Day 11
Coloring

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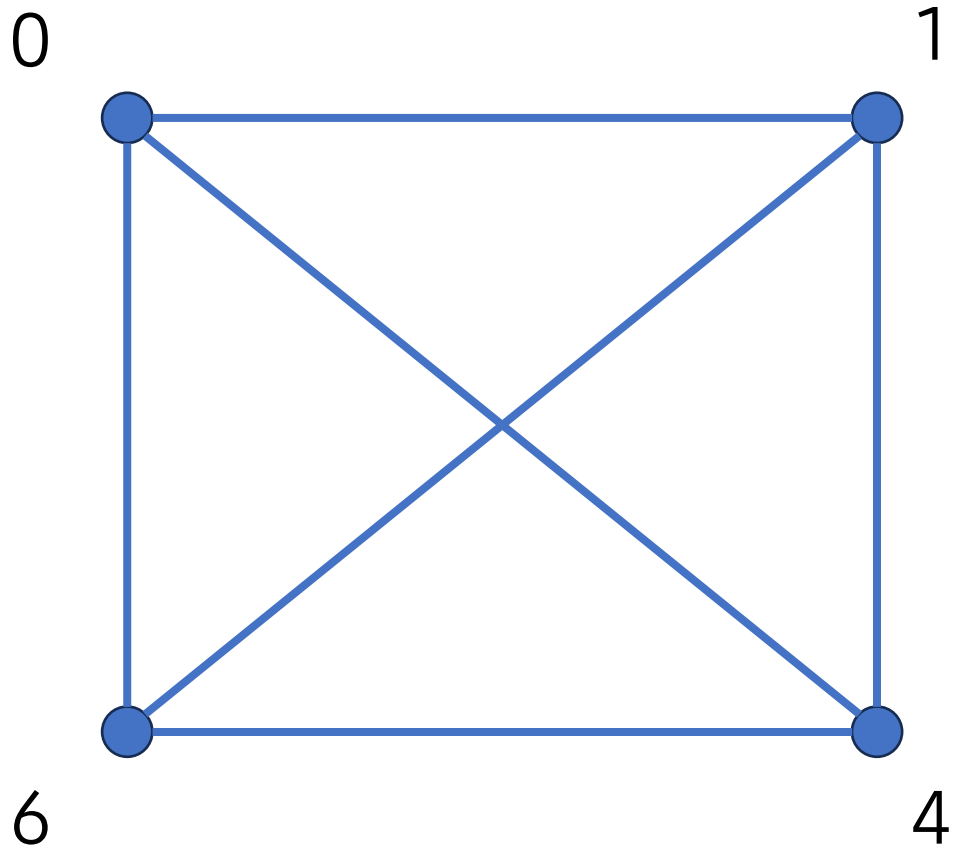
I. Graph labeling
II. Graph coloring
III. Approaches
IV. Examine graph applications in the internet ✨

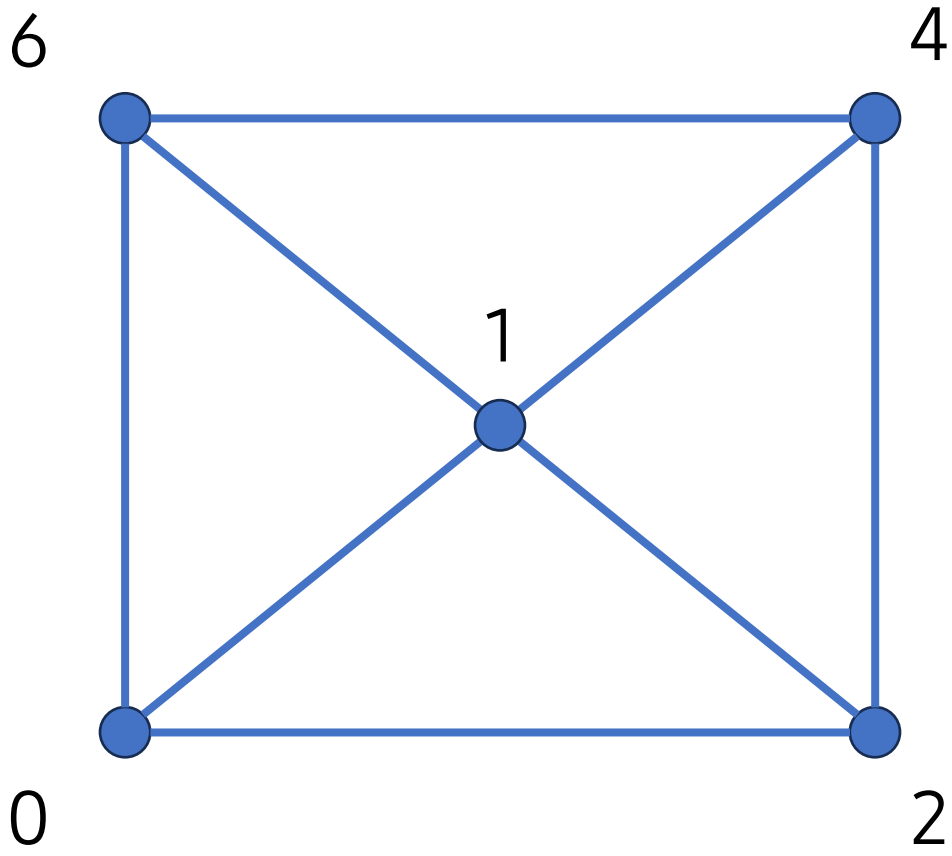
I. Graph labeling

- The job is to giving edges and/or vertices names.
- The problem was first mentioned by Alexander Rosa in 1967.
- Types:
  - β (Graceful) labeling, Edge-graceful labeling 👓
  - Lucky labeling
  - α-labeling
  - ρ-labeling

Graceful labeling

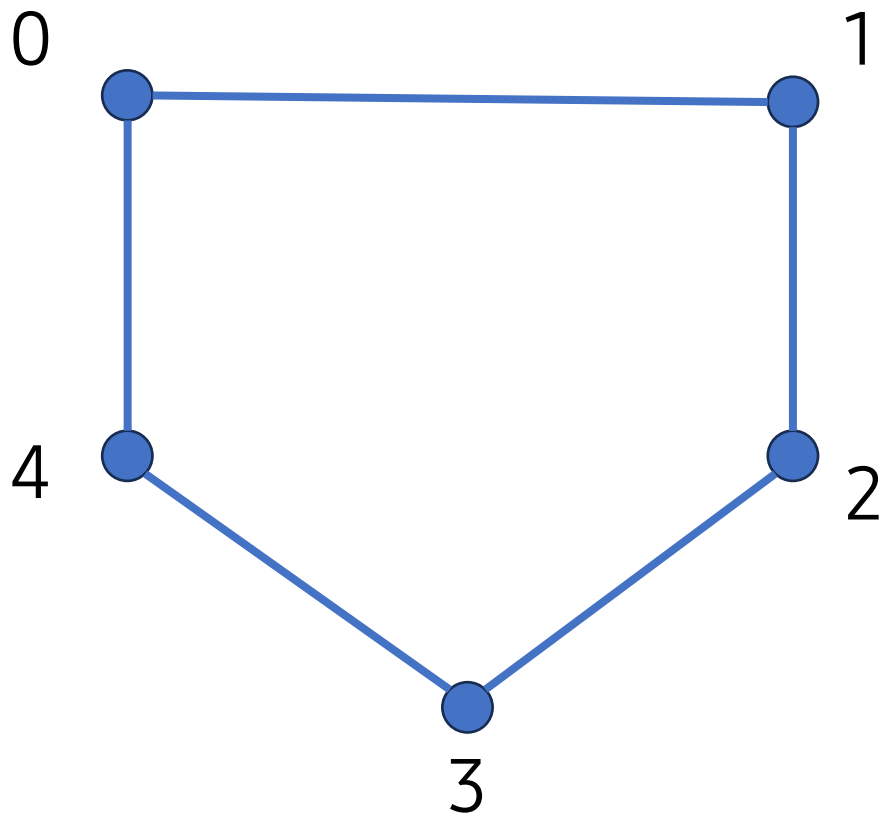
- If $v \in [0, |E|]$ such that:
  - No duplicate naming
  - $w_{v_a v_b} = |v_a - v_b|$ is unique




