account=26
[12:11:08] [AUTH] User user30 connected, account=30
[12:11:08] [AUTH] User user20 connected, account=20
[12:11:08] [AUTH] User user32 connected, account=32
[12:11:08] [AUTH] User user31 connected, account=31
[12:11:08] [AUTH] User user24 connected, account=24
[12:11:08] [AUTH] User user33 connected, account=33
[12:11:08] [AUTH] User user36 connected, account=36
[12:11:08] [AUTH] User user39 connected, account=39
[12:11:08] [AUTH] User user35 connected, account=35
[12:11:08] [AUTH] User user25 connected, account=25
[12:11:08] [AUTH] User user37 connected, account=37
[12:11:08] [AUTH] User user40 connected, account=40
[12:11:08] [AUTH] User user34 connected, account=34
[12:11:08] [AUTH] User user29 connected, account=29
[12:11:08] [AUTH] User user27 connected, account=27
[12:11:08] [AUTH] User user28 connected, account=28
[12:11:08] [AUTH] User user42 connected, account=42
[12:11:08] [AUTH] User user41 connected, account=41
[12:11:08] [AUTH] User user45 connected, account=45
[12:11:08] [AUTH] User user44 connected, account=44
[12:11:08] [AUTH] User user47 connected, account=47
[12:11:08] [AUTH] User user43 connected, account=43
[12:11:08] [AUTH] User user46 connected, account=46
[12:11:08] [AUTH] User user48 connected, account=48
[12:11:08] [AUTH] User user49 connected, account=49
[12:11:08] [AUTH] User user51 connected, account=51
[12:11:08] [AUTH] User user52 connected, account=52
[12:11:08] [AUTH] User user38 connected, account=38
[12:11:08] [AUTH] User user50 connected, account=50
[12:11:08] [AUTH] User user53 connected, account=53
[12:11:08] [AUTH] User user54 connected, account=54
[12:11:08] [AUTH] User user58 connected, account=58
[12:11:08] [AUTH] User user57 connected, account=57
[12:11:08] [AUTH] User user59 connected, account=59
[12:11:08] [AUTH] User user55 connected, account=55
[12:11:08] [AUTH] User user60 connected, account=60
[12:11:08] [AUTH] User user56 connected, account=56
[12:11:08] [AUTH] User user63 connected, account=63
[12:11:08] [AUTH] User user61 connected, account=61
[12:11:08] [AUTH] User user67 connected, account=67
[12:11:08] [AUTH] User user66 connected, account=66
[12:11:08] [AUTH] User user71 connected, account=71
[12:11:08] [AUTH] User user64 connected, account=64
[12:11:08] [AUTH] User user74 connected, account=74
[12:11:08] [AUTH] User user65 connected, account=65
[12:11:08] [AUTH] User user68 connected, account=68
[12:11:08] [AUTH] User user75 connected, account=75
[12:11:08] [AUTH] User user73 connected, account=73
[12:11:08] [AUTH] User user77 connected, account=77
[12:11:08] [AUTH] User user69 connected, account=69
[12:11:08] [AUTH] User user70 connected, account=70
[12:11:08] [AUTH] User user78 connected, account=78
[12:11:08] [AUTH] User user76 connected, account=76
[12:11:08] [AUTH] User user80 connected, account=80
[12:11:08] [AUTH] User user72 connected, account=72
[12:11:08] [AUTH] User user90 connected, account=90
[12:11:08] [AUTH] User user79 connected, account=79
[12:11:08] [AUTH] User user88 connected, account=88
[12:11:08] [AUTH] User user91 connected, account=91
[12:11:08] [AUTH] User user81 connected, account=81
[12:11:08] [AUTH] User user99 connected, account=99
[12:11:08] [AUTH] User user89 connected, account=89
[12:11:08] [AUTH] User user92 connected, account=92
[12:11:08] [AUTH] User user96 connected, account=96
[12:11:08] [AUTH] User user94 connected, account=94
[12:11:08] [AUTH] User user97 connected, account=97
[12:11:08] [AUTH] User user93 connected, account=93
[12:11:08] [AUTH] User user84 connected, account=84
[12:11:08] [AUTH] User user85 connected, account=85
[12:11:08] [AUTH] User user82 connected, account=82
[12:11:08] [AUTH] User user86 connected, account=86
[12:11:08] [AUTH] User user83 connected, account=83
[12:11:08] [AUTH] User user87 connected, account=87
[12:11:08] [AUTH] User user95 connected, account=95
[12:11:08] [AUTH] User user62 connected, account=62
[12:11:08] [AUTH] User user98 connected, account=98
^C
```

Each accounts' balance is shown on the server logs, assuming that the initial balance of each account is \$1000.

