

CSE344

Final Project

Design & Test Report

Author

Gökbey Gazi KESKİN

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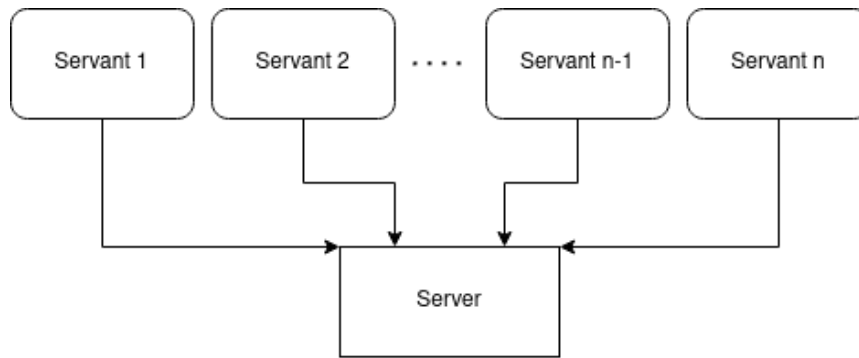
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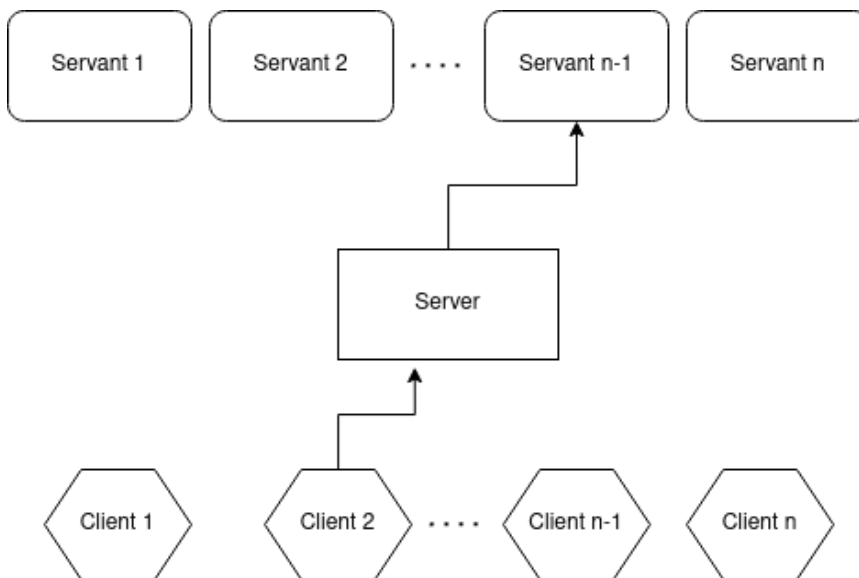
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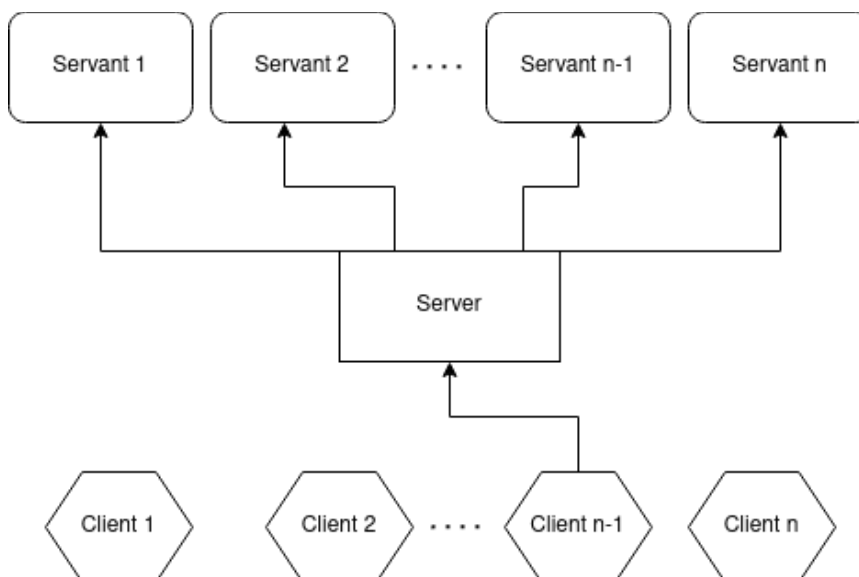
General Structure