6
4
1
0
2

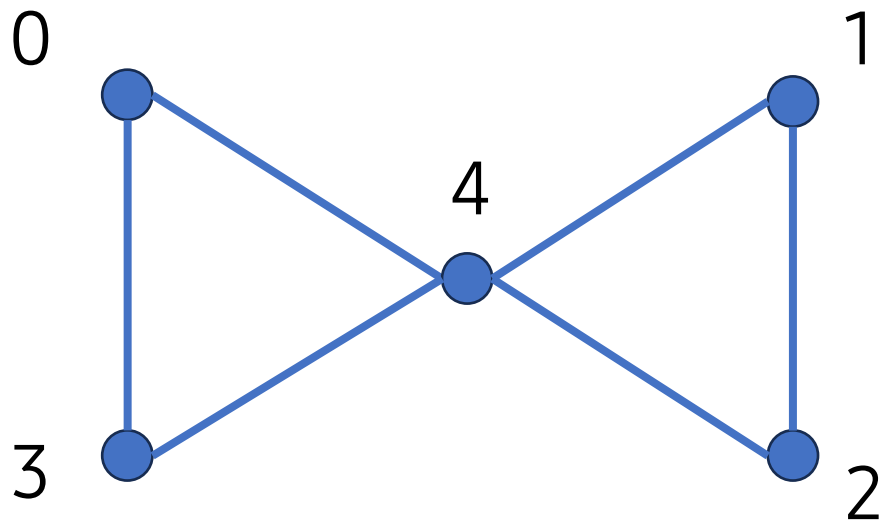
Theorems

1. An Eulerian graph with $\mathrm{mod}_4(|E|) \in \{1,2\}$ cannot be graceful.



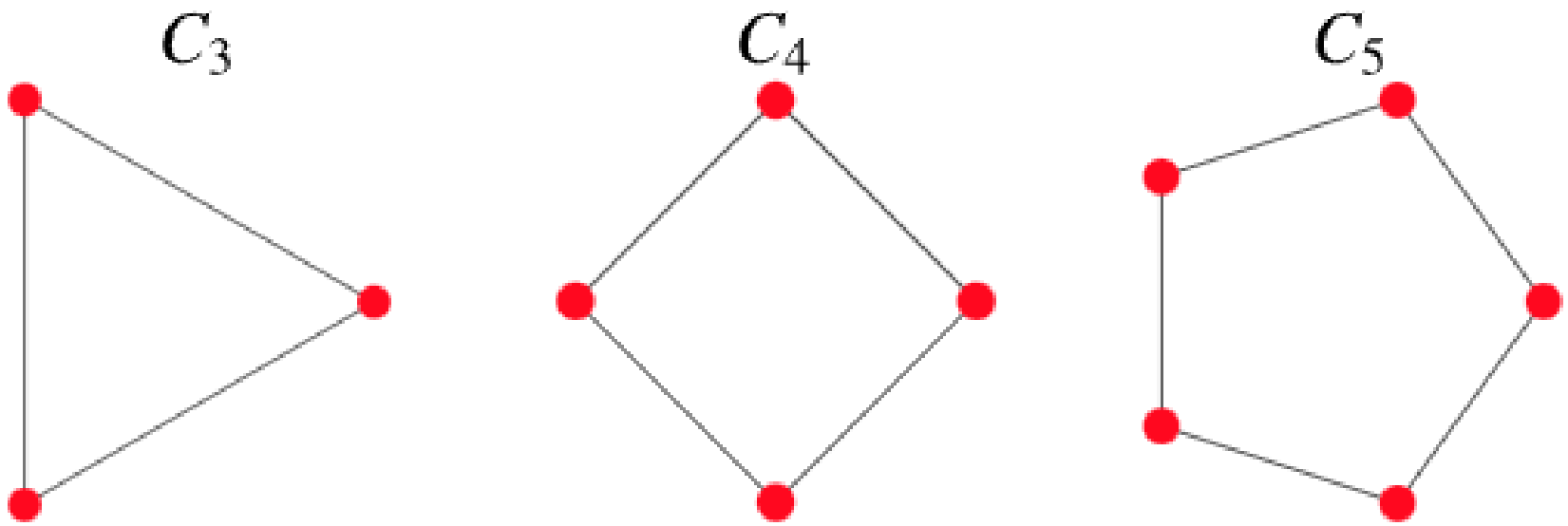
Theorems #1

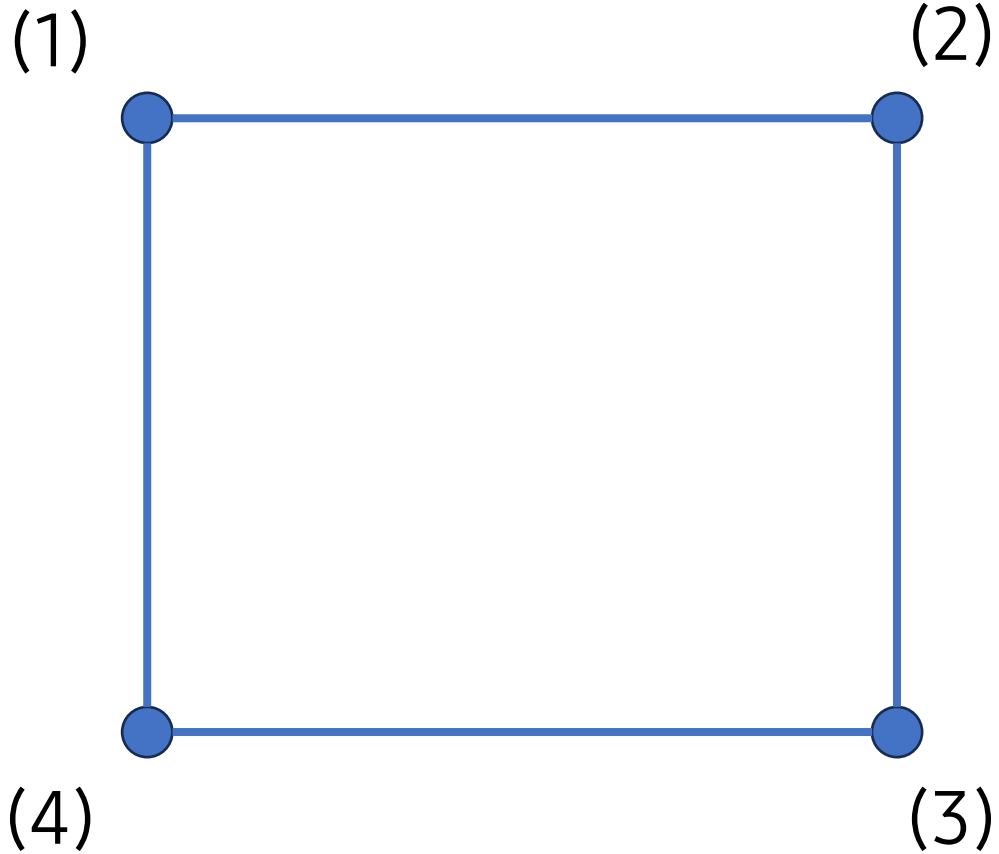
An Eulerian graph with $\mathbf{mod}_4(|E|) \in \{1,2\}$ cannot be graceful.



Theorem #2

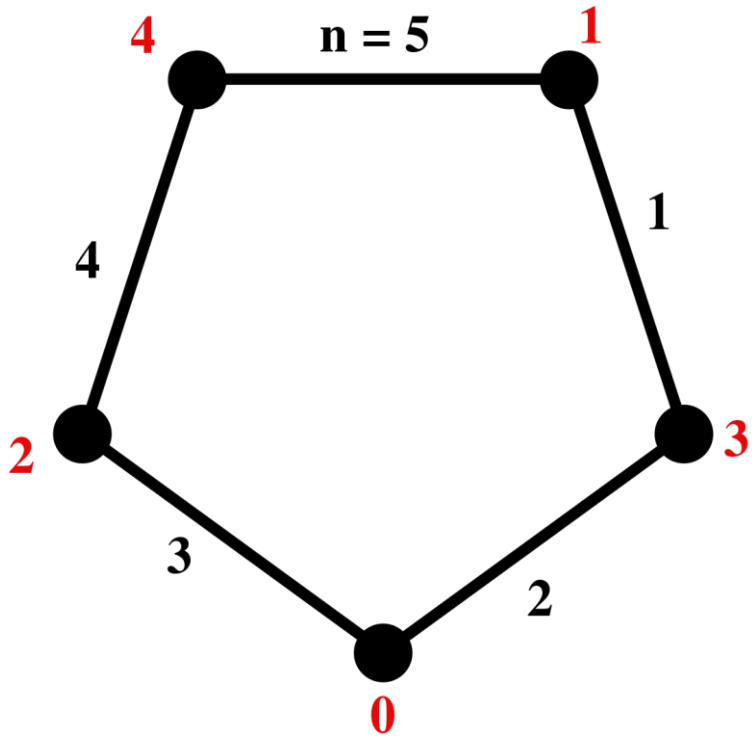
- A cycle graph is graceful iff $\mathrm{mod}_4(|V|) \in \{0,3\}$.



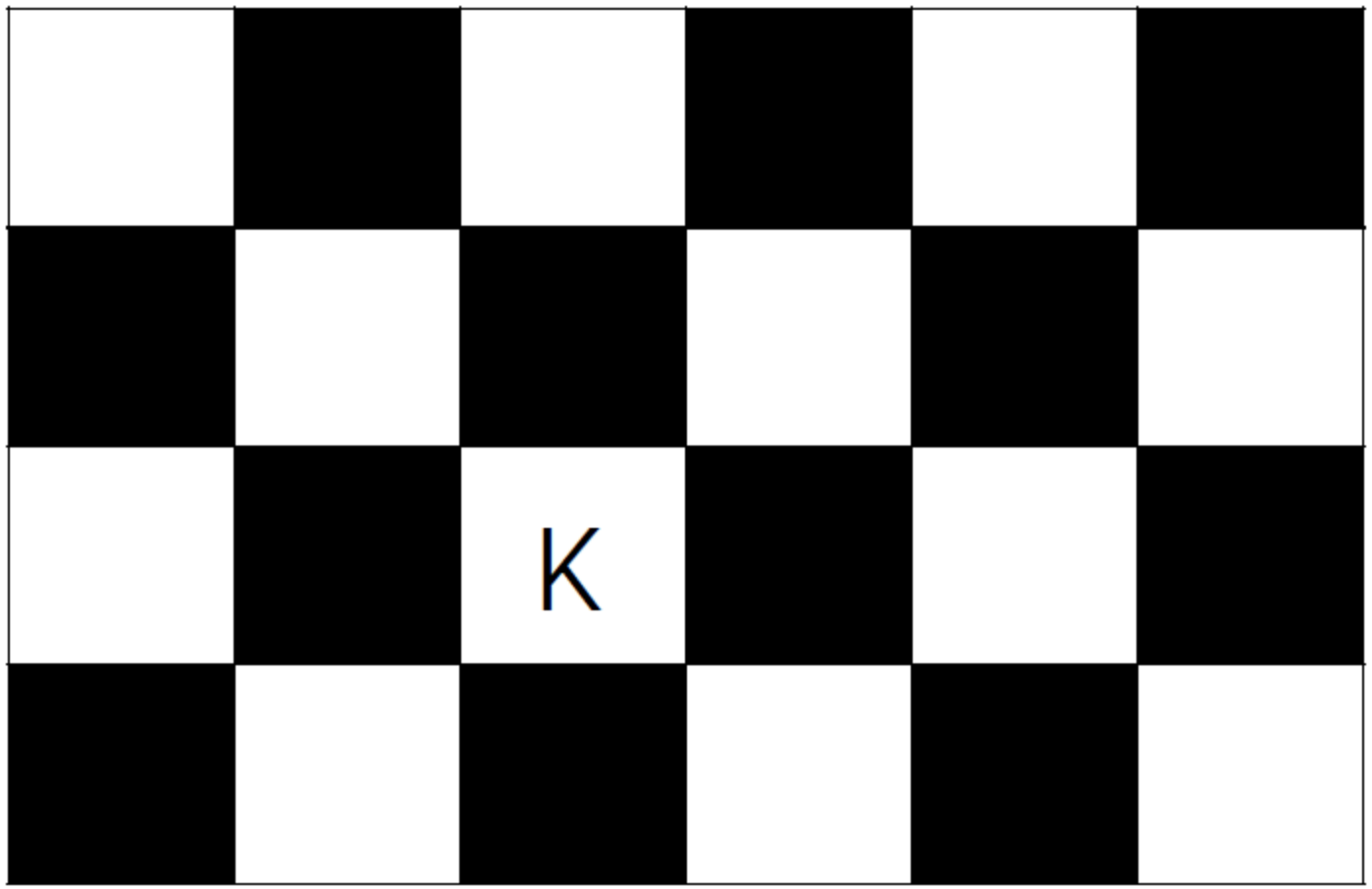

(1)
(2)
(4)
(3)

Edge-graceful labeling

- If $e \in [0, |E|]$ such that:
  - No duplicate naming
  - No edge have same v_a, v_b
  - No edge connecting to a single v_a
  - $v_{e_a e_b} = mod_{|V|}(e_a + e_b)$ is unique

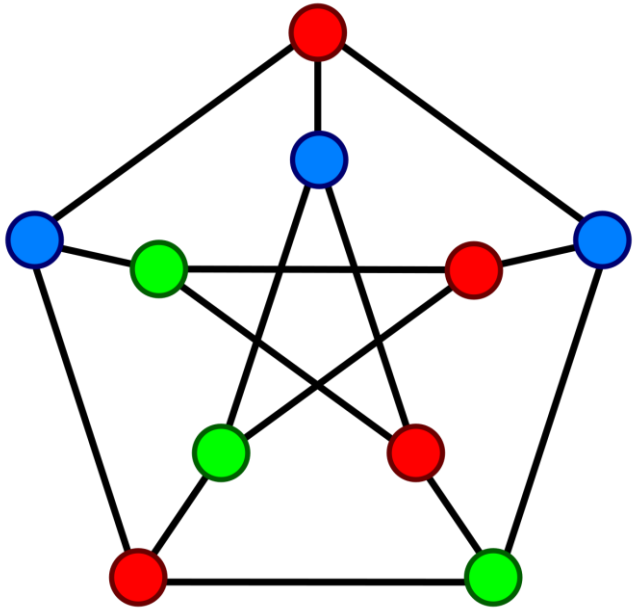


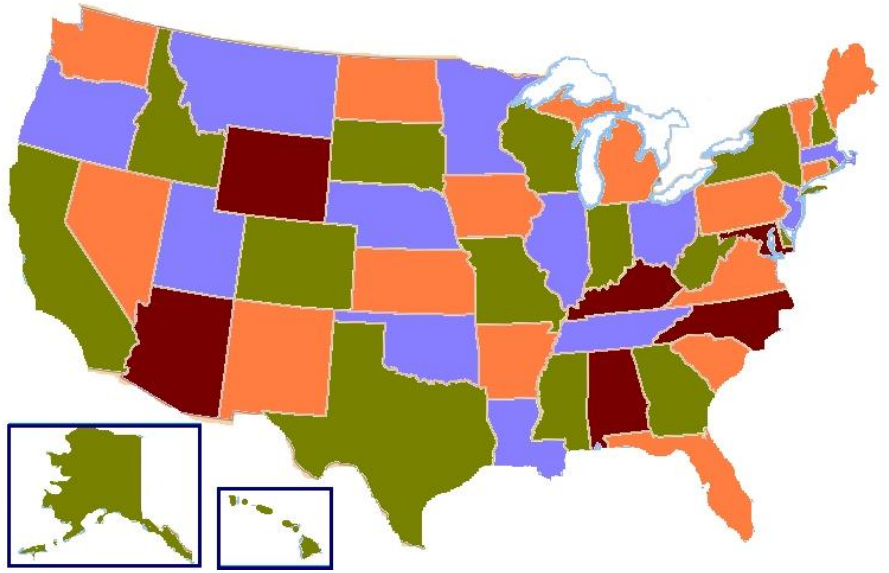
II Graph coloring



The problem

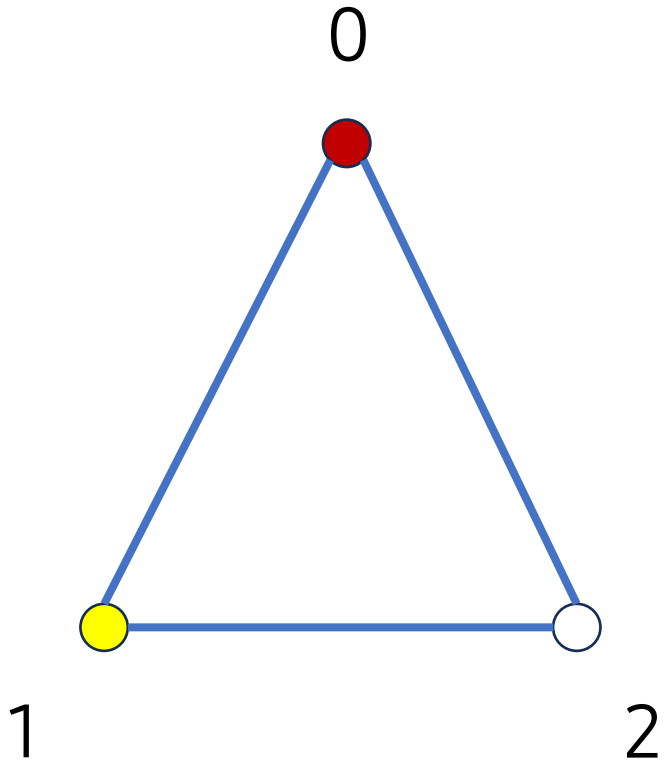
- We want to paint the areas so that no connected areas are colored the same.