===== [Mutex Bank 帳戶餘額一覽] =====			
[Acc 00: \$ 912]	[Acc 01: \$1015]	[Acc 02: \$1131]	[Acc 03: \$ 947]
[Acc 04: \$ 996]	[Acc 05: \$1025]	[Acc 06: \$1118]	[Acc 07: \$1093]
[Acc 08: \$ 993]	[Acc 09: \$1040]	[Acc 10: \$ 929]	[Acc 11: \$1058]
[Acc 12: \$ 909]	[Acc 13: \$ 990]	[Acc 14: \$ 906]	[Acc 15: \$ 919]
[Acc 16: \$ 980]	[Acc 17: \$1127]	[Acc 18: \$1009]	[Acc 19: \$ 920]
[Acc 20: \$ 971]	[Acc 21: \$ 997]	[Acc 22: \$ 962]	[Acc 23: \$ 964]
[Acc 24: \$ 919]	[Acc 25: \$1074]	[Acc 26: \$ 986]	[Acc 27: \$1094]
[Acc 28: \$1028]	[Acc 29: \$1022]	[Acc 30: \$ 980]	[Acc 31: \$1106]
[Acc 32: \$ 966]	[Acc 33: \$ 997]	[Acc 34: \$1079]	[Acc 35: \$1096]
[Acc 36: \$ 974]	[Acc 37: \$ 990]	[Acc 38: \$ 908]	[Acc 39: \$ 994]
[Acc 40: \$ 904]	[Acc 41: \$1080]	[Acc 42: \$1047]	[Acc 43: \$1023]
[Acc 44: \$ 948]	[Acc 45: \$1048]	[Acc 46: \$1002]	[Acc 47: \$ 953]
[Acc 48: \$1025]	[Acc 49: \$ 927]	[Acc 50: \$ 924]	[Acc 51: \$ 991]
[Acc 52: \$ 954]	[Acc 53: \$1051]	[Acc 54: \$ 999]	[Acc 55: \$ 995]
[Acc 56: \$1040]	[Acc 57: \$1154]	[Acc 58: \$1096]	[Acc 59: \$1106]
[Acc 60: \$ 918]	[Acc 61: \$1094]	[Acc 62: \$1059]	[Acc 63: \$ 928]
[Acc 64: \$ 983]	[Acc 65: \$1009]	[Acc 66: \$1058]	[Acc 67: \$1090]
[Acc 68: \$1086]	[Acc 69: \$ 919]	[Acc 70: \$ 941]	[Acc 71: \$ 979]
[Acc 72: \$ 957]	[Acc 73: \$ 939]	[Acc 74: \$ 993]	[Acc 75: \$ 975]
[Acc 76: \$ 943]	[Acc 77: \$ 981]	[Acc 78: \$ 938]	[Acc 79: \$1061]
[Acc 80: \$1116]	[Acc 81: \$ 965]	[Acc 82: \$ 946]	[Acc 83: \$ 942]
[Acc 84: \$ 927]	[Acc 85: \$1058]	[Acc 86: \$ 989]	[Acc 87: \$1069]
[Acc 88: \$1055]	[Acc 89: \$ 986]	[Acc 90: \$ 998]	[Acc 91: \$ 929]
[Acc 92: \$1083]	[Acc 93: \$1012]	[Acc 94: \$1001]	[Acc 95: \$ 900]
[Acc 96: \$ 974]	[Acc 97: \$ 985]	[Acc 98: \$ 932]	[Acc 99: \$ 904]

The statistical data on the server logs of the total assets in the Mutex Mutual Bank, the total transaction number, and the average latency in milliseconds.

統計數據：	
1. 銀行總資產：	\$100013
2. 總交易筆數：	100 筆
3. 平均延遲：	0.100 ms

The transaction content on the client logs.