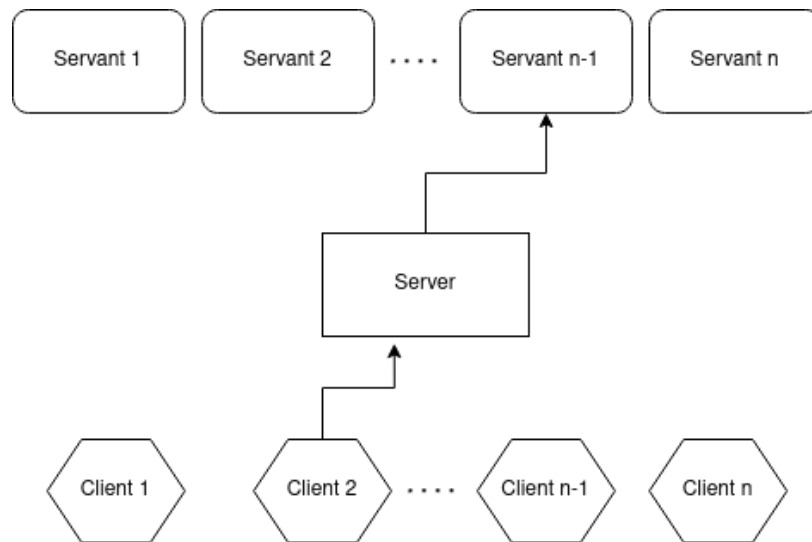
Initial State
Servants share their information with the server



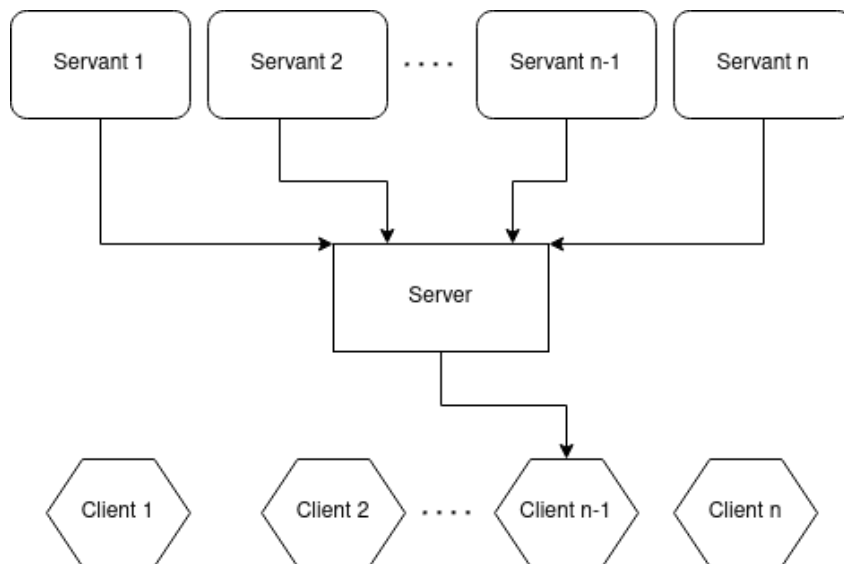
State 2.1: Client 2 sent a city specific request



State 2.2: Client n-1 sent a non city specific request



State 3.1: Client 2 received its city specific request



State 3.2: Client n-1 received its non city specific request

Step by step process explanation

- 1) Server establishes a stream socket and starts to listen.
- 2) Servants reads the dataset and keeps the information in its tree-like structure (given in the Servants subsection of Design Considerations section).
- 3) Servants connects to Server's socket and shares their information (the cities it is responsible for, port to connect back etc.). Server saves this information for future client requests. From this point on, servant acts as a server for the Server.
- 4) Clients connects to Server and requests transaction counts with real-estate type, optional city and given date intervals.

- 5) Server receives the client request and if it is city specific, finds the corresponding servant and sends it to it, else it sends the request to all servants.
- 6) Servants receives the client request and sends a response to server.
- 7) Server receives the response and sends it to client which made the request.
- 8) Server keeps repeating this until it receives a SIGINT signal.
- 9) When server receives SIGINT, frees all its resources and forwards it to server.

Design Issues & Considerations

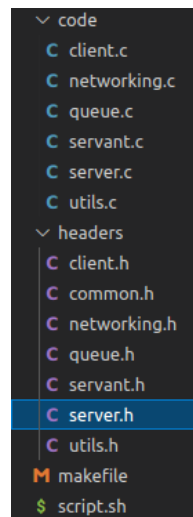
General

- 1) str_tok is not thread safe.

