**Chandransh Singh** **22CS30017**

# CLDP (Custom Lightweight Discovery Protocol)

## Specification

### 1. Introduction

The Custom Lightweight Discovery Protocol (CLDP) is a simple protocol designed for node discovery and metadata exchange in a network. It operates over raw sockets using a custom IP protocol number and provides lightweight discovery capabilities via HELLO announcements and QUERY/RESPONSE mechanisms.

### 2. Assumptions and Limitations

- The protocol operates on IPv4.
- It uses a custom IP protocol number (253) for communication.
- The protocol does not implement authentication or encryption.
- The system must allow the creation of raw sockets (requires root privileges in most systems).
- The server sends HELLO announcements every 10 seconds.
- The client listens for HELLO from server(s) for 10 seconds.
- Then the client sends custom query to the active servers.
- Query responses provide metadata such as hostname, system time, and CPU load.
- The maximum payload size is 1024 bytes.

### 3. Message Types

The CLDP protocol defines the following message types:

| Message Type | Code | Description |
|---|---|---|
| HELLO | 0x01 | Announced by servers periodically for discovery. |
| QUERY | 0x02 | Sent by clients to request metadata. |
| RESPONSE | 0x03 | Sent by the server in response to a QUERY message. |

# 4. Message Structure

Each CLDP packet consists of an IP header followed by a CLDP header and an optional payload.

## 4.1 CLDP Header (8 bytes)

| Field | Size (bytes) | Description |
|---|---|---|
| msg_type | 1 | Type of message (HELLO, QUERY, RESPONSE) |
| payload_len | 1 | Length of payload in bytes |
| trans_id | 2 | Unique transaction identifier |
| reserved | 4 | Reserved for future use |

## 4.2 Payload

- **HELLO:** No payload.
- **QUERY:** A 1-byte bitmask indicating requested metadata.
- **RESPONSE:** Variable-length text containing requested metadata.

# 5. Metadata Flags

| Flag Name | Value | Description |
|---|---|---|
| META_HOSTNAME | 0x01 | Request hostname |
| META_TIME | 0x02 | Request system time |
| META_CPULOAD | 0x04 | Request CPU load |

# 6. Packet Exchange

## 6.1 HELLO Announcement

The server broadcasts a HELLO message every 10 seconds to announce its presence.

## 6.2 Query-Response Mechanism

1. **Client Sends Query:**
   - The client constructs a QUERY message, setting the `msg_type` field to `0x02`.
   - A unique `trans_id` is assigned to the request for tracking purposes.
   - The `payload_len` field is set to 1 byte, containing a bitmask representing the requested metadata (e.g., hostname, system time, CPU load).
   - The QUERY message is then sent to the CLDP server using raw sockets.
2. **Server Processes Query:**

- The server receives the QUERY message and extracts the `trans_id` and metadata bitmask from the payload.
- It checks the bitmask to determine which metadata fields are requested.
- The server retrieves the requested metadata:
  - If the `META_HOSTNAME` flag is set, it retrieves the system hostname.
  - If the `META_TIME` flag is set, it fetches the current system time.
  - If the `META_CPULOAD` flag is set, it computes the CPU load.
- The retrieved metadata is formatted into a response payload.

3. **Server Sends Response:**
   - The server constructs a RESPONSE message, setting `msg_type` to `0x03`.
   - The `trans_id` from the QUERY message is copied to the RESPONSE message for correlation.
   - The payload contains the formatted metadata values.
   - The RESPONSE message is sent back to the client using raw sockets.
4. **Client Receives Response:**
   - The client listens for a RESPONSE message from the server.
   - Upon receiving the RESPONSE, it extracts the `trans_id` to match it with the original QUERY request.
   - The client parses the metadata from the payload and processes it accordingly.

## 7. Error Handling

- If a received message has an invalid structure, it is ignored.
- If the requested metadata is unavailable, the server returns an empty RESPONSE.
- Packets from unknown protocols are ignored.

# Build and run instructions

1. run cldp_server in a terminal

```
make rs
```

2. run cldp_client in other terminal

```
make rc
```

> We are using raw sockets and need root( `sudo` ) privileges

# CLDP Validation

# 1. Using `tcpdump`

`tcpdump` is a command-line packet analyzer that can be used to capture raw socket traffic.

## Start Capturing Traffic

Run the following command **before** starting your CLDP server and client:

```
sudo tcpdump -i any proto 253 -vv
```

- `-i any` → Captures packets on all network interfaces.
- `proto 253` → Filters packets using your custom protocol number (253).
- `-vv` → Displays verbose output with packet details.

To save the captured packets for later analysis:

```
sudo tcpdump -i any proto 253 -w cldp_traffic.pcap
```

This saves the packets in a `.pcap` file, which can be analyzed later using Wireshark.

- To stop `tcpdump`, press **Ctrl+C**.

# 2. Using Wireshark

Wireshark is a GUI-based packet analyzer that provides more detailed visualization.

