



# UNIVERSITY OF DHAKA

Department of Computer Science and Engineering

CSE-3111 : Computer Networking Lab

Lab Report 4 : Distributed Database Management,  
Implementation of Iterative, and Recursive Queries of  
DNS Records.

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# 1 Introduction

## 1.1 Objectives

The primary objective of this lab is to provide students with comprehensive hands-on experience in the setup and management of a Domain Name System (DNS) server, coupled with the implementation and comparison of iterative and recursive DNS resolution methods. Through practical exercises, participants will delve into the intricacies of configuring a DNS server, creating and managing DNS records, and subsequently developing scripts or programs to execute DNS queries. By scrutinizing the performance metrics and intricacies of iterative versus recursive resolution techniques across various scenarios, students will gain a nuanced understanding of DNS operation efficiency, while also discerning the distinct advantages, disadvantages, and security ramifications inherent to each method.

# 2 Theory of Distributed Database Management and DNS Queries

This section provides a theoretical overview of distributed database management systems (DDBMS) and the implementation of iterative and recursive queries for DNS (Domain Name System) records.

## 2.1 Distributed Database Management

- **Concepts:** Distributed database management involves the storage and management of data across multiple interconnected nodes or locations.
- **Advantages:** DDBMS offers benefits such as improved data availability, scalability, fault tolerance, and better performance through data replication and distribution.
- **Architecture:** DDBMS typically comprises distributed database servers, network infrastructure, and middleware for communication and coordination.

## 2.2 DNS (Domain Name System)

- **Functionality:** DNS is a hierarchical decentralized naming system that translates domain names into IP addresses, facilitating the navi-

gation of the internet.

- **Records:** DNS records contain information mapping domain names to IP addresses (A records), mail servers (MX records), aliases (CNAME records), and other resource records.
- **Resolution Process:** DNS resolution involves iterative or recursive queries to DNS servers to obtain IP addresses associated with domain names.

### 2.3 Implementation of Iterative DNS Queries

- **Iterative Query Process:** In iterative DNS resolution, a DNS client sends queries to DNS servers sequentially, and each server responds with the best information it has or refers the client to another server.
- **Implementation Steps:** Implementing iterative DNS queries involves sending queries to DNS servers, processing responses, and following referrals until the desired IP address is obtained or a timeout occurs.

### 2.4 Implementation of Recursive DNS Queries

- **Recursive Query Process:** In recursive DNS resolution, a DNS client sends a query to a DNS server, which then recursively queries other servers on behalf of the client until it obtains the IP address or determines it does not exist.
- **Implementation Steps:** Implementing recursive DNS queries requires a DNS server capable of recursively querying other DNS servers, processing responses, and caching results to improve performance.

### 2.5 Comparison of Iterative and Recursive Queries

- **Efficiency:** Iterative queries may involve multiple round-trip communications but provide more control over the resolution process. Recursive queries delegate resolution to DNS servers but may incur higher latency.
- **Scalability:** Recursive queries offload resolution tasks to DNS servers, making them suitable for large-scale environments. Iterative queries distribute workload to clients but may overwhelm servers with frequent queries.

## 2.6 Security Considerations

- **Cache Poisoning:** Both iterative and recursive DNS resolution methods are vulnerable to cache poisoning attacks, where malicious data is inserted into DNS caches to redirect traffic.
- **Encryption:** Implementing DNS over HTTPS (DoH) or DNS over TLS (DoT) can enhance security by encrypting DNS traffic and preventing eavesdropping or tampering.

## 3 Methodology

This section outlines the methodology followed to conduct the lab experiment on distributed database management and the implementation of iterative and recursive queries for DNS records.

### 3.1 Setup and Configuration

1. **Environment Setup:** Configure a network environment comprising multiple machines to simulate distributed database management and DNS resolution scenarios.
2. **Database Setup:** Install and configure distributed database management software (e.g., MySQL Cluster, Apache Cassandra) on designated server nodes to create distributed database instances.
3. **DNS Server Setup:** Set up a DNS server (e.g., BIND, dnsmasq) on a separate server node to handle DNS queries and host DNS records for domain resolution.

### 3.2 Experiment Design

1. **Database Experiment:** Design experiments to assess the performance and scalability of distributed database management systems. Consider factors such as data distribution, replication strategies, query processing, and fault tolerance mechanisms.
2. **DNS Query Experiment:** Define experiments to evaluate the effectiveness and efficiency of iterative and recursive DNS queries. Vary parameters such as query types, domain names, DNS server configurations, and network conditions.

### 3.3 Implementation of Iterative DNS Queries

1. **Programming Language Selection:** Choose a suitable programming language with robust networking capabilities - Python for implementing iterative DNS query scripts.
2. **Socket Programming:** Utilize the socket API to create client-side scripts that send iterative DNS queries to DNS servers and process responses sequentially.
3. **Error Handling:** Implement error handling mechanisms to handle connection timeouts, DNS server unavailability, and other network-related issues during iterative query execution.

### 3.4 Implementation of Recursive DNS Queries

1. **DNS Server Configuration:** Configure the DNS server to support recursive queries and enable caching to improve query resolution performance.
2. **Client-Side Scripting:** Develop client-side scripts using a suitable programming language to send recursive DNS queries to the DNS server and handle responses.
3. **Caching Mechanism:** Implement caching mechanisms in the client script to store resolved DNS records and optimize subsequent query resolutions.