Solution: I implemented my own str_tok (remove_until_delim). Removes the characters from beginning to given delimiter and returns them as a char*.

- 2) The project is too big and it tends to be more and more crowded.

Solution: I tried to implement the whole system as modular as possible.



- 3) When the Server exits, servants should exit too.

Solution: Servants gets their Process ID numbers using proc/self and sends it to Server at the initial handshake. Server forwards the SIGINT signal to servants.

- 4) There are lots of system calls which has to be dealt (error handling). This causes a too crowded code organization since each error check takes 4 lines. I created 3 functions for error handling and used them through the project.

```
void exit_on_error(int errnum, char* msg){
    fprintf(stderr, "%s: %s\n", msg, strerror(errnum));
    exit(EXIT_FAILURE);
}

void fail_check(int return_val, char* msg){
    if(return_val < 0){
        exit_on_error(errno, msg);
    }
}

void fail_check_pthread(int return_val, char* msg){
    if(return_val != 0){
        exit_on_error(return_val, msg);
    }
}
```

Server

1) Server should know who is connecting to it's socket.

Solution: Clients (both Client and Servants) adds a 4 character long signature to the beginning of their requests (srvt and clnt).

2) Servants shouldn't connect to Server's socket at the same time to write their data.

Reason: There is a global servants_amt variable in server. Server's threads updates this variable while initializing the data about it's servants and accessing it at the same time causes crashing.

Solution: I used a semaphore for creating a mutual exclusion zone

```
if(strncmp(buffer,"srvt",4)==0){  
    remove_first_n_chars(buffer,5);  
    pthread_mutex_lock(&servant_set_mutex);  
    set_servant_info(buffer);  
    pthread_mutex_unlock(&servant_set_mutex);  
}
```

3) Threads shouldn't access to connections queue at the same time and they should be sleeping while the queue is empty

Solution: I used a monitor.

Main:

```
pthread_mutex_lock(&queue_mutex);  
enqueue(connections,client_fd);  
pthread_cond_signal(&cond_var);  
pthread_mutex_unlock(&queue_mutex);
```

Thread Function:

```
pthread_mutex_lock(&queue_mutex);  
while((fd_client = dequeue(connections))==NULL){  
    pthread_cond_wait(&cond_var,&queue_mutex);  
}  
pthread_mutex_unlock(&queue_mutex);
```

4) Server should remember it's servants data for future connections.

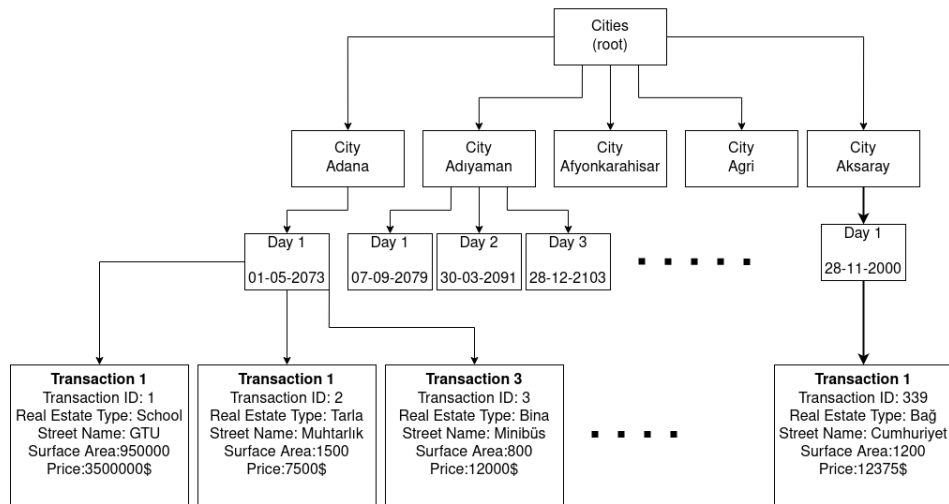
Solution: I created a servant structure and server keeps a dynamic array of servants.

```
struct servant{  
    int port;  
    int city_amt;  
    int pid;  
    char** cities;  
};
```

Servant

The dataset has too many nested informations (cities->days->transactions) and it is hard to keep it in a regular structure like an array.