```
daisy@LAPTOP-488RQ82M:~/MutexMutualBank$ ./client
=====
[System] 交易中...
=====
[User 03] 轉帳成功 ! Acc 03 -> Acc 59 ($53)
[User 11] 存款成功 ! Acc 11 ($58)
[User 12] 轉帳成功 ! Acc 12 -> Acc 31 ($91)
[User 14] 提款成功 ! Acc 14 ($94)
[User 10] 提款成功 ! Acc 10 ($88)
[User 13] 轉帳成功 ! Acc 13 -> Acc 93 ($10)
[User 05] 轉帳成功 ! Acc 05 -> Acc 18 ($71)
[User 04] 提款成功 ! Acc 04 ($4)
[User 07] 存款成功 ! Acc 07 ($93)
[User 18] 轉帳成功 ! Acc 18 -> Acc 57 ($62)
[User 15] 提款成功 ! Acc 15 ($81)
[User 19] 提款成功 ! Acc 19 ($80)
[User 23] 提款成功 ! Acc 23 ($36)
[User 22] 提款成功 ! Acc 22 ($38)
[User 21] 轉帳成功 ! Acc 21 -> Acc 94 ($71)
[User 01] 提款成功 ! Acc 01 ($6)
[User 02] 存款成功 ! Acc 02 ($72)
[User 08] 提款成功 ! Acc 08 ($7)
[User 30] 提款成功 ! Acc 30 ($20)
[User 32] 轉帳成功 ! Acc 32 -> Acc 21 ($68)
[User 26] 提款成功 ! Acc 26 ($14)
[User 31] 存款成功 ! Acc 31 ($15)
[User 20] 轉帳成功 ! Acc 20 -> Acc 28 ($29)
[User 35] 存款成功 ! Acc 35 ($96)
[User 24] 轉帳成功 ! Acc 24 -> Acc 53 ($81)
[User 36] 轉帳成功 ! Acc 36 -> Acc 66 ($26)
[User 34] 存款成功 ! Acc 34 ($8)
[User 39] 轉帳成功 ! Acc 39 -> Acc 73 ($6)
[User 25] 存款成功 ! Acc 25 ($64)
[User 33] 提款成功 ! Acc 33 ($3)
[User 29] 轉帳成功 ! Acc 29 -> Acc 17 ($75)
[User 40] 轉帳成功 ! Acc 40 -> Acc 05 ($96)
[User 37] 轉帳成功 ! Acc 37 -> Acc 25 ($10)
[User 42] 存款成功 ! Acc 42 ($47)
[User 28] 轉帳成功 ! Acc 28 -> Acc 54 ($1)
[User 41] 存款成功 ! Acc 41 ($80)
[User 45] 轉帳成功 ! Acc 45 -> Acc 32 ($34)
[User 44] 轉帳成功 ! Acc 44 -> Acc 80 ($52)
[User 47] 轉帳成功 ! Acc 47 -> Acc 06 ($47)
[User 46] 存款成功 ! Acc 46 ($2)
[User 43] 存款成功 ! Acc 43 ($23)
[User 51] 轉帳成功 ! Acc 51 -> Acc 29 ($9)
[User 52] 提款成功 ! Acc 52 ($46)
[User 49] 提款成功 ! Acc 49 ($73)
[User 27] 存款成功 ! Acc 27 ($94)
[User 50] 提款成功 ! Acc 50 ($76)
[User 38] 提款成功 ! Acc 38 ($92)
[User 48] 存款成功 ! Acc 48 ($23)
[User 57] 存款成功 ! Acc 57 ($92)
[User 63] 轉帳成功 ! Acc 63 -> Acc 59 ($72)
[User 56] 存款成功 ! Acc 56 ($40)
[User 53] 提款成功 ! Acc 53 ($30)
[User 55] 提款成功 ! Acc 55 ($72)
[User 58] 存款成功 ! Acc 58 ($82)
[User 71] 轉帳成功 ! Acc 71 -> Acc 01 ($21)