Theorems

1. 4-color: You only need no more than 4 colors to solve the problem.
2. 2-color: A graph can be colored with at least 2 colors if it doesn’t contain any odd cycle.



III. Approach: sequential coloring

- Some call it **greedy coloring**.
- The idea is beyond simple: We abstract the colors.
- Preparation:
  - Name nodes in order
  - usedColors = {Null, Null,...}

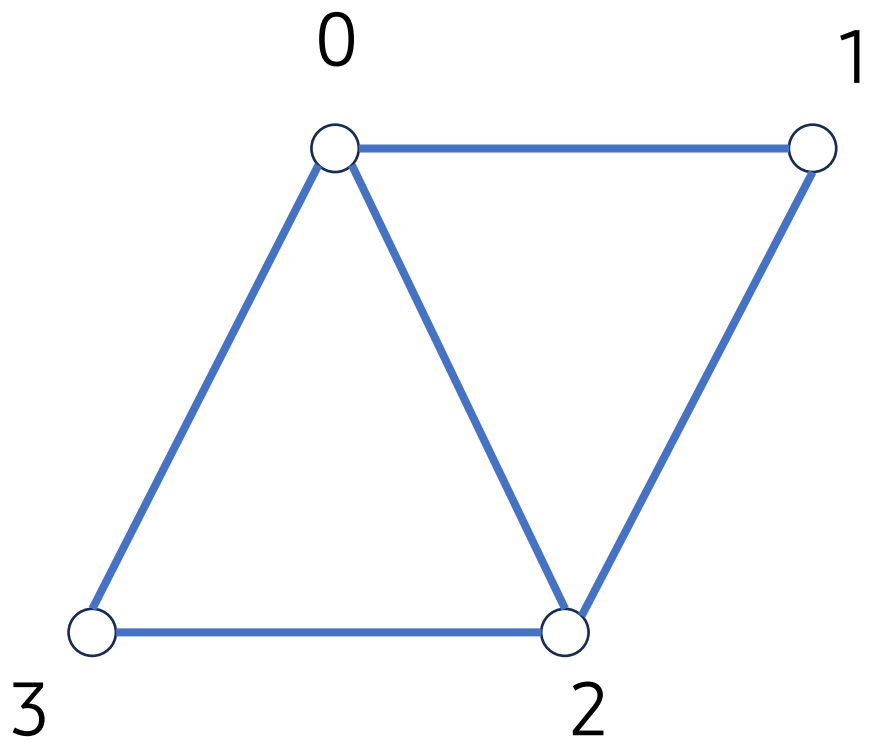
Steps

1. Travel nodes in order:

    usedColors = Used colors by neighbors.

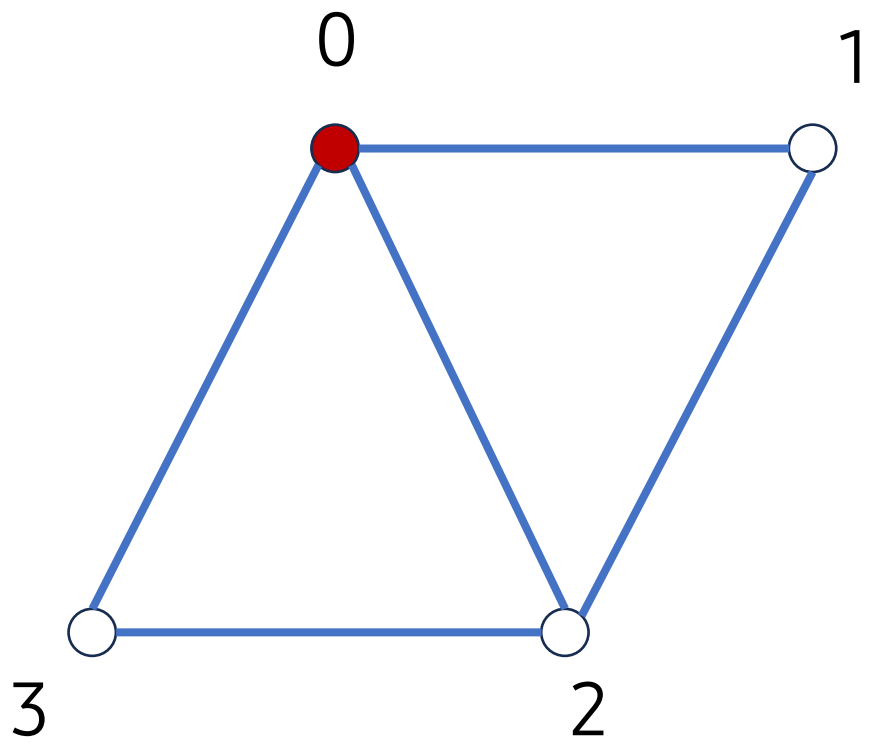
        colors[node] = mex(usedColors, P={possible colors at max})

