

## 【2025 Advanced Computer Networks Homework 4】

### Rules

1. 請在 Ubuntu 24.04 下完成本次作業。
2. 請使用 C 語言(不接受Python) 完成本次作業，並請提供 Makefile 來編譯你的程式。
3. 禁止抄襲任何人的作業。
4. 請將作業壓縮成 zip 或 tar 檔案，命名為 TCPIP\_HW4.zip，並於期限內上傳至中山網路大學。
5. 如果未遵守上述規則，作業以0分計算。
6. TAs email: [net\\_ta@net.nsysu.edu.tw](mailto:net_ta@net.nsysu.edu.tw)
7. Lab: Network & System Laboratory - EC5018 (11:00~17:00)
8. Deadline: 電子檔請於 2025/12/17 9:00 前上傳至網路大學。

### Rules

1. Please finish this homework under Ubuntu 24.04 OS system.
2. You must use C language to complete this homework with makefile.
3. You are not allowed to copy the other's homework. Otherwise, you will fail this course.
4. Compress this assignment to a zip file, and name it "TCPIP\_HW4.zip" and submit it to the Cyber University system before the deadline.
5. If you have any question, please send email to TA at [net\\_ta@net.nsysu.edu.tw](mailto:net_ta@net.nsysu.edu.tw) or drop by Room EC5018 in the duration of 11:00 to 17:00. However, TA will not help you to debug program.
6. Deadline: [2025/12/17 09:00](#)

## Hint

Supposedly, you need to refer source code of *traceroute* to learn how to create an ICMP message and send it out to some host. However, **you are not allowed to paste and copy source code of *traceroute*.**

## Motivation

*Expanding ring search (ERS)*: The ERS is an effective way of finding a route between a source node and a route node. A route node is referred to as either the destination or the node that can offer the route information to the destination. As a controlled flooding technique, ERS is used frequently in reactive routing protocols. Starting typically in a predefined small searching area, the ERS conducts a new search from the source node in an enlarged searching region each time if no route node is found. This incremental searching process continues until a route node is found or the maximum searching area is reached. The search in ERS is performed with flooding involving rebroadcasts through intermediate nodes in a continuous and relay fashion, and it is like a search zone expanding gradually, ring by ring, from a small ring to a large one.

The source node in ERS initializes the flooding and controls the searching area in each extended flooding as well as the maximum searching area. Two control signals, RREQ (Route REQuest) and RREP (Route REPLY), are used in ERS to effectively control the flooding. To minimize flooding, a time-to-live (TTL) mechanism is adopted by ERS. The TTL sequence determines the order of flooding search, and it may be assigned with an increment at a specified value, a fixed value of 1 or 2, or a random value. Fig. 1 shows how a set of flooding regions are controlled by a sequence of predefined TTL values of 1, 2, 3, ..., and  $n$ .

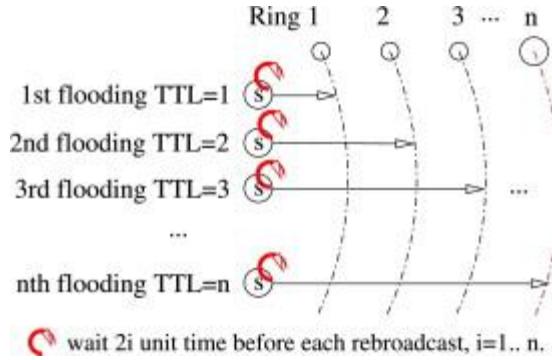


Fig. 1

The TTL-based ERS suffers from an energy inefficiency. As it can be seen from Fig. 1, if no RREP is received by the source node, the source node will rebroadcast a RREQ with an increased TTL value. The rebroadcasting of a new RREQ from the source node each time introduces energy waste. A redundancy happens in the area overlapped with the previously covered searching area. This may happen many times before a route node is found or an entire network is searched.

In this homework, you are asked to implement a basic primitive of ERS which is similar to traceroute. It outputs the router of a given hop-distance to a special destination, and its usage is “*prog hop-distance destination*”. For example, “*prog 3 140.117.11.1*” is to look for the 3-hop far router from the source host on the way to 140.117.11.1 host.