Solution: I created a tree structure to hold this data.



Client

Clients should send their requests at once to force Server's limits. I implemented a synchronization barrier using a monitor to achieve this.

```
printf("Client-Thread-%d: Thread-%d has been created\n",thread_num,thread_num);
pthread_mutex_lock(&lock);
++arrived;
if(arrived<thread_amt){
pthread_cond_wait(&condvar,&lock);
}
pthread_cond_broadcast(&condvar);
pthread_mutex_unlock(&lock);
printf("Client-Thread-%d: I am requesting \"%s\"\n",thread_num,requests[thread_num]);
```

Tests

Test Case 1

Server Thread Amount = 5

Request Amount = 1 (transactionCount TARLA 01-01-2073 30-12-2074 ADANA)

Servant Amount = 1 (cover cities 1-81)

Result: Works as expected (passed)

```
Servant 65221: loaded dataset, cities ADANA-ZONGULDAK
Servant 65221: Dataset Information is sent to Server
Servant 65221: listening at port 20003
2022/06/15|10:31:44|Servant 65221 is present at the port 20003 handling cities ADANA-ZONGULDAK
Client: I have loaded 1 requests and I'm creating 1 threads.
Client-Thread-0: Thread-0 has been created
Client-Thread-0: I am requesting "clnt TARLA 01-01-2073 30-12-2074 ADANA "
2022/06/15|10:31:47|Request arrived "TARLA 01-01-2073 30-12-2074 ADANA "
2022/06/15|10:31:47|Contacting servant 65221
Servant 65221: Request Received from Server:TARLA|756676|757400|ADANA
Servant 65221: Sent response to server:3
2022/06/15|10:31:47|Response received: 3, forwarded to client.
Client-Thread-0: The server's response to "clnt TARLA 01-01-2073 30-12-2074 ADANA " is 3
Client-Thread-0: Terminating.
Client: All threads have terminated, goodbye.
```

Test Case 2

Same with Case 1 but there are 10 requests:

transactionCount TARLA 01-01-2073 30-12-2074 ADANA

transactionCount MERA 03-02-2018 09-11-2050

transactionCount DUKKAN 20-04-2000 23-01-2031 KILIS

transactionCount BAG 01-12-2004 27-09-2089 ADIYAMAN

transactionCount FIDANLIK 02-09-2016 12-09-2081 BALIKESIR

transactionCount BAHCE 02-03-2005 17-01-2084

transactionCount FABRIKA 22-07-2004 11-05-2072 ANKARA

transactionCount AMBAR 28-01-2044 13-09-2050 AKSARAY

transactionCount VILLA 22-04-2049 20-03-2061

transactionCount IMALATHANE 04-06-2004 11-11-2011 ISPARTA

Result: Works as expected. (Passed)

```
Servant 65418: loaded dataset, cities ADANA-ZONGULDAK
Servant 65418: Dataset Information is sent to Server
Servant 65418: listening at port 20003
2022/06/15|10:32:39|Servant 65418 is present at the port 20003 handling cities ADANA-ZONGULDAK
Client: I have loaded 10 requests and I'm creating 10 threads.
Client-Thread-0: Thread-0 has been created
Client-Thread-1: Thread-1 has been created
Client-Thread-2: Thread-2 has been created
Client-Thread-3: Thread-3 has been created
Client-Thread-4: Thread-4 has been created
Client-Thread-5: Thread-5 has been created
Client-Thread-6: Thread-6 has been created
Client-Thread-8: Thread-8 has been created
Client-Thread-7: Thread-7 has been created
Client-Thread-9: Thread-9 has been created
Client-Thread-9: I am requesting "clnt IMALATHANE 04-06-2004 11-11-2011 ISPARTA"
Client-Thread-0: I am requesting "clnt TARLA 01-01-2073 30-12-2074 ADANA "
Client-Thread-2: I am requesting "clnt DUKKAN 20-04-2000 23-01-2031 KILIS"
Client-Thread-3: I am requesting "clnt BAG 01-12-2004 27-09-2089 ADIYAMAN"
Client-Thread-5: I am requesting "clnt BAHCE 02-03-2005 17-01-2084"
Client-Thread-4: I am requesting "clnt FIDANLIK 02-09-2016 12-09-2081 BALIKESIR"
Client-Thread-1: I am requesting "clnt MERA 03-02-2018 09-11-2050 "
Client-Thread-8: I am requesting "clnt VILLA 22-04-2049 20-03-2061"
Client-Thread-7: I am requesting "clnt AMBAR 28-01-2044 13-09-2050 AKSARAY"
Client-Thread-6: I am requesting "clnt FABRIKA 22-07-2004 11-05-2072 ANKARA"
2022/06/15|10:32:42|Request arrived "IMALATHANE 04-06-2004 11-11-2011 ISPARTA"
2022/06/15|10:32:42|Contacting servant 65418
2022/06/15|10:32:42|Request arrived "TARLA 01-01-2073 30-12-2074 ADANA "
2022/06/15|10:32:42|Contacting servant 65418
Servant 65418: Request Received from Server:IMALATHANE|731644|734356|ISPARTA
2022/06/15|10:32:42|Request arrived "DUKKAN 20-04-2000 23-01-2031 KILIS"
2022/06/15|10:32:42|Contacting servant 65418
Servant 65418: Request Received from Server:TARLA|756676|757400|ADANA
Servant 65418: Sent response to server:4
2022/06/15|10:32:42|Request arrived "BAG 01-12-2004 27-09-2089 ADIYAMAN"
Servant 65418: Sent response to server:3
2022/06/15|10:32:42|Contacting servant 65418
2022/06/15|10:32:42|Request arrived "FIDANLIK 02-09-2016 12-09-2081 BALIKESIR"
2022/06/15|10:32:42|Contacting servant 65418
2022/06/15|10:32:42|Response received: 4, forwarded to client.
Client-Thread-9: The server's response to "clnt IMALATHANE 04-06-2004 11-11-2011 ISPARTA" is 4
2022/06/15|10:32:42|Request arrived "MERA 03-02-2018 09-11-2050 "