2. Return colors

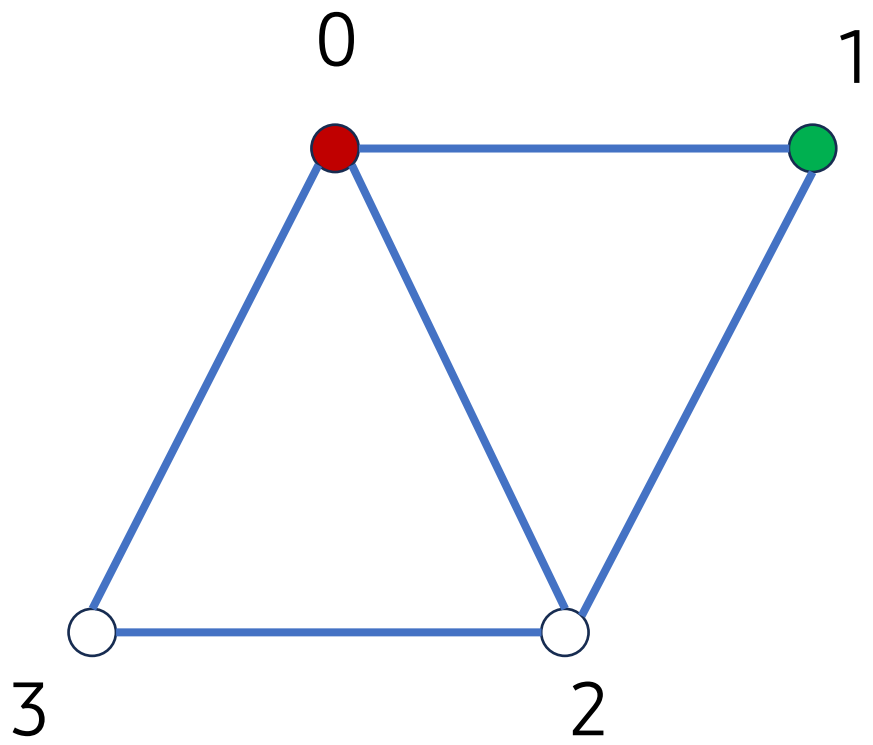


usedColors = {Null, Null, Null, Null}

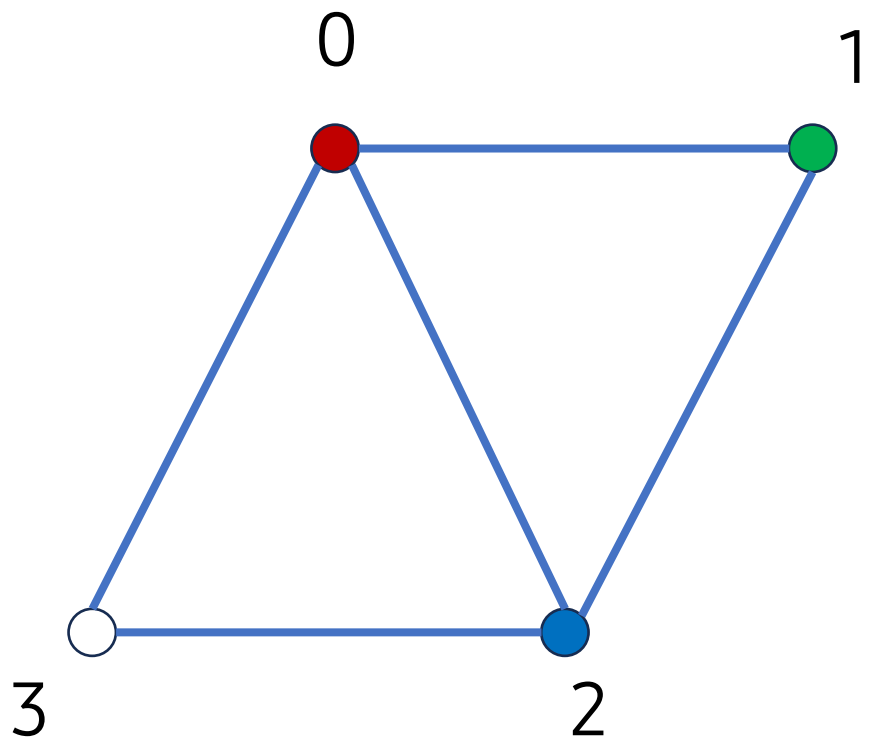
P = {Red, green, blue, yellow}



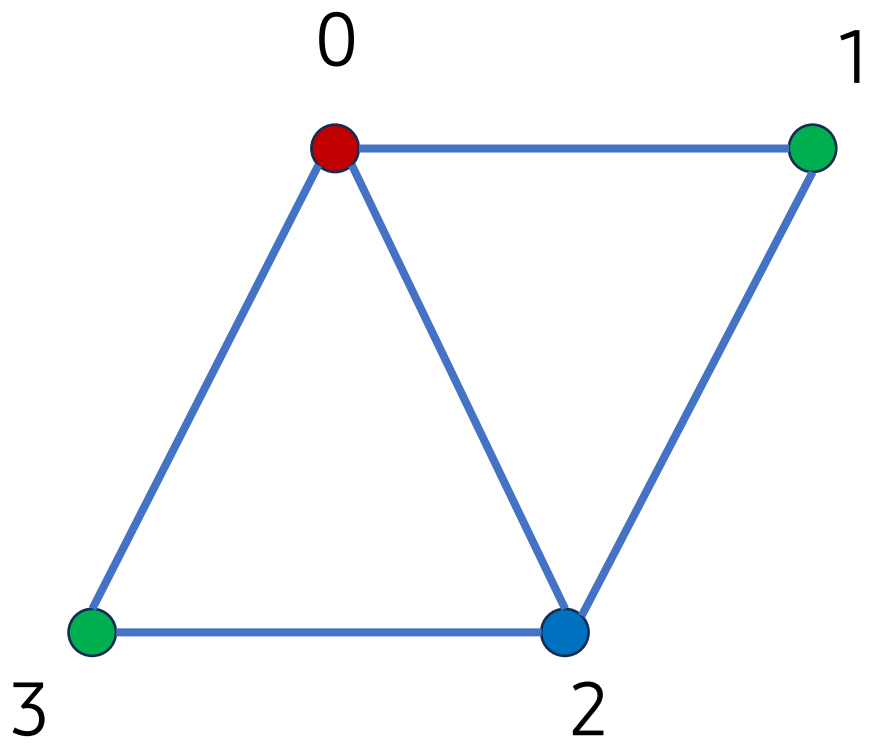
usedColors = {1, Null, Null, Null}



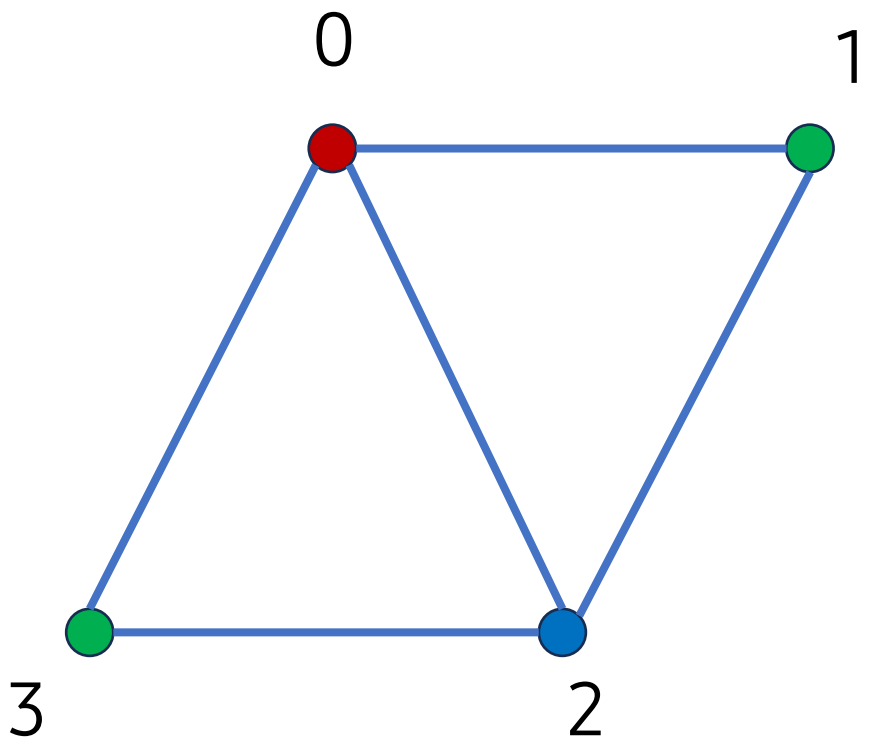
usedColors = {1, 2, Null, Null}



usedColors = {1, 2, 3, Null}



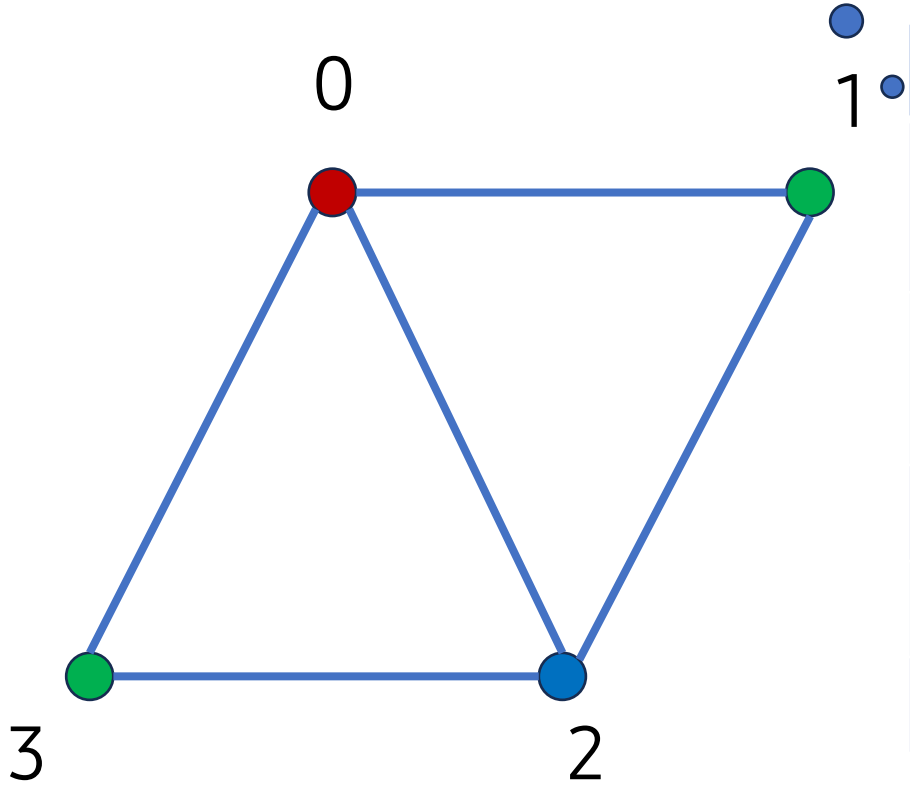
usedColors = {1, 2, 3, 2}



Bước	0	1	2	3	Màu tô
Khởi tạo	Đ, XL, XB, V	Đ, XL, XB, V	Đ, XL, XB, V	Đ, XL, XB, V	

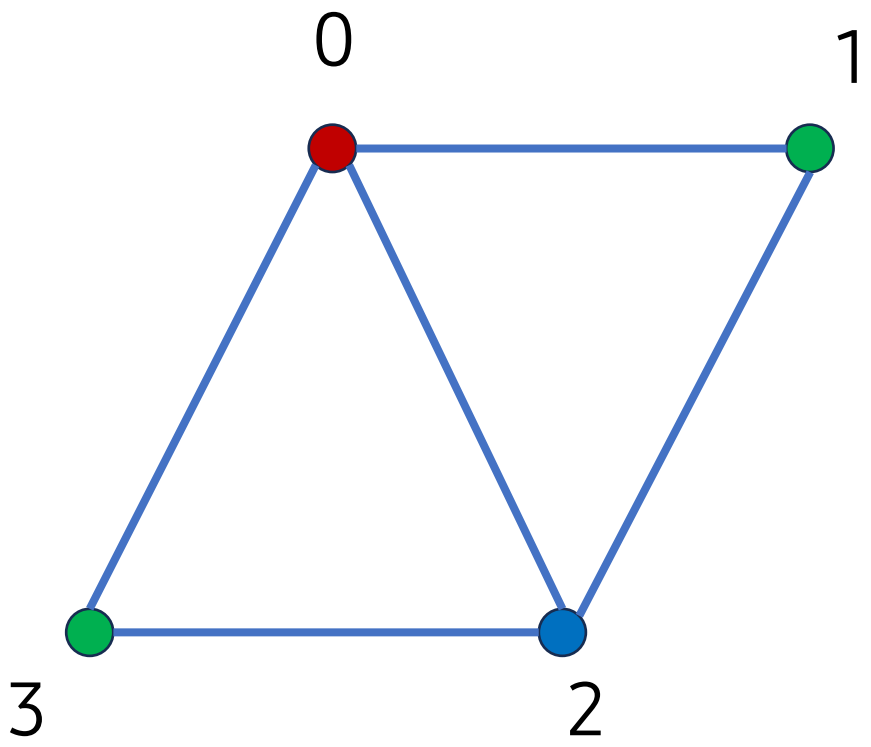
usedColors = {1, 2, 3, 2}

Mex



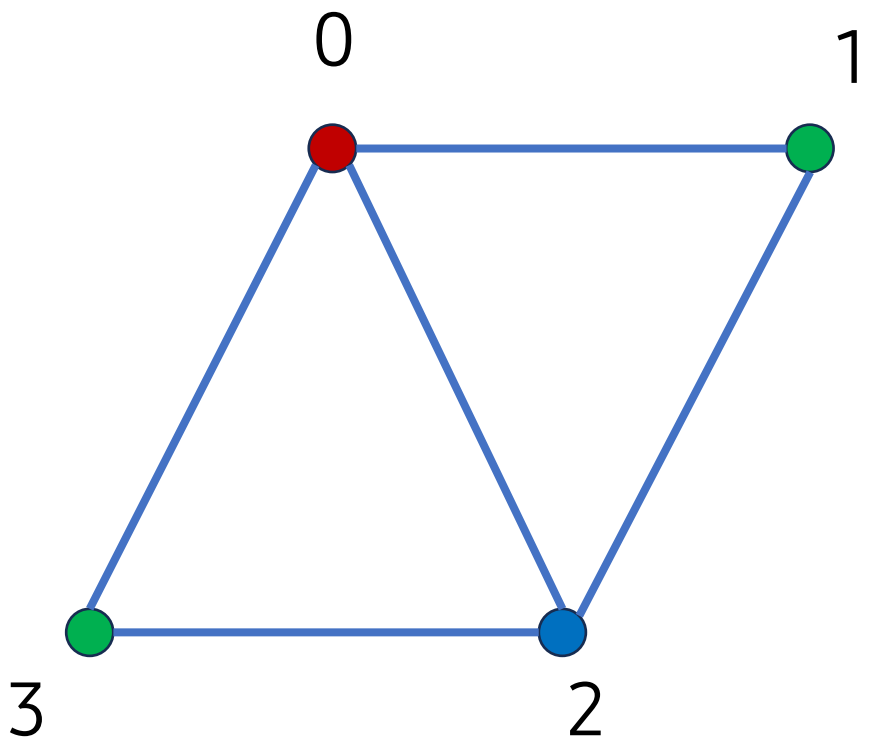
Bước	0	1	2	3	Màu tô
Khởi tạo	Đ, XL, XB, V	Đ, XL, XB, V	Đ, XL, XB, V	Đ, XL, XB, V	
i=0	Đ	XL, XB, V	XL, XB, V	XL, XB, V	Đỏ

usedColors = {1, 2, 3, 2}



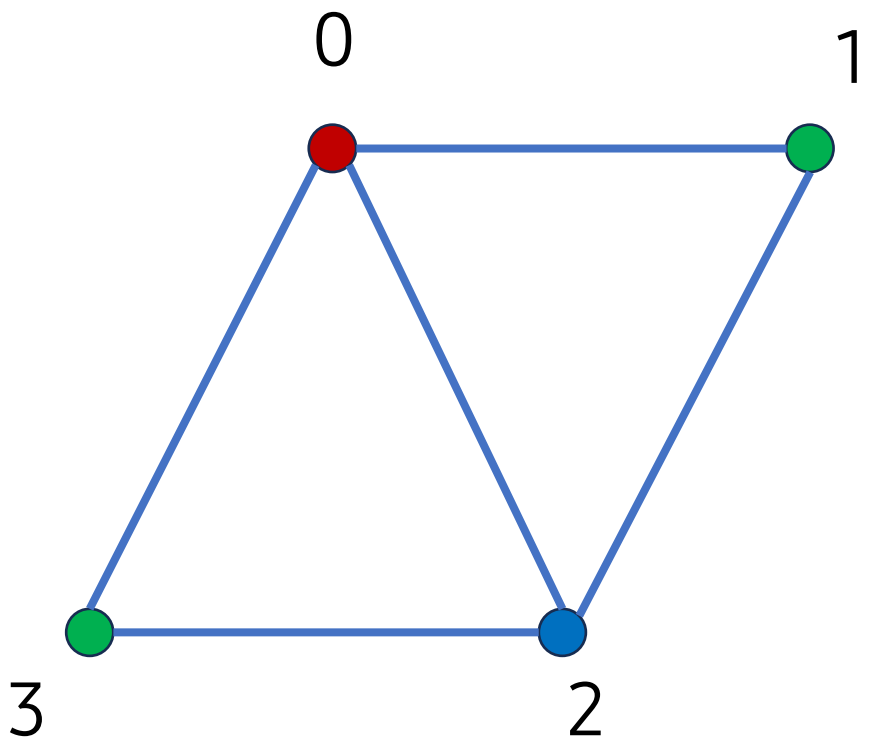
Bước	Mex	1	2	3	Màu tô
Khởi tạo	Đ, XL, XB, V	Đ, XL, XB, V	Đ, XL, XB, V	Đ, XL, XB, V	
i=0	Đ	XL, XB, V	XL, XB, V	XL, XB, V	Đỏ
i=1	Đ	XL	XB, V	XL, XB, V	Xanh lá

usedColors = {1, 2, 3, 2}



usedColors = {1, 2, 3, 2}

Bước	0	1	2	3	Màu tô
Khởi tạo	Đ, XL, XB, V	Đ, XL, XB, V	Đ, XL, XB, V	Đ, XL, XB, V	
i=0	Đ	XL, XB, V	XL, XB, V	XL, XB, V	Đỏ
i=1	Đ	XL	XB, V	XL, XB, V	Xanh lá
i=2	Đ	XL	XB	XL, V	Xanh biển