## Start Capturing

1. Open Wireshark.
2. Select the appropriate network interface (e.g., `eth0`, `wlan0`, `lo0`).
3. Apply a capture filter for your custom protocol:

   ```
   ip proto 253
   ```

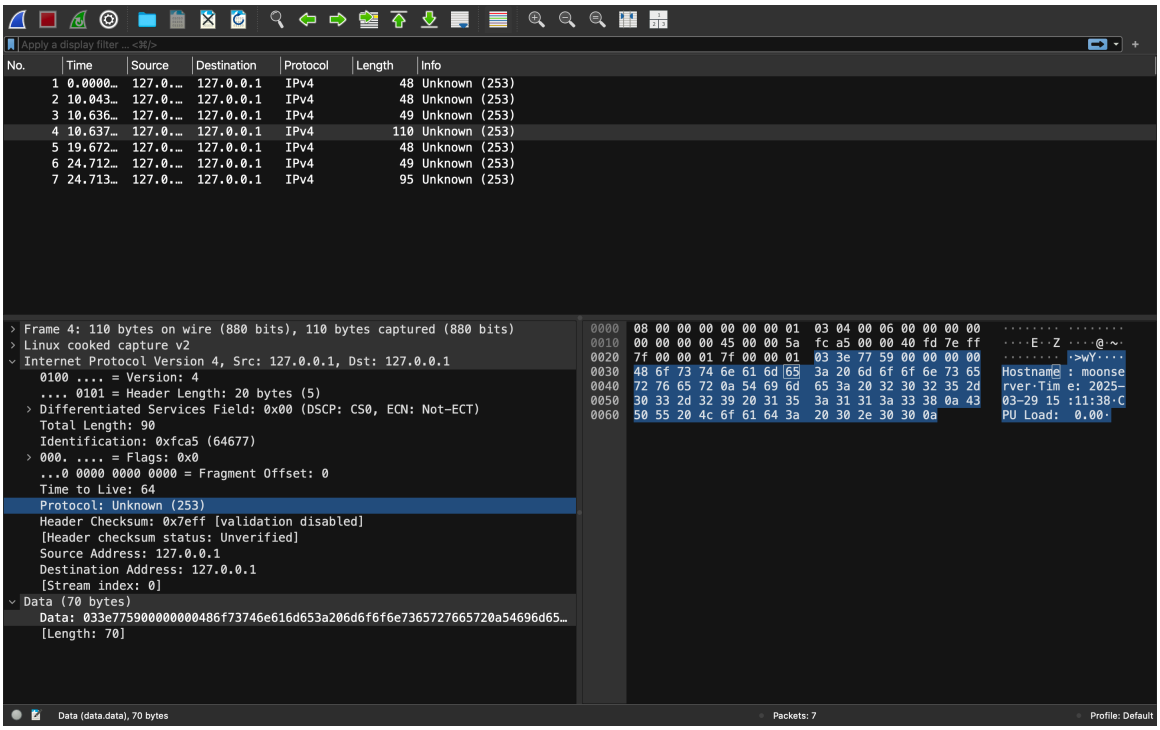
4. Click **Start** to begin capturing packets.

After testing, stop the capture and save the file:

- **File → Save As → cldp_traffic.pcapng**

# Analyze the Packets

- You should see raw packets under **Protocol: IPv4** (since your protocol is at the IP level).
- Expand the IP header section to verify:
  - **Protocol** → 253 (custom protocol)
  - **Source/Destination IPs**
  - **Total length**
  - **Checksum**
- Expand the packet payload section to check your **CLDP message types and payload**.




# Demo output:

## 1. CLDP server

```
gcc -Wall -o s cldp_server.c
sudo ./s
+++ CLDP Server running...
<== Broadcast HELLO sent.
<-- Sent RESPONSE to 127.0.0.1 (trans_id 2824)
<== Broadcast HELLO sent.
<== Broadcast HELLO sent.
<-- Sent RESPONSE to 127.0.0.1 (trans_id 18260)
<== Broadcast HELLO sent.
```

# 2. CLDP client

```
gcc -Wall -o c cldp_client.c
sudo ./c
+++ CLDP Client running...
~~~ Listening for HELLO messages: 6 seconds remaining....
==> Received HELLO from 127.0.0.1
+++ Added new server: 127.0.0.1
~~~ Listening for HELLO messages: 1 seconds remaining...
+++ Found 1 new servers during HELLO listening.
Querying 1 active servers...
>>> Select metadata to request (enter y/n for each option):
Request hostname? (y/n): y
Request system time? (y/n): y
Request CPU load? (y/n): y
<-- Sent QUERY (trans_id 2824) to 127.0.0.1

--> Received RESPONSE from 127.0.0.1:
Hostname: moonserver
Time: 2025-03-29 15:05:48
CPU Load: 0.43

:D Query complete. [1/1] servers responded.

Press Enter to repeat the process or type 'exit' to quit:
~~~ Listening for HELLO messages: 10 seconds remaining...
==> Received HELLO from 127.0.0.1
~~~ Listening for HELLO messages: 4 seconds remaining....
==> Received HELLO from 127.0.0.1
~~~ Listening for HELLO messages: 1 seconds remaining...
`` `No new servers found during HELLO listening.
Querying 1 active servers...
>>> Select metadata to request (enter y/n for each option):
Request hostname? (y/n): y
Request system time? (y/n): y
Request CPU load? (y/n): n
<-- Sent QUERY (trans_id 18260) to 127.0.0.1

--> Received RESPONSE from 127.0.0.1:
Hostname: moonserver
Time: 2025-03-29 15:06:08

:D Query complete. [1/1] servers responded.

Press Enter to repeat the process or type 'exit' to quit: exit
```

> **reference:** A Guide to Using Raw Sockets