2022/06/15|10:32:42|Contacting ALL servants.
Client-Thread-9: Terminating.
Servant 65418: Request Received from Server:FIDANLIK|736112|759847|BALIKESIR
Servant 65418: Request Received from Server:MERLA|736633|748589
2022/06/15|10:32:42|Response received: 3, forwarded to client.
2022/06/15|10:32:42|Response received: 3, forwarded to client.
2022/06/15|10:32:42|Request arrived "VILLA 22-04-2049 20-03-2061"
2022/06/15|10:32:42|Contacting ALL servants.
Client-Thread-4: The server's response to "clnt FIDANLIK 02-09-2016 12-09-2081 BALIKESIR" is 3
2022/06/15|10:32:42|Request arrived "AMBAR 28-01-2044 13-09-2050 AKSARAY"
2022/06/15|10:32:42|Contacting servant 65418
Client-Thread-4: Terminating.
Servant 65418: Sent response to server:3
2022/06/15|10:32:42|Response received: 158, forwarded to client.
Client-Thread-1: The server's response to "clnt MERA 03-02-2018 09-11-2050 " is 158
2022/06/15|10:32:42|Request arrived "BAHCE 02-03-2005 17-01-2084"
Servant 65418: Request Received from Server:AMBAR|746118|748533|AKSARAY
Servant 65418: Request Received from Server:VILLA|748027|752375
Client-Thread-1: Terminating.
Servant 65418: Sent response to server:0
Servant 65418: Request Received from Server:DUKKAN|730140|741368|KILIS
2022/06/15|10:32:42|Response received: 0, forwarded to client.
Servant 65418: Sent response to server:29
Servant 65418: Sent response to server:158
2022/06/15|10:32:42|Response received: 1, forwarded to client.
2022/06/15|10:32:42|Response received: 29, forwarded to client.
Client-Thread-7: The server's response to "clnt AMBAR 28-01-2044 13-09-2050 AKSARAY" is 0
2022/06/15|10:32:42|Request arrived "FABRIKA 22-07-2004 11-05-2072 ANKARA"
Client-Thread-2: The server's response to "clnt DUKKAN 20-04-2000 23-01-2031 KILIS" is 1
2022/06/15|10:32:42|Contacting servant 65418
Client-Thread-7: Terminating.
2022/06/15|10:32:42|Contacting ALL servants.
Client-Thread-8: The server's response to "clnt VILLA 22-04-2049 20-03-2061" is 29
Servant 65418: Sent response to server:1
Client-Thread-8: Terminating.
Client-Thread-2: Terminating.
Client-Thread-0: The server's response to "clnt TARLA 01-01-2073 30-12-2074 ADANA " is 3
Client-Thread-0: Terminating.
Servant 65418: Request Received from Server:BAHCE|731917|760707
Servant 65418: Request Received from Server:BAG|731821|762782|ADIYAMAN
Servant 65418: Request Received from Server:FABRIKA|731692|756441|ANKARA
2022/06/15|10:32:42|Response received: 5, forwarded to client.
Client-Thread-3: The server's response to "clnt BAG 01-12-2004 27-09-2089 ADIYAMAN" is 5
Servant 65418: Sent response to server:4
Servant 65418: Sent response to server:5
Client-Thread-3: Terminating.
2022/06/15|10:32:42|Response received: 4, forwarded to client.
Client-Thread-6: The server's response to "clnt FABRIKA 22-07-2004 11-05-2072 ANKARA" is 4
Client-Thread-6: Terminating.
Servant 65418: Sent response to server:343
2022/06/15|10:32:42|Response received: 343, forwarded to client.
Client-Thread-5: The server's response to "clnt BAHCE 02-03-2005 17-01-2084" is 343
Client-Thread-5: Terminating.
Client: All threads have terminated, goodbye.
```