### 3.5 Experiment Execution

1. **Database Experiment:** Execute experiments on the distributed database setup to measure performance metrics such as query latency, throughput, scalability, and fault tolerance under varying loads and configurations.
2. **DNS Query Experiment:** Conduct experiments to compare the performance of iterative and recursive DNS queries in terms of query resolution time, network overhead, and scalability across different scenarios.

### 3.6 Data Collection and Analysis

1. **Database Experiment Data:** Collect experimental data including query execution times, throughput, and system resource utilization metrics from the distributed database environment.
2. **DNS Query Experiment Data:** Gather data on DNS query resolution times, network traffic, and server load for both iterative and recursive query methods.
3. **Analysis:** Analyze collected data to evaluate the effectiveness, efficiency, and scalability of distributed database management systems and DNS query resolution methods. Compare results to draw conclusions and identify any performance bottlenecks or areas for improvement.

### 3.7 Reporting

1. **Documentation:** Document experimental setup details, methodology, results, and analysis in a comprehensive lab report.
2. **Presentation:** Prepare a presentation summarizing the lab experiment, key findings, and conclusions for presentation to peers or instructors.

## 4 Experimental Result

### 4.1 Task 1

- Setting up the DNS server

```
1      SERVER SIDE CODE
2
3  import socket
4
5  class IPSearch:
6      list = []
7
8      def create_list():
9          ins = IPSearch("cse.du.ac.bd.", "ns1.cse.du.ac.bd.", "NS", "86400")
10             IPSearch.list.append(ins)
11             ins3 = IPSearch("ns2.cse.du.ac.bd.", "192.0.2.2", "A", "86400")
```

```

12     IPSearch.list.append(ins3)
13     ins4 = IPSearch("ns1.cse.du.ac.bd.", "2001:db8::1", "AAAA", "86400")
14     IPSearch.list.append(ins4)
15     ins5 = IPSearch("ns2.cse.du.ac.bd.", "2001:db8::2", "AAAA", "86400")
16     IPSearch.list.append(ins5)
17     ins6 = IPSearch("cse.du.ac.bd.", "192.0.2.3", "A", "86400")
18     IPSearch.list.append(ins6)
19     ins7 = IPSearch("cse1.du.ac.bd.", "2001:db8::3", "AAAA", "86400")
20     IPSearch.list.append(ins7)
21     ins8 = IPSearch("www.cse.du.ac.bd.", "cse.du.ac.bd.", "CNAME", "86400")
22     IPSearch.list.append(ins8)
23     ins9 = IPSearch("cse2.du.ac.bd.", "10 mail.cse.du.ac.bd.", "MX", "86400")
24     IPSearch.list.append(ins9)
25     ins10 = IPSearch("mail.cse.du.ac.bd.", "192.0.2.4", "A", "86400")
26     IPSearch.list.append(ins10)
27
28
29     def __init__(self, Name, Value, Type, TTL):
30         self.Name = Name
31         self.Value = Value
32         self.Type = Type
33         self.TTL = TTL
34
35     class Server:
36         def search(s):
37             ret = 0
38             rs = "nf"
39             for item in IPSearch.list:
40                 if item.Name == s:
41                     rs = item.Type
42                     break
43
44             if rs.strip() == "NS":
45                 return 1
46             elif rs.strip() == "MX":
47                 return 5
48             elif rs.strip() == "nf":
49                 return 0
50             elif rs.strip() == "CNAME":
51                 return 2

```



```

52         elif rs.strip() == "AAAA":
53             return 3
54         elif rs.strip() == "A":
55             return 4
56         return ret
57
58
59     # def search1(s):
60     #     ret = 0
61     #     rs = "nf"
62     #     for item in IPSearch.list:
63     #         if item.Name == s:
64     #             rs = item.Type
65     #             break
66
67     #     if rs.strip() == "NS":
68     #         return 1
69     #     elif rs.strip() == "MX":
70     #         return 5
71     #     elif rs.strip() == "nf":
72     #         return 0
73     #     elif rs.strip() == "CNAME":
74     #         return 2
75     #     elif rs.strip() == "AAAA":
76     #         return 3
77     #     elif rs.strip() == "A":
78     #         return 4
79     #     return ret
80
81     def main():
82         IPSearch.create_list()
83         response = "Welcome to CSE 3111!"
84         port = 1500
85         server_socket = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
86         server_socket.bind((socket.gethostname(), port))
87         print("Domain server Started")
88         buffer_size = 1024
89
90         while True:
91             buffer, client_address = server_socket.recvfrom(buffer_size)

```

```

92         message = buffer.decode().strip()
93         print("Client message:", message)
94         flag = Server.search(message)
95         print(flag)
96
97         if flag == 0:
98             response = "Not Found"
99         elif flag == 1:
100             response = "NS type domain found"
101         elif flag == 2:
102             response = "Cname type domain found"
103         elif flag == 3:
104             response = "AAAA type domain found"
105         elif flag == 4:
106             response = "A type domain found"
107             # response = IPSearch.list[IPSearch.index].Value
108         elif flag == 5:
109             response = "MX type domain found"
110
111         server_socket.sendto(response.encode(), client_address)
112
113     server_socket.close()
114
115 if __name__ == "__main__":
116     Server.main()
117
118