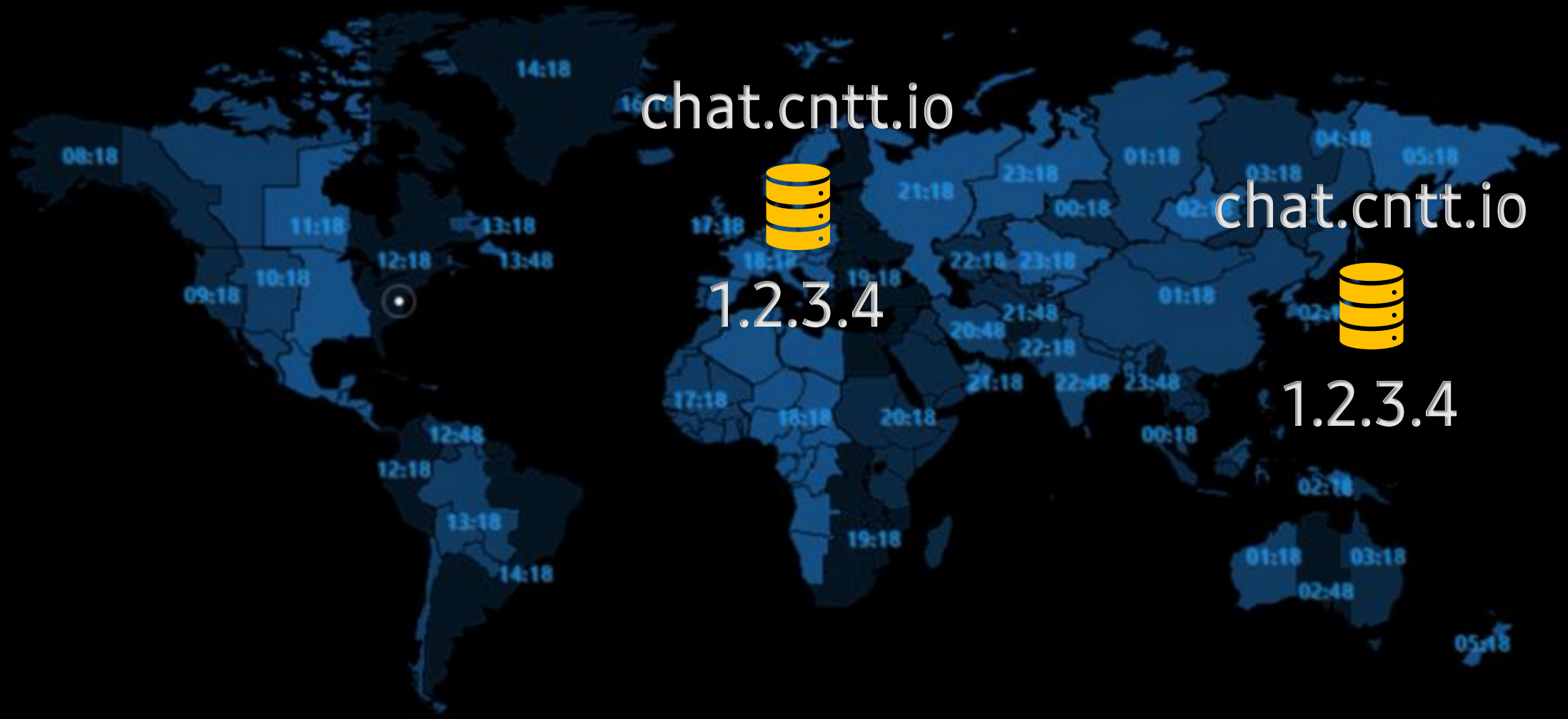


usedColors = {1, 2, 3, 2}

Màu sử dụng: Đỏ (Đ), xanh lá (XL), xanh biển (XB), vàng (V)

Bước	0	1	2	3	Màu tô
Khởi tạo	Đ, XL, XB, V	Đ, XL, XB, V	Đ, XL, XB, V	Đ, XL, XB, V	
i=0	Đ	XL, XB, V	XL, XB, V	XL, XB, V	Đỏ
i=1	Đ	XL	XB, V	XL, XB, V	Xanh lá
i=2	Đ	XL	XB	XL, V	Xanh biển
i=3	Đ	XL	XB	XL	Xanh lá

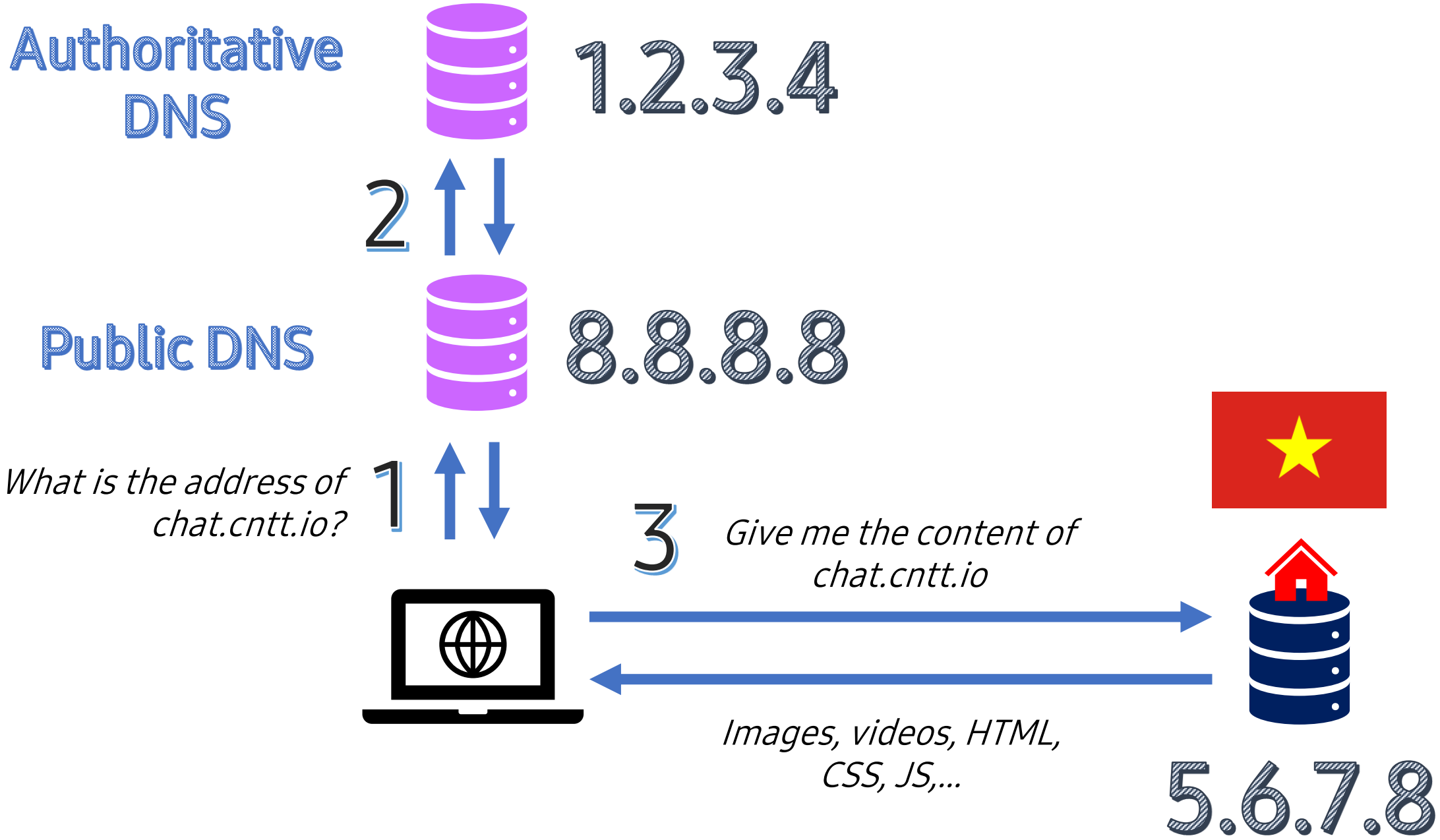
IV. Examine graph application in the internet

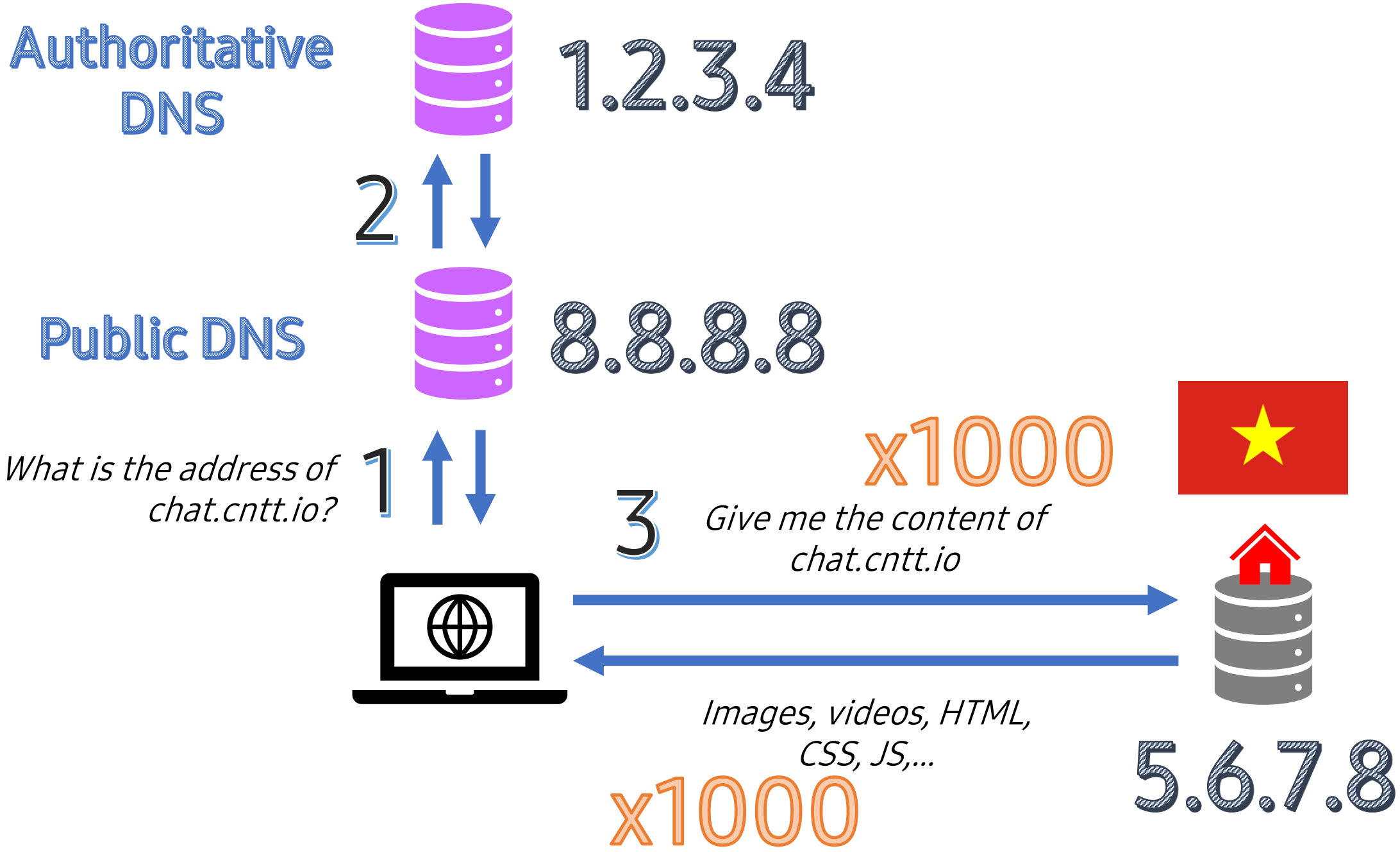

chat.cntt.io
1.2.3.4
chat.cntt.io
1.2.3.4

ping

nslookup

tracert


Authoritative DNS
1.2.3.4
2
Public DNS
8.8.8.8
What is the address of chat.cntt.io?
1
3
Give me the content of chat.cntt.io
Images, videos, HTML, CSS, JS,...
5.6.7.8


Authoritative DNS
1.2.3.4
2
Public DNS
8.8.8.8
What is the address of chat.cntt.io?
1
3
x1000
Give me the content of chat.cntt.io
Images, videos, HTML, CSS, JS,...
x1000
5.6.7.8