[User 54] 提款成功 ! Acc 54 ($95)
[User 59] 轉帳成功 ! Acc 59 -> Acc 93 ($19)
[User 60] 轉帳成功 ! Acc 60 -> Acc 45 ($82)
[User 74] 轉帳成功 ! Acc 74 -> Acc 79 ($7)
[User 66] 存款成功 ! Acc 66 ($32)
[User 61] 存款成功 ! Acc 61 ($68)
[User 64] 轉帳成功 ! Acc 64 -> Acc 10 ($17)
[User 65] 存款成功 ! Acc 65 ($9)
[User 73] 轉帳成功 ! Acc 73 -> Acc 55 ($67)
[User 69] 提款成功 ! Acc 69 ($81)
[User 06] 存款成功 ! Acc 06 ($71)
[User 78] 提款成功 ! Acc 78 ($62)
[User 68] 存款成功 ! Acc 68 ($86)
[User 67] 存款成功 ! Acc 67 ($90)
[User 72] 提款成功 ! Acc 72 ($43)
[User 00] 轉帳成功 ! Acc 00 -> Acc 29 ($88)
[User 75] 轉帳成功 ! Acc 75 -> Acc 98 ($25)
[User 77] 提款成功 ! Acc 77 ($19)
[User 88] 存款成功 ! Acc 88 ($55)
[User 79] 存款成功 ! Acc 79 ($54)
[User 81] 提款成功 ! Acc 81 ($35)
[User 76] 提款成功 ! Acc 76 ($57)
[User 70] 轉帳成功 ! Acc 70 -> Acc 02 ($59)
[User 91] 轉帳成功 ! Acc 91 -> Acc 34 ($71)
[User 80] 存款成功 ! Acc 80 ($64)
[User 90] 轉帳成功 ! Acc 90 -> Acc 48 ($2)
[User 99] 提款成功 ! Acc 99 ($96)
[User 94] 提款成功 ! Acc 94 ($70)
[User 92] 存款成功 ! Acc 92 ($83)
[User 96] 轉帳成功 ! Acc 96 -> Acc 61 ($26)
[User 84] 提款成功 ! Acc 84 ($73)
[User 93] 提款成功 ! Acc 93 ($17)
[User 89] 轉帳成功 ! Acc 89 -> Acc 58 ($14)
[User 82] 提款成功 ! Acc 82 ($54)
[User 85] 存款成功 ! Acc 85 ($58)
[User 86] 提款成功 ! Acc 86 ($11)
[User 87] 存款成功 ! Acc 87 ($69)
[User 97] 提款成功 ! Acc 97 ($15)
[User 62] 存款成功 ! Acc 62 ($59)
[User 83] 提款成功 ! Acc 83 ($58)
[User 95] 提款成功 ! Acc 95 ($100)
[User 98] 轉帳成功 ! Acc 98 -> Acc 54 ($93)
[User 09] 存款成功 ! Acc 09 ($40)
[User 17] 存款成功 ! Acc 17 ($52)
[User 16] 提款成功 ! Acc 16 ($20)
```

The total transaction number, average latency, overall throughput (TPS), and total consume time show on the client logs.

```
===== [Client 統計] =====
總交易筆數: 100
平均延遲: 7.465 ms
整體 Throughput (TPS): 236.88 交易/秒
總耗時: 0.422 秒
=====
```

The transection log example.

```
[Thu Dec 25 13:18:57 2025] #39 Transfer: Acc 51 -> Acc 50 ($76)
[Thu Dec 25 13:18:57 2025] #40 Deposit: Acc 41 ($30)
[Thu Dec 25 13:18:57 2025] #41 Withdraw: Acc 49 ($96)
```

TCP Handshake Flood from clients.