```

1        CLIENT SIDE CODE

```

2  import socket
3
4  def string_to_binary(input_string):
5      binary_representation = ' '.join(format(ord(char), '08b') for char in input_string)
6      return binary_representation
7
8
9
10 udp_socket = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
11 message = "mail.cse.du.ac.bd."
12

```

```

13  buffer = message.encode('utf-8')
14  server_address = ('10.42.0.74', 1500)
15
16
17  udp_socket.sendto(buffer, server_address)
18
19  buffer, server_address = udp_socket.recvfrom(1024)
20  response = buffer.decode('utf-8')
21
22  binary_result = string_to_binary(response)
23  print(f"Server Response : After Encode : {binary_result}")
24
25
26  print("Server response: After Decode : ", response)
27
28  udp_socket.close()
29

```

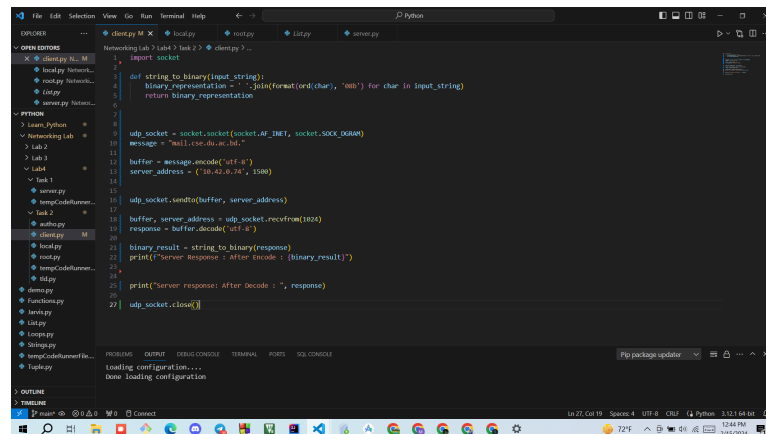


Figure 1: Client side code

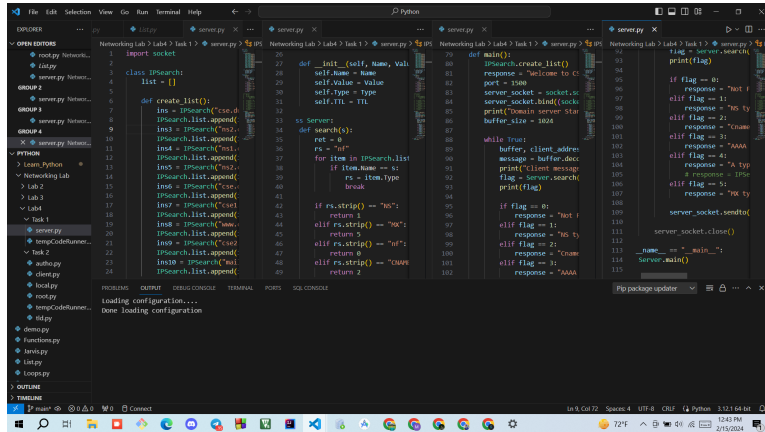


Figure 2: Server Side Code

## 4.2 Task 2

- Iterative DNS resolution.

```

1      Local SERVER SIDE CODE
2
3  import socket
4  import struct
5
6  def main():
7      # Create a UDP socket
8      socket_server = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
9      socket_server.bind(('localhost', 5000))
10
11     while True:
12         # Receive message from client
13         receive_data, address = socket_server.recvfrom(1024)
14         message_length = struct.unpack('!I', receive_data[:4])[0]
15         domain = receive_data[4:4+message_length].decode('utf-8')
16         print("Received from client:", domain)
17
18         # Send message to Root DNS Server
19         root_dns_address = ('localhost', 7000)
20         send_message(socket_server, root_dns_address, domain)
21

```

```

22     # Receive message from Root DNS Server
23     root_dns_response = receive_message(socket_server)
24
25     # Send message to TLD DNS Server
26     tld_dns_address = ('localhost', 9876)
27     send_message(socket_server, tld_dns_address, "0.0.0.1")
28
29     # Receive message from TLD DNS Server
30     tld_dns_response = receive_message(socket_server)
31
32     # Send message to Authoritative DNS Server
33     auth_dns_address = ('localhost', 9000)
34     send_message(socket_server, auth_dns_address, "0.0.1.0")
35
36     # Receive message from Authoritative DNS Server
37     auth_dns_response = receive_message(socket_server)
38
39     # Send message back to client
40     #client_address = (address[0], 5000)
41     send_message(socket_server, address, "0.0.1.0")
42
43     socket_server.close()
44
45     def send_message(socket_server, address, ip):
46         message_bytes = ip.encode('utf-8')
47         message_length = len(message_bytes)
48         buffer = struct.pack('!HBBI', 1, 2, 2, message_length) + message_bytes
49         print("Sending to", address[0] + ":", ip)
50         socket_server.sendto(buffer, address)
51
52     def receive_message(socket_server):
53         receive_data, address = socket_server.recvfrom(1024)
54         message_length = struct.unpack('!I', receive_data[:4])[0]
55         ip = receive_data[4:4+message_length].decode('utf-8')
56         print("Received from", address[0] + ":", ip)
57         return ip
58
59     if __name__ == "__main__":
60         main()
61