Test Case 3

Same with Test Case 2 but there are 9 servants (each covers 9 cities)

Result: Works as expected. (Passed)

```
Servant 66150: loaded dataset, cities ARTVIN-BITLIS
Servant 66150: Dataset Information is sent to Server
2022/06/15|10:37:31|Servant 66150 is present at the port 20912 handling cities ARTVIN-BITLIS
Servant 66150: listening at port 20912
Servant 66149: loaded dataset, cities ADANA-ARDAHAN
2022/06/15|10:37:31|Servant 66149 is present at the port 20803 handling cities ADANA-ARDAHAN
Servant 66149: Dataset Information is sent to Server
Servant 66149: listening at port 20803
Servant 66151: loaded dataset, cities BOLU-DUZCE
Servant 66152: loaded dataset, cities EDIRNE-HAKKARI
2022/06/15|10:37:31|Servant 66151 is present at the port 20821 handling cities BOLU-DUZCE
2022/06/15|10:37:31|Servant 66152 is present at the port 20930 handling cities EDIRNE-HAKKARI
Servant 66151: Dataset Information is sent to Server
Servant 66151: listening at port 20821
Servant 66154: loaded dataset, cities HATAY-KARS
Servant 66152: Dataset Information is sent to Server
2022/06/15|10:37:31|Servant 66154 is present at the port 20939 handling cities HATAY-KARS
Servant 66158: loaded dataset, cities TEKIRDAG-ZONGULDAK
Servant 66152: listening at port 20939
2022/06/15|10:37:31|Servant 66158 is present at the port 20975 handling cities TEKIRDAG-ZONGULDAK
Servant 66158: Dataset Information is sent to Server
Servant 66158: listening at port 20975
Servant 66154: Dataset Information is sent to Server
Servant 66154: listening at port 20939
Servant 66155: loaded dataset, cities KASTAMONU-KUTAHYA
2022/06/15|10:37:31|Servant 66155 is present at the port 20048 handling cities KASTAMONU-KUTAHYA
Servant 66155: Dataset Information is sent to Server
Servant 66155: listening at port 20048
Servant 66156: loaded dataset, cities MALATYA-ORDU
Servant 66157: loaded dataset, cities OSMANIYE-SIVAS
Servant 66156: Dataset Information is sent to Server
2022/06/15|10:37:31|Servant 66156 is present at the port 20057 handling cities MALATYA-ORDU
Servant 66156: listening at port 20057
Servant 66157: Dataset Information is sent to Server
2022/06/15|10:37:31|Servant 66157 is present at the port 20066 handling cities OSMANIYE-SIVAS
Servant 66157: listening at port 20066
Client: I have loaded 10 requests and I'm creating 10 threads.
Client-Thread-0: Thread-0 has been created
Client-Thread-1: Thread-1 has been created
Client-Thread-2: Thread-2 has been created
Client-Thread-3: Thread-3 has been created
Client-Thread-4: Thread-4 has been created
Client-Thread-5: Thread-5 has been created
Client-Thread-6: Thread-6 has been created
Client-Thread-7: Thread-7 has been created
Client-Thread-8: Thread-8 has been created
Client-Thread-9: Thread-9 has been created
Client-Thread-9: I am requesting "clnt IMALATHANE 04-06-2004 11-11-2011 ISPARTA"
Client-Thread-2: I am requesting "clnt DUKKAN 20-04-2000 23-01-2031 KILIS"
Client-Thread-4: I am requesting "clnt FIDANLIK 02-09-2016 12-09-2081 BALIKESIR"
Client-Thread-1: I am requesting "clnt MERA 03-02-2018 09-11-2050 "
Client-Thread-8: I am requesting "clnt VILLA 22-04-2049 20-03-2061"
Client-Thread-0: I am requesting "clnt FARUKA 22-07-2004 11-05-2072 ANKARA "
Client-Thread-6: I am requesting "clnt FABRIKA 22-07-2004 11-05-2072 ANKARA"
Client-Thread-7: I am requesting "clnt AMBAR 28-01-2044 13-09-2050 AKSARAY"
Client-Thread-5: I am requesting "clnt BAKCE 02-03-2005 17-01-2084"
2022/06/15|10:37:34|Request arrived "IMALATHANE 04-06-2004 11-11-2011 ISPARTA"
2022/06/15|10:37:34|Request arrived "FIDANLIK 02-09-2016 12-09-2081 BALIKESIR"
2022/06/15|10:37:34|Contacting servant 66154
2022/06/15|10:37:34|Request arrived "DUKKAN 20-04-2000 23-01-2031 KILIS"
2022/06/15|10:37:34|Contacting servant 66150
2022/06/15|10:37:34|Request arrived "MERA 03-02-2018 09-11-2050 "
2022/06/15|10:37:34|Contacting servant 66155
2022/06/15|10:37:34|Contacting ALL servants.
2022/06/15|10:37:34|Request arrived "FABRIKA 22-07-2004 11-05-2072 ANKARA"
2022/06/15|10:37:34|Contacting servant 66149
Servant 66150: Request Received from Server: MERA|736633|748589
Servant 66155: Request Received from Server: DUKKAN|730140|741368|KILIS
Servant 66150: Request Received from Server: FIDANLIK|736112|758047|BALIKESIR
2022/06/15|10:37:34|Response received: 1, forwarded to client.
Servant 66155: Sent response to server:1
2022/06/15|10:37:34|Response received: 3, forwarded to client.
Client-Thread-2: The server's response to "clnt DUKKAN 20-04-2000 23-01-2031 KILIS" is 1
Servant 66150: Sent response to server:23
Servant 66154: Request Received from Server: IMALATHANE|731641|734356|ISPARTA
2022/06/15|10:37:34|Request arrived "AMBAR 28-01-2044 13-09-2050 AKSARAY"
2022/06/15|10:37:34|Contacting servant 66149
Servant 66150: Sent response to server:3
2022/06/15|10:37:34|Response received: 4, forwarded to client.
Servant 66154: Sent response to server:4
Client-Thread-2: Terminating.
Client-Thread-9: The server's response to "clnt IMALATHANE 04-06-2004 11-11-2011 ISPARTA" is 4
Client-Thread-4: The server's response to "clnt FIDANLIK 02-09-2016 12-09-2081 BALIKESIR" is 3
2022/06/15|10:37:34|Request arrived "VILLA 22-04-2049 20-03-2061"
Client-Thread-9: Terminating.
2022/06/15|10:37:34|Contacting ALL servants.
Servant 66149: Request Received from Server: FABRIKA|731692|756441|ANKARA