Intel NUC

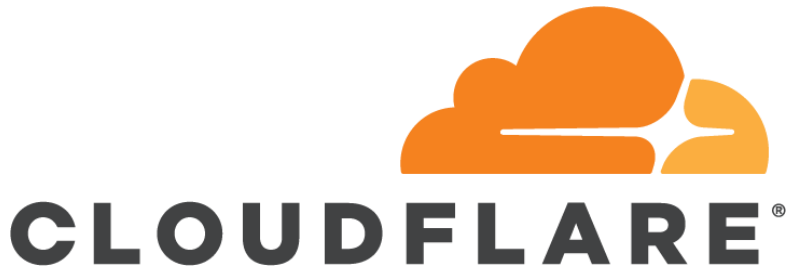
Intel Pentium Silver J5005

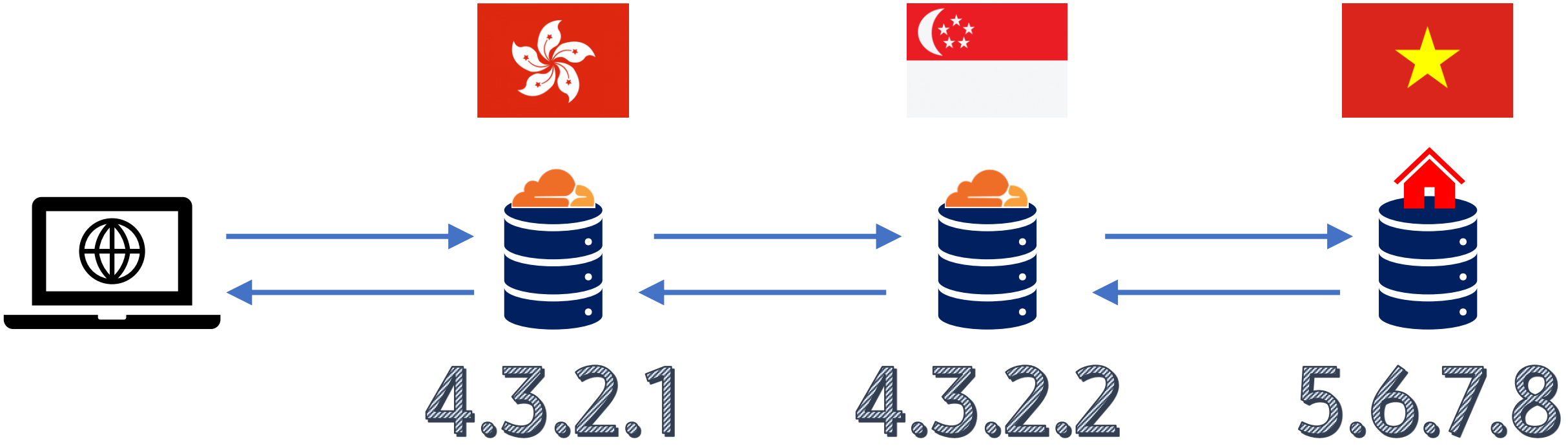
4 cores 4 threads 1.50GHz

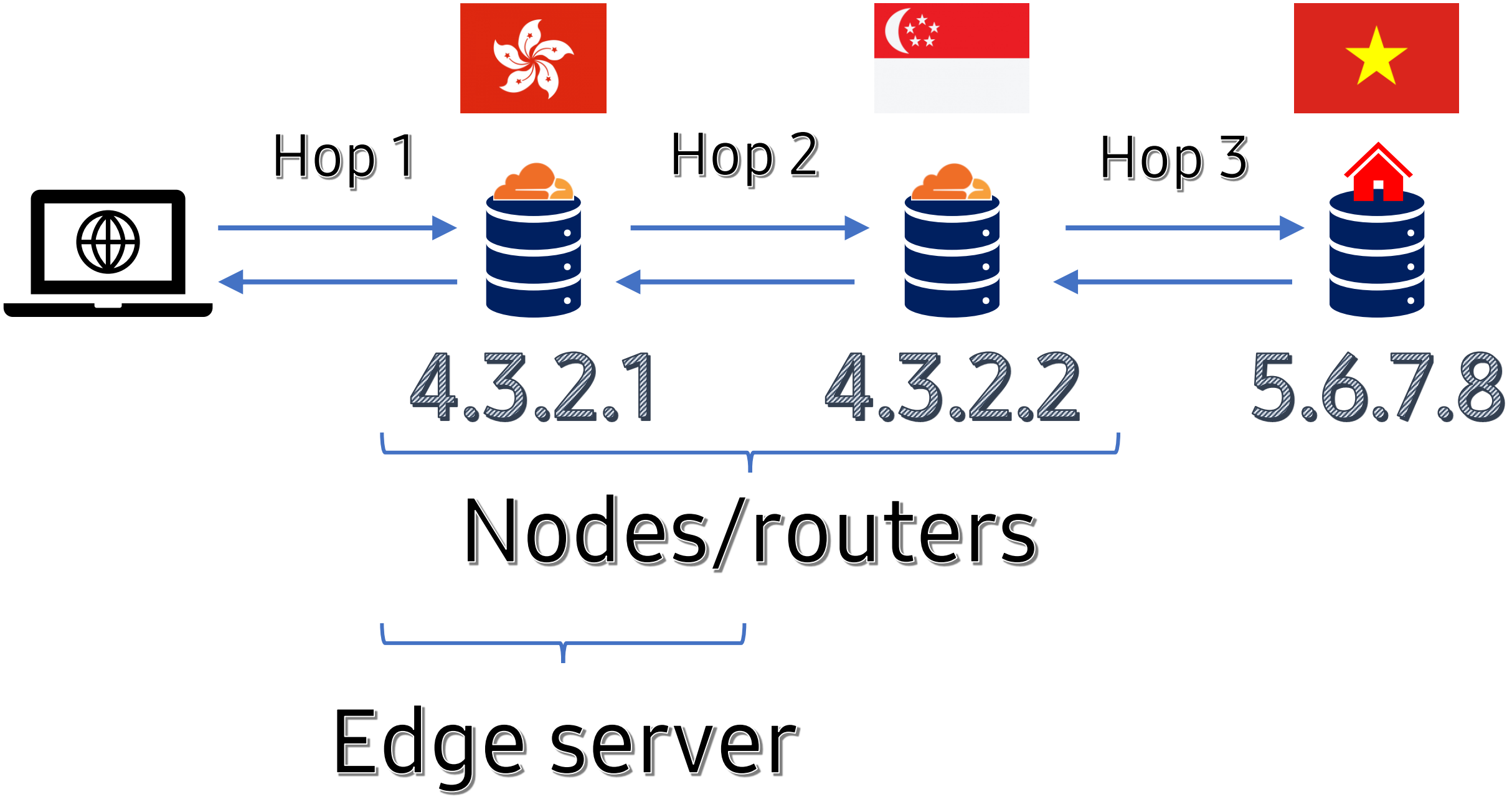
16GB RAM

1Gb ethernet

CDN




4.3.2.1
4.3.2.2
5.6.7.8


Hop 1
Hop 2
Hop 3
4.3.2.1
4.3.2.2
5.6.7.8
Nodes/routers
Edge server

CDN benefits

- Speed
  - Minification
  - Caching
- Security
  - WAF (Web application firewall)
  - DDOS protection
- Load balancing
- Custom pages

vinhthanh.net

Monitor security and performance for vinhthanh.net. Configure products and services from the menu.

Review Cloudflare fundamentals

☆ Star

24 Hours 7 Days 30 Days 17 NOVEMBER — 18 NOVEMBER

Unique Visitors

338

Total Requests

28.01k

Percent Cached

40.44%

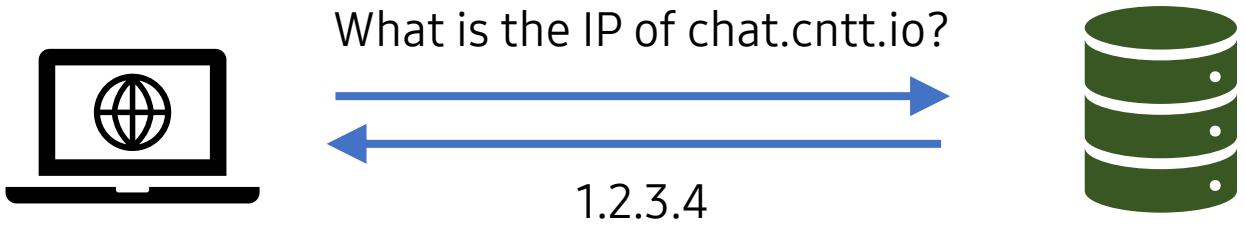
Total Data Served

1 GB

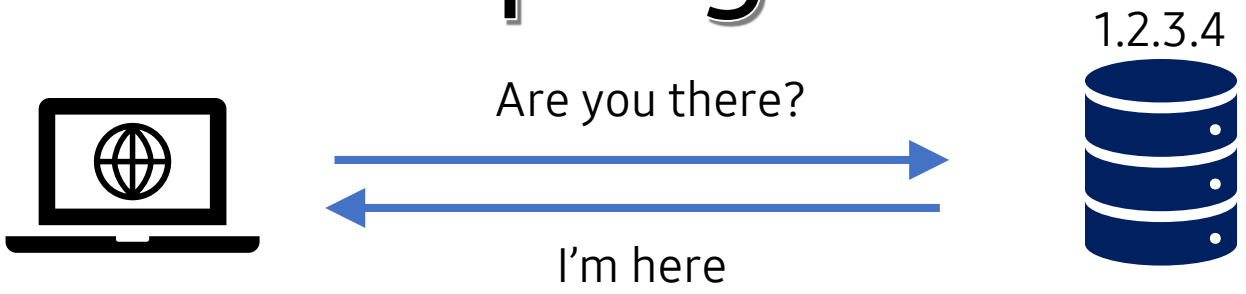
Data Cached

535 MB

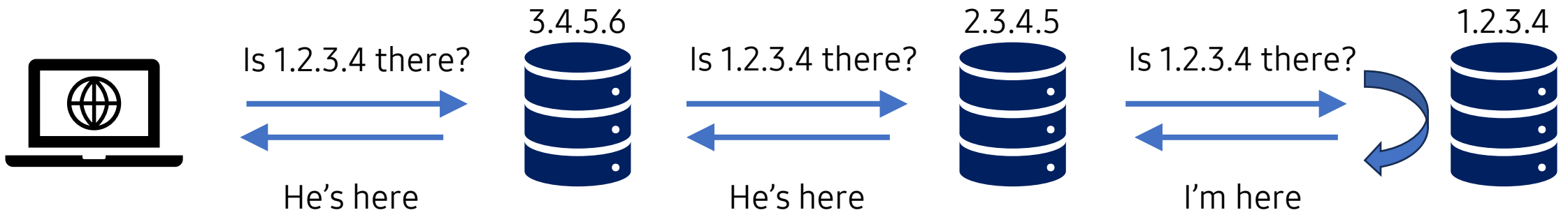
nslookup



ping

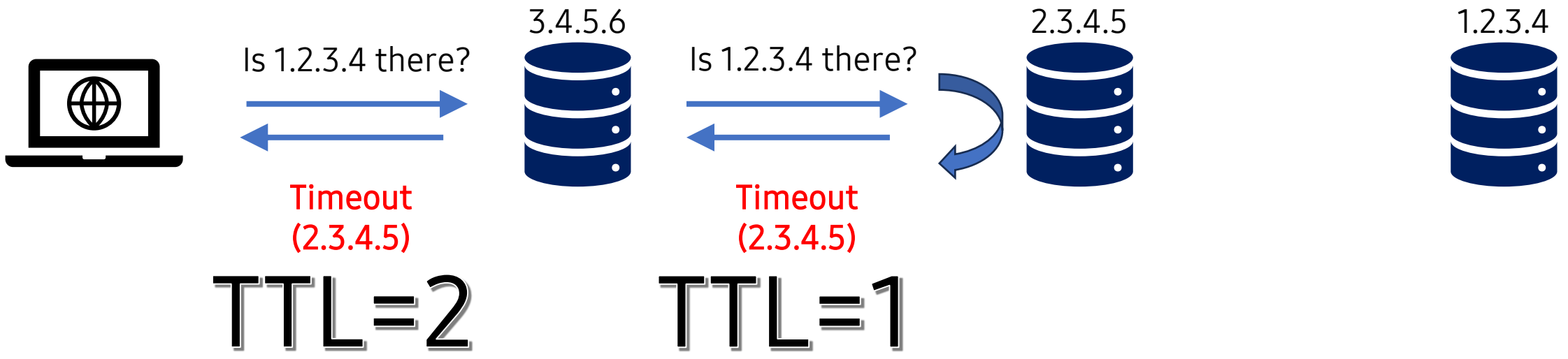


ping

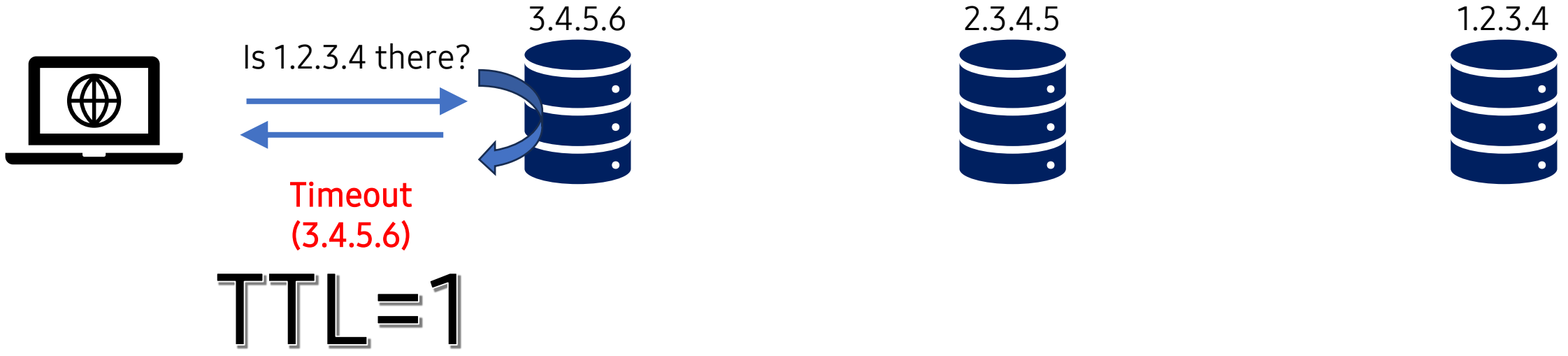


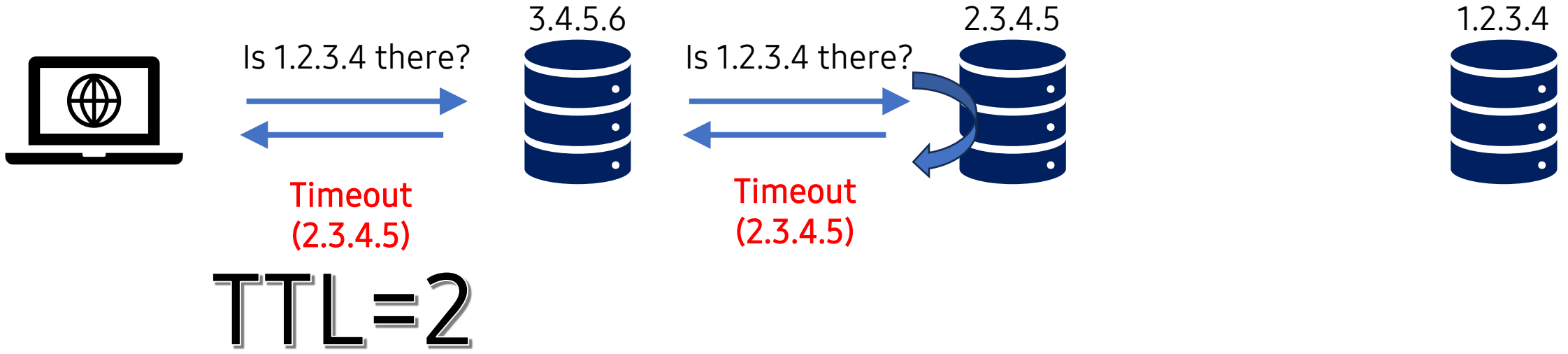
TTL=5 TTL=4 TTL=3

ping


Is 1.2.3.4 there?
3.4.5.6
Is 1.2.3.4 there?
2.3.4.5
1.2.3.4
Timeout
(2.3.4.5)
Timeout
(2.3.4.5)
TTL=2
TTL=1