```

62

```
1      Root SERVER SIDE CODE
2
3      import socket
4      import struct
5
6      def main():
7          # Create a UDP socket
8          socket_server = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
9          socket_server.bind(('localhost', 7000))
10
11         # Receive message from Local DNS Server
12         receive_data, address = socket_server.recvfrom(1024)
13         message_length = struct.unpack('!I', receive_data[:4])[0]
14         domain = receive_data[4:4+message_length].decode('utf-8')
15         print("Received from Local DNS:", domain)
16
17         # Sending message to Local DNS Server
18         IP = "0.0.0.1"
19         message_bytes = IP.encode('utf-8')
20         message_length = len(message_bytes)
21
22         buffer = struct.pack('!HBI', 1, 2, 2, message_length) + message_bytes
23
24         print("Sending to Local DNS:", IP)
25         socket_server.sendto(buffer, ('localhost', 5000))
26
27         socket_server.close()
28
29     if __name__ == "__main__":
30         main()
31
32
33     TLD SERVER SIDE CODE
34
35     import socket
36     import struct
37
38     def main():
```

```

7      # Create a UDP socket
8      socket_server = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
9      socket_server.bind(('localhost', 9876))
10
11     while True:
12         # Receive message from Local DNS Server
13         receive_data, address = socket_server.recvfrom(1024)
14         message_length = struct.unpack('!I', receive_data[:4])[0]
15         domain = receive_data[4:4+message_length].decode('utf-8')
16         print("Receiving from local DNS:", domain)
17
18         # Send message from Local DNS Server
19         IP = "0.0.1.0"
20         send_message(socket_server, ('localhost', 5000), IP)
21
22     socket_server.close()
23
24     def send_message(socket_server, address, ip):
25         message_bytes = ip.encode('utf-8')
26         message_length = len(message_bytes)
27         buffer = struct.pack('!HBB', 1, 2, 2, message_length) + message_bytes
28         print("Sending to Local DNS:", ip)
29         socket_server.sendto(buffer, address)
30
31     if __name__ == "__main__":
32         main()
33
34

```

```

1      Authoritative SERVER SIDE CODE
2
3      import socket
4      import struct
5
6      def main():
7          # Create a UDP socket
8          socket_server = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
9          socket_server.bind(('localhost', 9000))
10
11         while True:

```

```

12     # Receive message from Local DNS Server
13     receive_data, address = socket_server.recvfrom(1024)
14     message_length = struct.unpack('!I', receive_data[:4])[0]
15     domain = receive_data[4:4+message_length].decode('utf-8')
16     print("Receiving from local DNS:", domain)
17
18     # Send message from Local DNS Server
19     IP = "1.0.2.1"
20     send_message(socket_server, ('localhost', 5000), IP)
21
22     socket_server.close()
23
24     def send_message(socket_server, address, ip):
25         message_bytes = ip.encode('utf-8')
26         message_length = len(message_bytes)
27         buffer = struct.pack('!HBBi', 1, 2, 2, message_length) + message_bytes
28         print("Sending to Local DNS:", ip)
29         socket_server.sendto(buffer, address)
30
31     if __name__ == "__main__":
32         main()
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17
18     socket_client.sendto(send_data, server_address)
19
20     # Receiving IP from the Local DNS Server
21     receive_data, server = socket_client.recvfrom(1024)
22     message_length, = struct.unpack("!i", receive_data[:4])
23     IP = receive_data[4:message_length + 4].decode('utf-8')
24     print("Received IP:", IP)
25
26     socket_client.close()
27
28 if __name__ == "__main__":
29     main()
30