Servant 66149: Request Received from Server: AMBAR|746118|748533|AKSARAY
2022/06/15|10:37:34|Response received: 0, forwarded to client.
Servant 66158: Request Received from Server: VILLA|748027|752375
2022/06/15|10:37:34|Request arrived "FARUKA 22-07-2004 11-05-2072 ANKARA"
2022/06/15|10:37:34|Contacting ALL servants.
Client-Thread-7: The server's response to "clnt AMBAR 28-01-2044 13-09-2050 AKSARAY" is 0
Servant 66149: Sent response to server:0
Client-Thread-4: Terminating.
Servant 66150: Sent response to server:8
2022/06/15|10:37:34|Response received: 4, forwarded to client.
Client-Thread-6: The server's response to "clnt FABRIKA 22-07-2004 11-05-2072 ANKARA" is 4
2022/06/15|10:37:34|Request arrived "FARUKA 22-07-2004 11-05-2072 ANKARA "
2022/06/15|10:37:34|Contacting servant 66149
Client-Thread-6: Terminating.
Servant 66150: Request Received from Server: VILLA|748027|752375
Client-Thread-7: Terminating.
Servant 66149: Request Received from Server: BAKCE|731917|760707
2022/06/15|10:37:34|Request arrived "MERA 03-02-2018 09-11-2050 "
2022/06/15|10:37:34|Contacting servant 66149
Servant 66151: Request Received from Server: MERA|736633|748589
Servant 66151: Sent response to server:18
Servant 66152: Request Received from Server: MERA|736633|748589
Servant 66152: Sent response to server:20
Servant 66154: Request Received from Server: MERA|736633|748589
Servant 66154: Sent response to server:9
Servant 66151: Request Received from Server: VILLA|748027|752375
Servant 66151: Sent response to server:9
Servant 66151: Request Received from Server: BAKCE|731917|760707
Servant 66158: Request Received from Server: MERA|736633|748589
Servant 66158: Sent response to server:12
Servant 66151: Sent response to server:44
Servant 66151: Sent response to server:2
Servant 66152: Request Received from Server: VILLA|748027|752375
Servant 66152: Sent response to server:2
Servant 66155: Request Received from Server: MERA|736633|748589
Servant 66155: Request Received from Server: BAKCE|731917|760707
Servant 66155: Sent response to server:15
Servant 66154: Request Received from Server: VILLA|748027|752375
Servant 66155: Sent response to server:38
Servant 66154: Sent response to server:1
Servant 66156: Request Received from Server: MERA|736633|748589
Servant 66154: Request Received from Server: BAKCE|731917|760707
Servant 66158: Request Received from Server: VILLA|748027|752375
Servant 66156: Sent response to server:13
Servant 66154: Sent response to server:37
Client-Thread-3: The server's response to "clnt BAG 01-12-2004 27-09-2089 ADIYAMAN" is 9
Servant 66150: Sent response to server:6
Client-Thread-3: Terminating.
Servant 66150: Request Received from Server: BAKCE|731917|760707
Servant 66157: Request Received from Server: MERA|736633|748589
Servant 66158: Sent response to server:44
Servant 66157: Sent response to server:23
2022/06/15|10:37:34|Response received: 158, forwarded to client.
Client-Thread-1: The server's response to "clnt MERA 03-02-2018 09-11-2050 " is 158
Client-Thread-1: Terminating.
Servant 66155: Request Received from Server: VILLA|748027|752375
Servant 66155: Sent response to server:3
Servant 66157: Request Received from Server: BAKCE|731917|760707
Servant 66155: Sent response to server:32
Servant 66156: Request Received from Server: VILLA|748027|752375
Servant 66156: Sent response to server:5
Servant 66156: Request Received from Server: BAKCE|731917|760707
Servant 66157: Request Received from Server: VILLA|748027|752375
Servant 66156: Sent response to server:35
2022/06/15|10:37:34|Response received: 29, forwarded to client.
Servant 66157: Sent response to server:6
Servant 66157: Request Received from Server: BAKCE|731917|760707
Servant 66157: Sent response to server:39
2022/06/15|10:37:34|Response received: 343, forwarded to client.
Client-Thread-5: The server's response to "clnt BAKCE 02-03-2005 17-01-2084" is 343
Client-Thread-5: Terminating.
Client-Thread-8: The server's response to "clnt VILLA 22-04-2049 20-03-2061" is 29
Client-Thread-8: Terminating.
Client: All threads have terminated, goodbye.
```

Changing Server thread amount doesn't affect the output.

Test Case 4

Same with Test Case 3 but there are 5 different Client's each has different number of transaction count requests (total of 70 requests)

Result: Output is too large to give, it works as expected. (Passed)

SIGINT to Server

```
2022/06/15|10:44:17|SIGINT has been received. I handled a total of 10 requests. Goodbye.
Servant 67293: termination message received, handled 7 requests in total.
Servant 67294: termination message received, handled 4 requests in total.
Servant 67300: termination message received, handled 3 requests in total.
Servant 67302: termination message received, handled 3 requests in total.
Servant 67298: termination message received, handled 4 requests in total.
gokbey@gokbey-ABRA-A5-V15-3:~/Desktop/sysprog_final/src$ Servant 67297: termination message received, handled 3 requests in total.
Servant 67301: termination message received, handled 3 requests in total.
Servant 67296: termination message received, handled 3 requests in total.
Servant 67299: termination message received, handled 4 requests in total.
```

Additional Note: You can find the function manuals inside the header files.