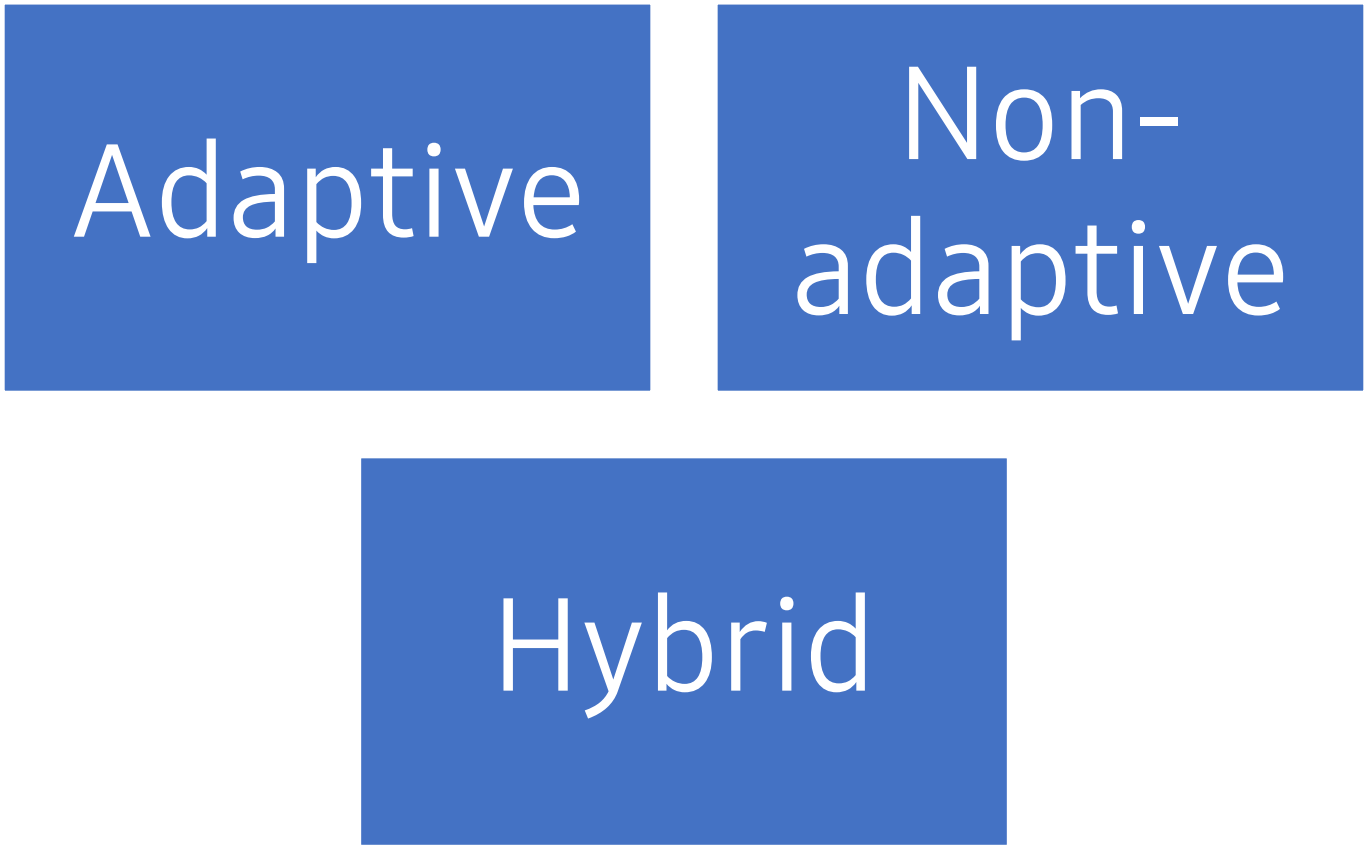
Traceroute = Multiple pings





Examine

III. Routing protocol algorithms



Adaptive

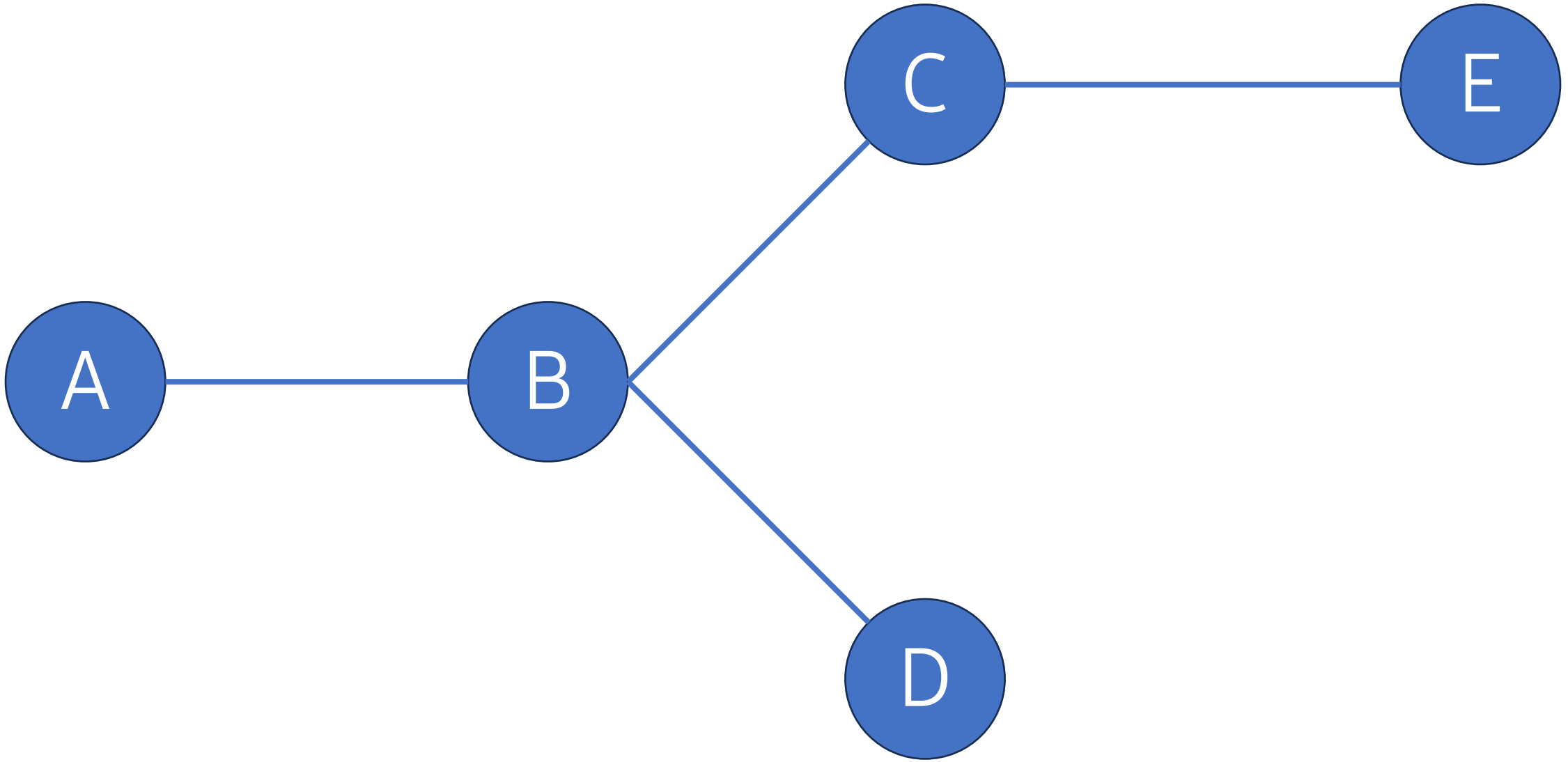
- The routing decisions change when the topology or traffic load changes.
- Parameters: Distance, number of hops, estimated transit time.
- 3 types: Isolated, centralized, and distributed.
  - Isolated: **Backward Learning**, Source Routing, Hot Potato.

Backward Learning algorithm

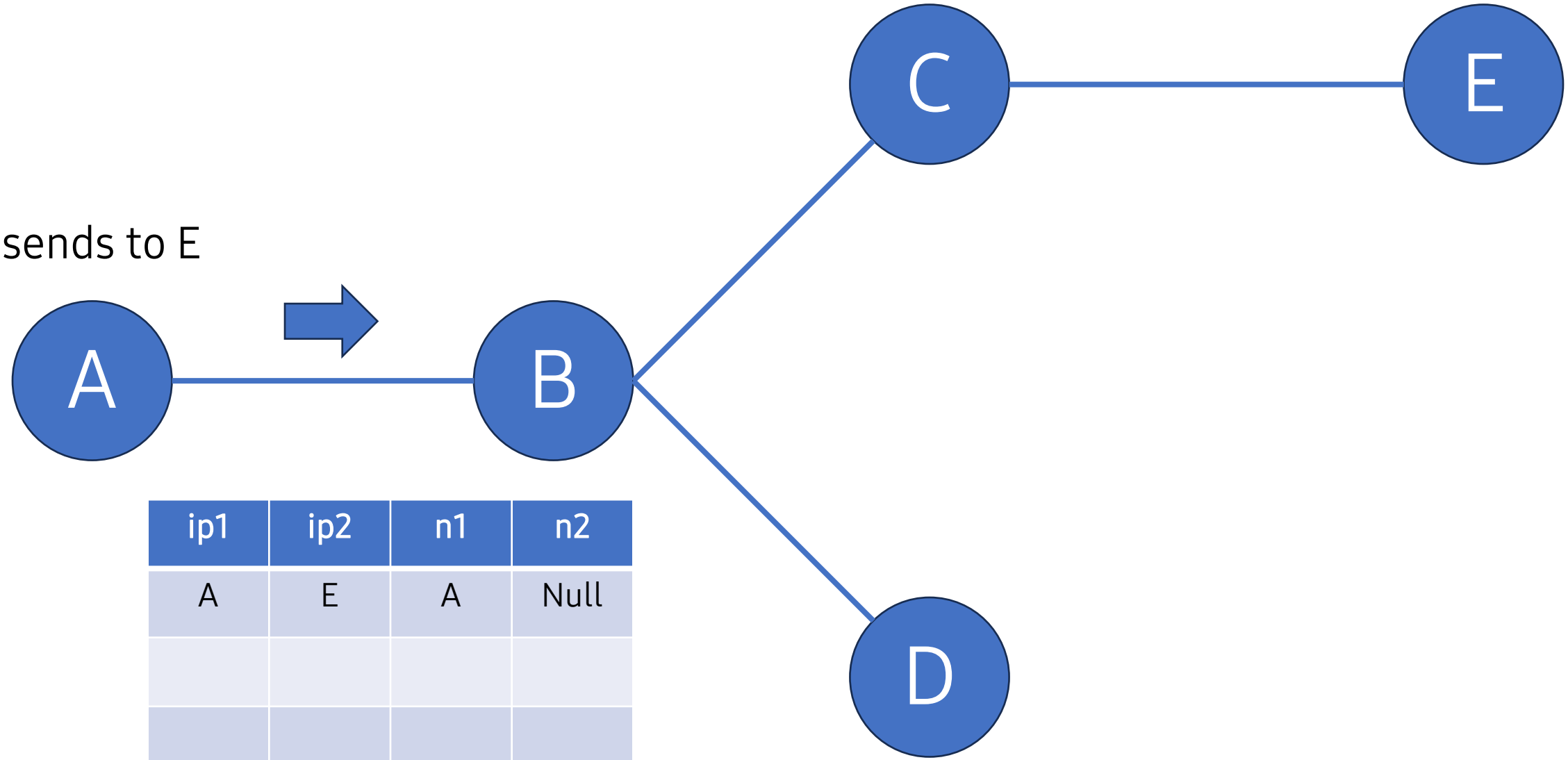
- Preparation: table[ip1, ip2] = [n1, n2]
- When Node B receives the packet (srcip, destip) from node A:
  - Step 1: If B is the destination, process, response and stop.
  - Step 2: If there's table[srcip, destip] or table[destip, srcip], go to step 3.