```

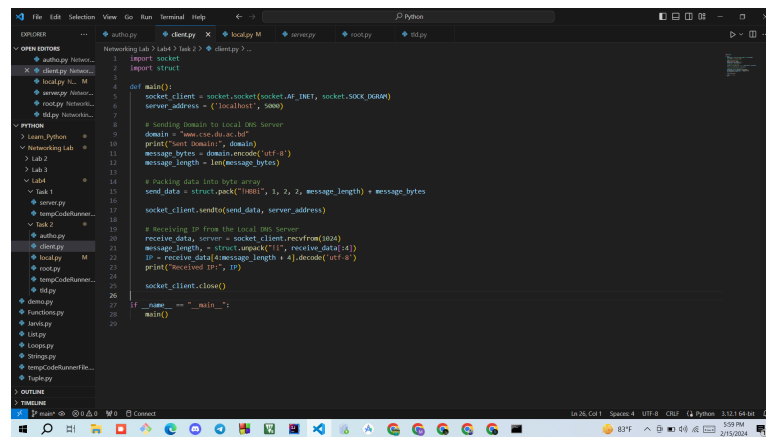


Figure 3: Client side code

```

1  # Import socket
2  import socket
3  import struct
4
5  def main():
6      # Create a UDP socket
7      socket_server = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
8      socket_server.bind(("localhost", 5000))
9
10     while True:
11         # Receive message from client
12         receive_data, address = socket_server.recvfrom(1024)
13         message_length = struct.unpack('I', receive_data[4:8])[0]
14         domain = receive_data[8:message_length].decode('utf-8')
15         print("Received from client:", domain)
16
17         # Send message to Root DNS Server
18         root_dns_address = ("localhost", 7000)
19         send_message(socket_server, root_dns_address, domain)
20
21         # Receive message from Root DNS Server
22         root_dns_response = receive_message(socket_server)
23
24         # Send message to TLD DNS Server
25         tld_dns_address = ("localhost", 8000)
26         send_message(socket_server, tld_dns_address, "0.0.0.0")
27
28         # Receive message from TLD DNS Server
29         tld_dns_response = receive_message(socket_server)
30
31         # Send message to Authoritative DNS Server
32         auth_dns_address = ("localhost", 9000)
33         send_message(socket_server, auth_dns_address, "0.0.0.0")
34
35         # Receive message from authoritative DNS Server
36         auth_dns_response = receive_message(socket_server)
37
38         # Send message back to client
39         # (root address = address[0], 5000)
40         send_message(socket_server, address, "0.0.0.0")
41
42     socket_server.close()
43
44 def send_message(socket_server, address, ip):
45     message_bytes = ip.encode('utf-8')
46     message_length = len(message_bytes)
47     buffer = struct.pack('IHHI', 1, 2, 2, message_length) + message_bytes
48     print("Sending to", address[0], ":", IP)
49     socket_server.sendto(buffer, address)
50
51 def receive_message(socket_server):
52     receive_data, address = socket_server.recvfrom(1024)
53     message_length = struct.unpack('I', receive_data[4:8])[0]
54     ip = receive_data[8:message_length].decode('utf-8')
55     print("Received from", address[0], ":", ip)
56     return ip
57
58 if __name__ == "__main__":
59     main()

```

Figure 4: Local Server Side Code

```

1  # Import socket
2  import socket
3
4  def main():
5      # Create a UDP socket
6      socket_server = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
7      socket_server.bind(("localhost", 7000))
8
9      # Receive message from Local DNS Server
10     receive_data, address = socket_server.recvfrom(1024)
11     message_length = struct.unpack('I', receive_data[4:8])[0]
12     domain = receive_data[8:message_length].decode('utf-8')
13     print("Received from Local DNS:", domain)
14
15     # Sending message to Local DNS Server
16     IP = "0.0.0.0"
17     message_bytes = ip.encode('utf-8')
18     message_length = len(message_bytes)
19     buffer = struct.pack('IHHI', 1, 2, 2, message_length) + message_bytes
20     print("Sending to Local DNS:", IP)
21     socket_server.sendto(buffer, ("localhost", 5000))
22
23     socket_server.close()
24
25 if __name__ == "__main__":
26     main()

```

Figure 5: Root Server Side Code

```

1 import socket
2 import struct
3
4 def main():
5     # Create a UDP socket
6     socket_server = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
7     socket_server.bind(('localhost', 5000))
8
9     while True:
10        # Receive message from local DNS server
11        receive_data, address = socket_server.recvfrom(1024)
12        message_length = struct.unpack('!I', receive_data[4:8])[0]
13        domain = receive_data[8:message_length].decode('utf-8')
14        print("Receiving from local DNS:", domain)
15
16        # Send message from local DNS server
17        IP = "8.8.8.8"
18        send_message(socket_server, ('localhost', 5000), IP)
19
20    socket_server.close()
21
22 def send_message(socket_server, address, ip):
23     message_bytes = ip.encode('utf-8')
24     message_length = len(message_bytes)
25     buffer = struct.pack('!I', 1, 2, 2, message_length) + message_bytes
26     print("Sending to local DNS:", ip)
27     socket_server.sendto(buffer, address)
28
29 if __name__ == "__main__":
30     main()
31

```

Figure 6: TLD Server Side Code

```

1 import socket
2 import struct
3
4 def main():
5     # Create a UDP socket
6     socket_server = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
7     socket_server.bind(('localhost', 5000))
8
9     while True:
10        # Receive message from local DNS server
11        receive_data, address = socket_server.recvfrom(1024)
12        message_length = struct.unpack('!I', receive_data[4:8])[0]
13        domain = receive_data[8:message_length].decode('utf-8')
14        print("Receiving from local DNS:", domain)
15
16        # Send message from local DNS server
17        IP = "8.8.8.8"
18        send_message(socket_server, ('localhost', 5000), IP)
19
20    socket_server.close()
21
22 def send_message(socket_server, address, ip):
23     message_bytes = ip.encode('utf-8')
24     message_length = len(message_bytes)
25     buffer = struct.pack('!I', 1, 2, 2, message_length) + message_bytes
26     print("Sending to local DNS:", ip)
27     socket_server.sendto(buffer, address)
28
29 if __name__ == "__main__":
30     main()
31

```

Figure 7: Authoritative Server Side Code

```
C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19045.3398]
(c) Microsoft Corporation. All rights reserved.

C:\Python\PythonNetworking\lab1\lab4>task 2>python -u client.py
Sent Domain: www.cse.du.ac.bd
Received IP: 8.8.8.8
C:\Python\PythonNetworking\lab1\lab4>
```

Figure 8: Client Result side code

```
C:\Windows\System32\cmd.exe python -u local.py
Microsoft Windows [Version 10.0.19045.3398]
(c) Microsoft Corporation. All rights reserved.

C:\Python\PythonNetworking\lab1\lab4>task 2>python -u local.py
Received from client: www.cse.du.ac.bd
Sending to localhost: www.cse.du.ac.bd
Received from 127.0.0.1: 8.8.8.8
Sending to localhost: 8.8.8.8
Received from 127.0.0.1: 8.8.8.8
Sending to localhost: 8.8.8.8
Received from 127.0.0.1: 1.9.2.1
Sending to 127.0.0.1: 8.8.8.8
C:\Python\PythonNetworking\lab1\lab4>
```