793	31.36335...	127.0.0.1	127.0.0.1	TCP	74	59716 → 8888	[SYN]	Seq=0 Win=65495 Len=0 MSS=65495 SACK_PERM=1 TSval=323344261 TSecr=0 WS=128
794	31.36337...	127.0.0.1	127.0.0.1	TCP	74	8888 → 59716	[SYN, ACK]	Seq=0 Ack=1 Win=65483 Len=0 MSS=65495 SACK_PERM=1 TSval=323344261 TSecr=323344261 WS=128
795	31.36340...	127.0.0.1	127.0.0.1	TCP	66	59716 → 8888	[ACK]	Seq=1 Ack=1 Win=65536 Len=0 TSval=323344261 TSecr=323344261
796	31.36341...	127.0.0.1	127.0.0.1	TCP	74	59718 → 8888	[SYN]	Seq=0 Win=65495 Len=0 MSS=65495 SACK_PERM=1 TSval=323344261 TSecr=0 WS=128
797	31.36347...	127.0.0.1	127.0.0.1	TCP	74	59720 → 8888	[SYN]	Seq=0 Win=65495 Len=0 MSS=65495 SACK_PERM=1 TSval=323344261 TSecr=0 WS=128
798	31.36355...	127.0.0.1	127.0.0.1	TCP	74	59724 → 8888	[SYN]	Seq=0 Win=65495 Len=0 MSS=65495 SACK_PERM=1 TSval=323344261 TSecr=0 WS=128
799	31.36357...	127.0.0.1	127.0.0.1	TCP	74	8888 → 59720	[SYN, ACK]	Seq=0 Ack=1 Win=65483 Len=0 MSS=65495 SACK_PERM=1 TSval=323344261 TSecr=323344261 WS=128
800	31.36359...	127.0.0.1	127.0.0.1	TCP	74	59728 → 8888	[SYN]	Seq=0 Win=65495 Len=0 MSS=65495 SACK_PERM=1 TSval=323344261 TSecr=0 WS=128

| Length | Checksum | Payload | packets

They are divided into three packets (you can observe 60552 -> 8888).

The three “Login content” 60552 -> 8888 packets sent by the client.

10...	31.37035...	127.0.0.1	127.0.0.1	TCP	70	60552 → 8888	[PSH, ACK]	Seq=1 Ack=1 Win=65536 Len=4 TSval=323344268 TSecr=323344268
10...	31.37036...	127.0.0.1	127.0.0.1	TCP	66	8888 → 60552	[ACK]	Seq=1 Ack=5 Win=65536 Len=0 TSval=323344268 TSecr=323344268
10...	31.37038...	127.0.0.1	127.0.0.1	TCP	70	60552 → 8888	[PSH, ACK]	Seq=5 Ack=1 Win=65536 Len=4 TSval=323344268 TSecr=323344268
10...	31.37038...	127.0.0.1	127.0.0.1	TCP	66	8888 → 60552	[ACK]	Seq=1 Ack=9 Win=65536 Len=0 TSval=323344268 TSecr=323344268
10...	31.37039...	127.0.0.1	127.0.0.1	TCP	98	60552 → 8888	[PSH, ACK]	Seq=9 Ack=1 Win=65536 Len=32 TSval=323344268 TSecr=323344268

Encrypted username and password of payload using AES.

```
Data (32 bytes)
Data: 356598f117abbd1e7b675da415a337626caca5092b364dc11f2c8473ef4f4db8
[Length: 32]
```

The three “transaction content” 59872 -> 8888 packets sent by the client.

18...	31.56681...	127.0.0.1	127.0.0.1	TCP	70	59872 → 8888	[PSH, ACK]	Seq=41 Ack=77 Win=65536 Len=4 TSval=323344464 TSecr=323344464
18...	31.56686...	127.0.0.1	127.0.0.1	TCP	66	8888 → 59872	[ACK]	Seq=77 Ack=45 Win=65536 Len=0 TSval=323344464 TSecr=323344464
18...	31.56687...	127.0.0.1	127.0.0.1	TCP	70	59872 → 8888	[PSH, ACK]	Seq=45 Ack=77 Win=65536 Len=4 TSval=323344464 TSecr=323344464
18...	31.56688...	127.0.0.1	127.0.0.1	TCP	66	8888 → 59872	[ACK]	Seq=77 Ack=49 Win=65536 Len=0 TSval=323344464 TSecr=323344464
18...	31.56688...	127.0.0.1	127.0.0.1	TCP	82	59872 → 8888	[PSH, ACK]	Seq=49 Ack=77 Win=65536 Len=16 TSval=323344464 TSecr=323344464

Encrypted src_id, dst_id, amount and op of payload using XOR.

```
Data (16 bytes)
Data: aaaaaaaaa94aaaaaf8aaaaaaaaabaaaaaa
[Length: 16]
```