Figure 9: Local Result Server Side Code

```
C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19045.3306]
(c) Microsoft Corporation. All rights reserved.

C:\Python\PythonNetworker\Lab1\Lab4\Task 2>python -u root.py
Receiving from Local DB: 0.0.0.1
Sending to Local DB: 0.0.0.1

C:\Python\PythonNetworker\Lab1\Lab4\Task 2>
```

Figure 10: Root Result Server Side Code

```
C:\Windows\System32\cmd.exe python -u tld.py
Microsoft Windows [Version 10.0.19045.3306]
(c) Microsoft Corporation. All rights reserved.

C:\Python\PythonNetworker\Lab1\Lab4\Task 2>python -u tld.py
Receiving from Local DB: 0.0.0.1
Sending to Local DB: 0.0.0.1

C:\Python\PythonNetworker\Lab1\Lab4\Task 2>
```

Figure 11: TLD Result Server Side Code

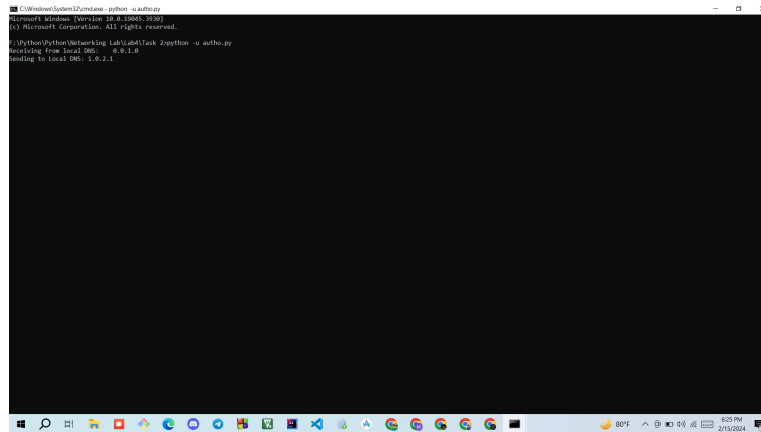


Figure 12: Authoritative Result Server Side Code

### 4.3 Task 3

#### – Recursive DNS resolution

```

1      Local DNS SERVER SIDE CODE
2
3      import socket
4      import struct
5
6      def main():
7          server_socket = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
8          server_socket.bind(('localhost', 5000))
9
10         # Receive message from client
11         receive_data, client_address = server_socket.recvfrom(1024)
12         received_buffer = memoryview(receive_data)
13
14         message_length = struct.unpack('!I', received_buffer[:4])[0]
15         domain = received_buffer[4:4+message_length].tobytes().decode('utf-8')
16         print("Received from client:", domain)
17
18         # Send message to Root DNS Server
19         root_dns_address = ('localhost', 7000)
20         root_ip = "0.0.0.0"
21

```

```

22     print("Sending to Root DNS:", root_ip)
23
24     message_bytes2 = root_ip.encode('utf-8')
25     message_length2 = len(message_bytes2)
26
27     send_data = struct.pack('!HBI', 1, 2, 2, message_length2) + message_byt
28
29     server_socket.sendto(send_data, root_dns_address)
30
31     # Receive message from Root DNS Server
32     receive_data2, _ = server_socket.recvfrom(1024)
33     received_buffer2 = memoryview(receive_data2)
34
35     message_length3 = struct.unpack('!I', received_buffer2[:4])[0]
36     domain2 = received_buffer2[4:4+message_length3].tobytes().decode('utf-8')
37     print("Received from Root DNS:", domain2)
38
39     # Send message to client
40     client_ip = "1.1.1.1"
41
42     print("Sending to Client:", client_ip)
43
44     message_bytes5 = client_ip.encode('utf-8')
45     message_length5 = len(message_bytes5)
46
47     send_data2 = struct.pack('!HBI', 1, 2, 2, message_length5) + message_by
48
49     server_socket.sendto(send_data2, client_address)
50
51     if __name__ == "__main__":
52         main()
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```

```

6     server_socket = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
7     server_socket.bind(('localhost', 7000))
8
9     # Receive message from Local DNS Server
10    receive_data, local_dns_address = server_socket.recvfrom(1024)
11    received_buffer = memoryview(receive_data)
12
13    message_length = struct.unpack('!I', received_buffer[:4])[0]
14    domain = received_buffer[4:4+message_length].tobytes().decode('utf-8')
15    print("Received from Local DNS:", domain)
16
17    # Send message to Root TLD DNS Server
18    tld_dns_address = ('localhost', 9800)
19    tld_ip = "0.0.1.0"
20
21    print("Sending to TLD DNS:", tld_ip)
22
23    message_bytes2 = tld_ip.encode('utf-8')
24    message_length2 = len(message_bytes2)
25
26    send_data = struct.pack('!HBB', 1, 2, 2, message_length2) + message_bytes2
27
28    server_socket.sendto(send_data, tld_dns_address)
29
30    # Receive message from TLD DNS Server
31    receive_data2, _ = server_socket.recvfrom(1024)
32    received_buffer2 = memoryview(receive_data2)
33
34    message_length3 = struct.unpack('!I', received_buffer2[:4])[0]
35    domain2 = received_buffer2[4:4+message_length3].tobytes().decode('utf-8')
36    print("Received from TLD DNS:", domain2)
37
38    # Send message to Local DNS Server
39    local_dns_ip = "1.1.1.1"
40
41    print("Sending to Local DNS:", local_dns_ip)
42
43    message_bytes5 = local_dns_ip.encode('utf-8')
44    message_length5 = len(message_bytes5)
45

```



```

46     send_data2 = struct.pack('!HBBi', 1, 2, 2, message_length5) + message_by
47
48     server_socket.sendto(send_data2, local_dns_address)
49
50 if __name__ == "__main__":
51     main()
52
53
1     TLD DNS SERVER SIDE CODE
2     import socket
3     import struct
4
5     def main():
6         server_socket = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
7         server_socket.bind(('localhost', 9800))
8
9         # Receive message from Root DNS Server
10        receive_data, root_dns_address = server_socket.recvfrom(1024)
11        received_buffer = memoryview(receive_data)
12
13        message_length = struct.unpack('!I', received_buffer[:4])[0]
14        domain = received_buffer[4:4+message_length].tobytes().decode('utf-8')
15        print("Received from Root DNS:", domain)
16
17        # Send message to Auth DNS Server
18        auth_dns_address = ('localhost', 9000)
19        auth_ip = "1.1.0.0"
20
21        print("Sending to Auth DNS:", auth_ip)
22
23        message_bytes2 = auth_ip.encode('utf-8')
24        message_length2 = len(message_bytes2)
25
26        send_data = struct.pack('!HBBi', 1, 2, 2, message_length2) + message_byt
27
28        server_socket.sendto(send_data, auth_dns_address)
29
30        # Receive message from Auth DNS Server
31        receive_data2, _ = server_socket.recvfrom(1024)

```

```

32     received_buffer2 = memoryview(receive_data2)
33
34     message_length3 = struct.unpack('!I', received_buffer2[:4])[0]
35     domain2 = received_buffer2[4:4+message_length3].tobytes().decode('utf-8')
36     print("Received from Auth DNS:", domain2)
37
38     # Send message to Root DNS Server
39     root_dns_ip = "1.1.1.1"
40
41     print("Sending to Root DNS:", root_dns_ip)
42
43     message_bytes5 = root_dns_ip.encode('utf-8')
44     message_length5 = len(message_bytes5)
45
46     send_data2 = struct.pack('!HBI', 1, 2, 2, message_length5) + message_by
47
48     server_socket.sendto(send_data2, root_dns_address)
49
50 if __name__ == "__main__":
51     main()
52
53
54 1     Authoritative DNS SERVER SIDE CODE
55 2     import socket
56 3     import struct
57 4
58 5     def main():
59 6         # Receiving message from TLD DNS Server
60 7         server_socket = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
61 8         server_socket.bind(('localhost', 9000))
62 9
63 10        receive_data, address = server_socket.recvfrom(1024)
64 11        received_buffer = memoryview(receive_data)
65 12
66 13        message_length = struct.unpack('!I', received_buffer[:4])[0]
67 14        domain = received_buffer[4:4+message_length].tobytes().decode('utf-8')
68 15        print("Received from TLD DNS:", domain)
69 16
70 17        # Sending message to TLD DNS Server
71 18        client_socket = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)

```

```

19
20     ip = "1.1.1.1"
21     message_bytes2 = ip.encode('utf-8')
22     message_length2 = len(message_bytes2)
23
24     print("Sending to TLD DNS:", ip)
25
26     send_data = struct.pack('!HBI', 1, 2, 2, message_length2) + message_byt
27
28     client_socket.sendto(send_data, ('localhost', 9800))
29
30     server_socket.close()
31     client_socket.close()
32
33     if __name__ == "__main__":
34         main()
35
36
1     Client SIDE CODE
2     import socket
3     import struct
4
5     def main():
6         client_socket = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
7         server_address = ('localhost', 5000)
8
9         # Sending Domain to Local DNS Server
10        domain = "www.cse.du.ac.bd"
11        print("Sending domain:", domain)
12        message_bytes = domain.encode('utf-8')
13        message_length = len(message_bytes)
14
15        send_data = struct.pack('!HBI', 1, 2, 2, message_length) + message_byte
16
17        client_socket.sendto(send_data, server_address)
18
19        # Receiving IP from the Local DNS Server
20        receive_data, _ = client_socket.recvfrom(1024)
21        received_buffer = memoryview(receive_data)

```

```

22
23     query_id2, query_type2, query_class2, message_length2 = struct.unpack('!'
24     message_bytes2 = received_buffer[8:8+message_length2].tobytes()
25     received_ip = message_bytes2.decode('utf-8')
26
27     print("Received IP:", received_ip)
28
29     client_socket.close()
30
31 if __name__ == "__main__":
32     main()
33
34

```

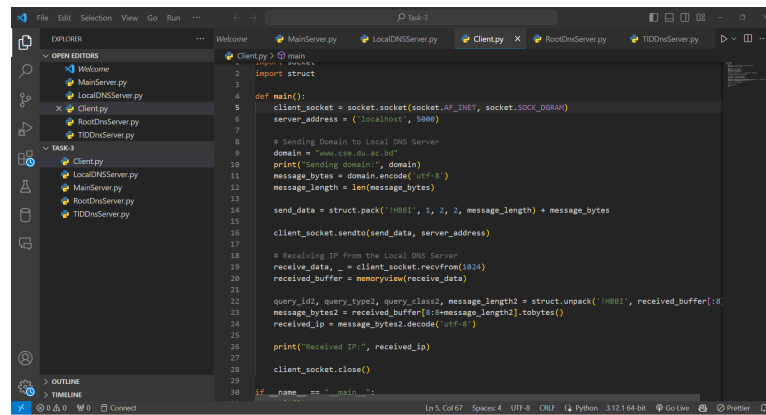


Figure 13: Client side code



```

1  #!/usr/bin/env python
2  import socket
3  import struct
4
5  def main():
6      server_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
7      server_socket.bind((localhost, 8080))
8
9      # Receiving message from Root DNS Server
10     receive_data, root_dns_address = server_socket.recvfrom(1024)
11     received_buffer = memoryview(receive_data)
12
13     message_length = struct.unpack('I', received_buffer[4:8])[0]
14     domain = received_buffer[8:message_length].tobytes().decode('utf-8')
15     print("Received from Root DNS:", domain)
16
17     # Sending message to Root DNS Server
18     auth_dns_address = (localhost, 8080)
19     auth_ip = "1.1.1.1"
20     print("Sending to Root DNS:", auth_ip)
21     message_bytes2 = auth_ip.encode('utf-8')
22     message_length2 = len(message_bytes2)
23     send_data = struct.pack('!HHI', 1, 1, 2, message_length2) + message_bytes2
24     server_socket.sendto(send_data, auth_dns_address)
25
26     # Receiving message from Root DNS Server
27     receive_data2 = server_socket.recvfrom(1024)
28     received_buffer2 = memoryview(receive_data2)
29
30     message_length3 = struct.unpack('I', received_buffer2[4:8])[0]
31     domain2 = received_buffer2[8:message_length3].tobytes().decode('utf-8')
32     print("Received from Root DNS:", domain2)
33
34     # Sending message to Root DNS Server
35     root_dns_ip = "1.1.1.1"
36     print("Sending to Root DNS:", root_dns_ip)
37     message_bytes3 = root_dns_ip.encode('utf-8')
38     message_length3 = len(message_bytes3)
39     send_data2 = struct.pack('!HHI', 1, 1, 2, message_length3) + message_bytes3
40

```

Figure 16: TLD DNS Server Side Code

```

1  #!/usr/bin/env python
2  import socket
3  import struct
4
5  def main():
6      # Receiving message from TLD DNS Server
7      server_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
8      server_socket.bind((localhost, 8080))
9
10     receive_data, address = server_socket.recvfrom(1024)
11     received_buffer = memoryview(receive_data)
12
13     message_length = struct.unpack('I', received_buffer[4:8])[0]
14     domain = received_buffer[8:message_length].tobytes().decode('utf-8')
15     print("Received from TLD DNS:", domain)
16
17     # Sending message to TLD DNS Server
18     client_socket = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
19
20     ip = "1.1.1.1"
21     message_bytes2 = ip.encode('utf-8')
22     message_length2 = len(message_bytes2)
23     print("Sending to TLD DNS:", ip)
24
25     send_data = struct.pack('!HHI', 1, 1, 2, message_length2) + message_bytes2
26     client_socket.sendto(send_data, (localhost, 8080))
27
28     server_socket.close()
29     client_socket.close()
30
31 if __name__ == "__main__":
32     main()
33

```

Figure 17: Authoritative Server Side Code

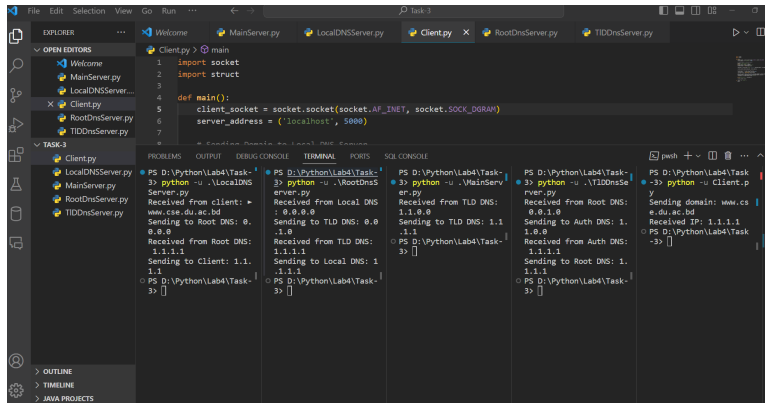


Figure 18: Result

## 5 Experience

1. Configuring the DNS server to act as an authoritative server for a domain (e.g., cse.du.ac.bd) involves understanding and defining the necessary records (A, AAAA, CNAME, MX).
2. We have create multiple server , thats why we needs more than one terminal
3. First we run all DNS server side program and then client request server for specific task
4. Creating a tree of DNS servers with parent and child relationships provides a structured approach to DNS hierarchy.
5. Ensuring the script accurately follows the DNS resolution path and retrieves the correct IP address may encounter challenges in parsing responses.
6. Verifying the correct implementation of recursive DNS resolution requires monitoring the entire resolution process.

## References

- [1] DNS basic -<https://aws.amazon.com/route53/what-is-dns>
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