    Else, go to step 4.
  - Step 3: Find one node n in [n1, n2] that isn't A. If found, send to n, set

    Null node in [n1, n2] with A and stop.
  - Step 4: table[srcip, destip] = [A, Null].
  - Step 5: Send to all nodes, except for node A.


A
B
C
D
E

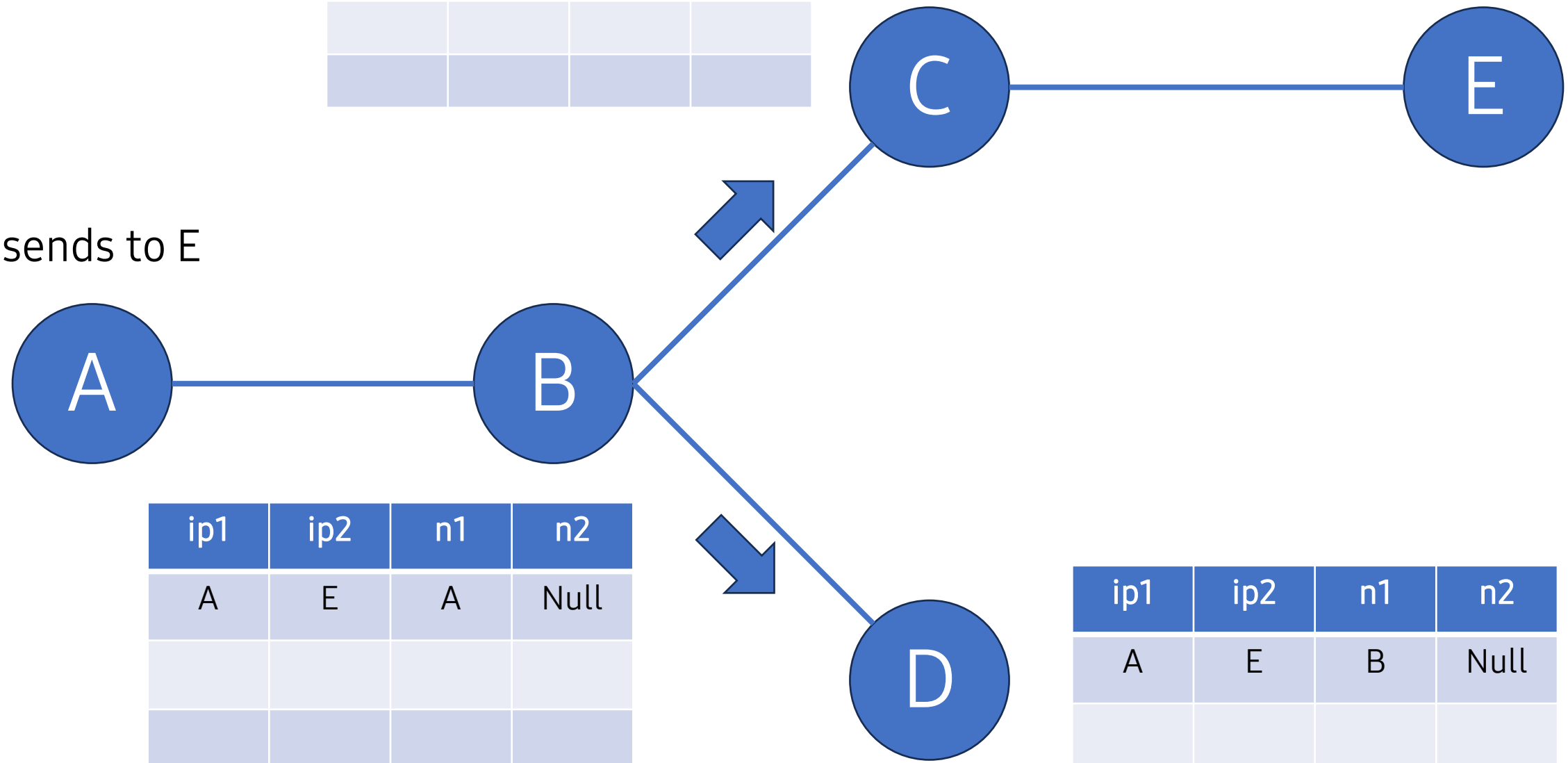
A sends to E



ip1	ip2	n1	n2
A	E	A	Null

ip1	ip2	n1	n2
A	E	B	Null

A sends to E

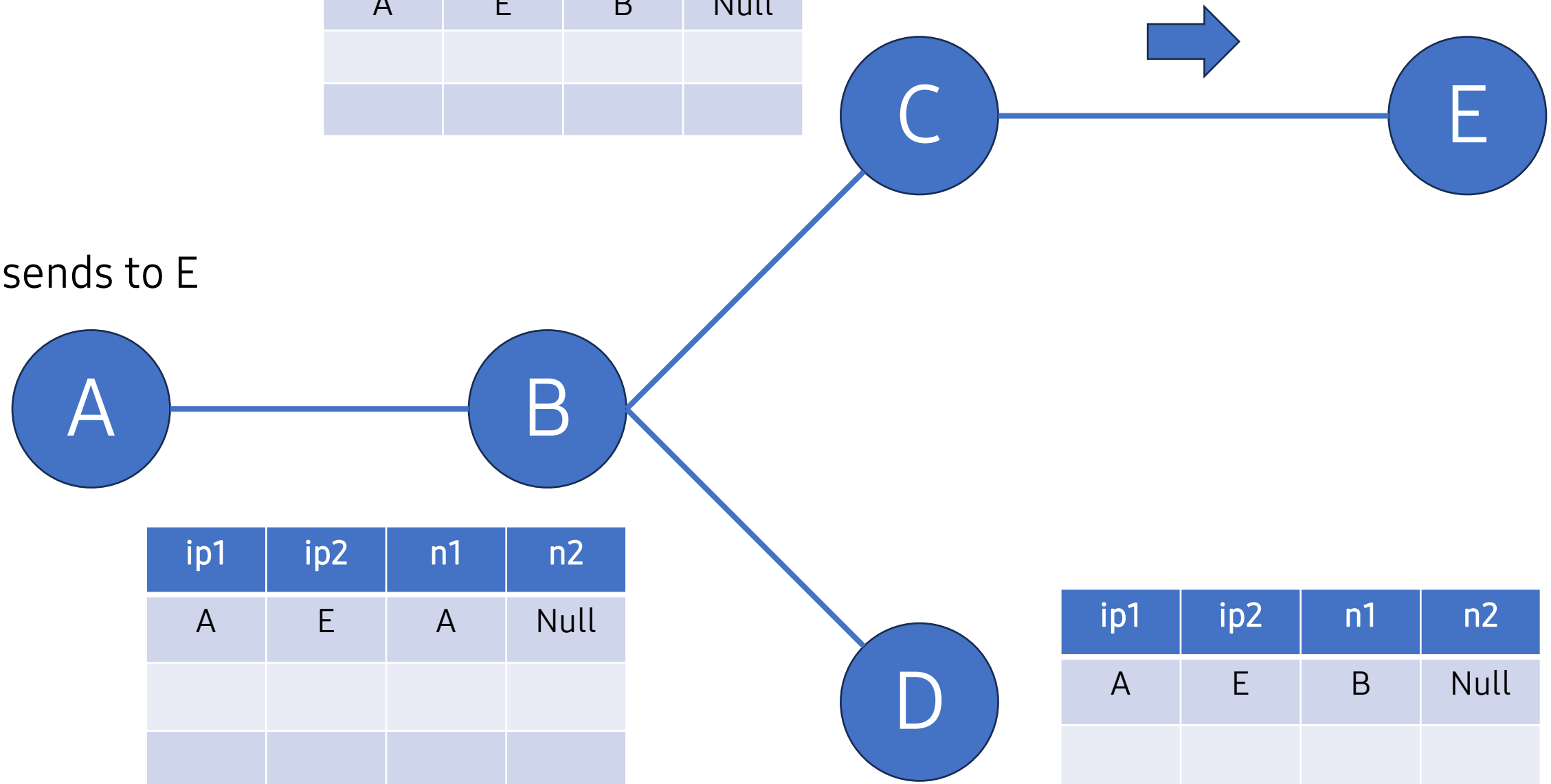


ip1	ip2	n1	n2
A	E	A	Null

ip1	ip2	n1	n2
A	E	B	Null

ip1	ip2	n1	n2
A	E	B	Null

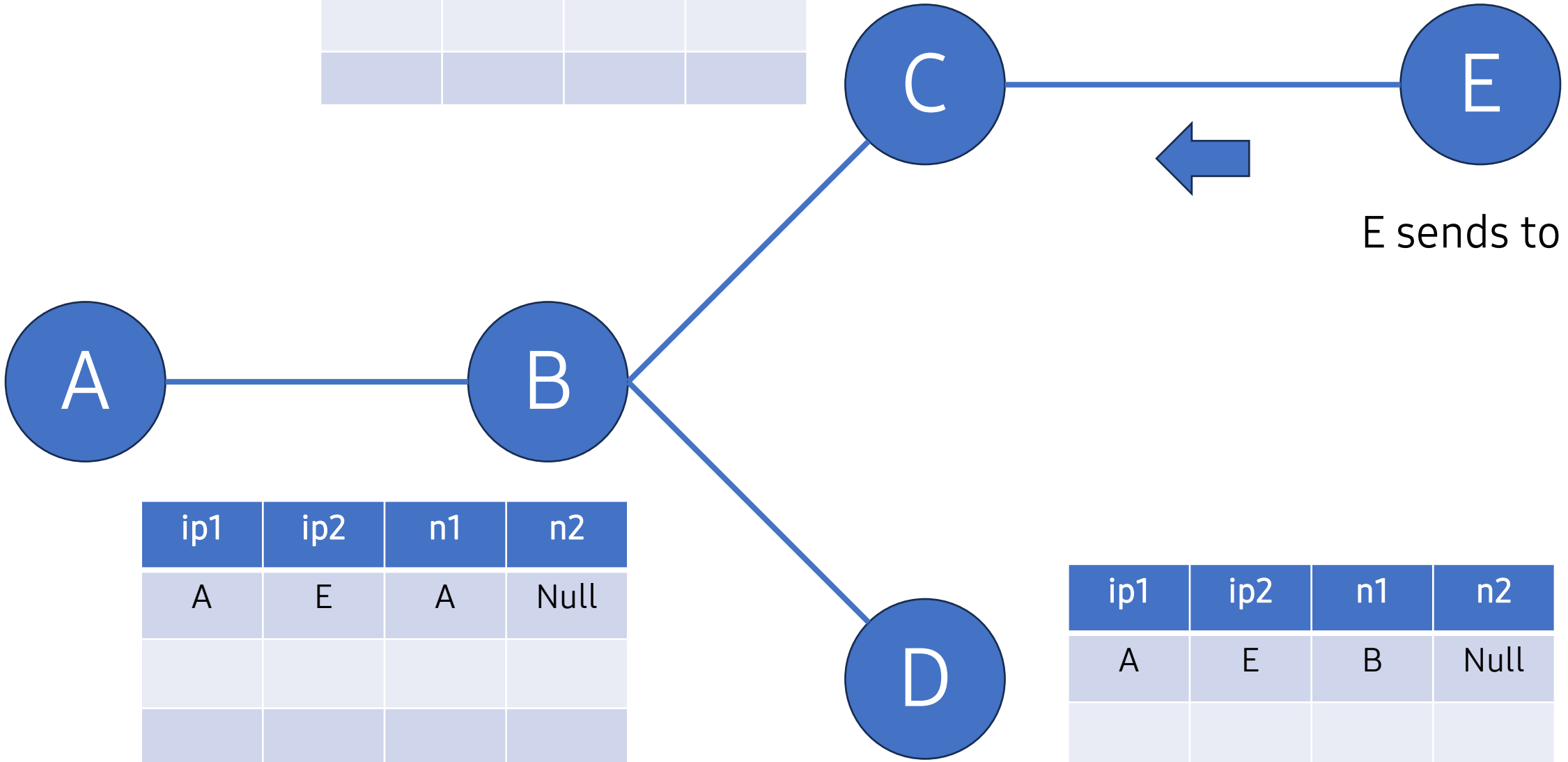
A sends to E



ip1	ip2	n1	n2
A	E	A	Null

ip1	ip2	n1	n2
A	E	B	Null

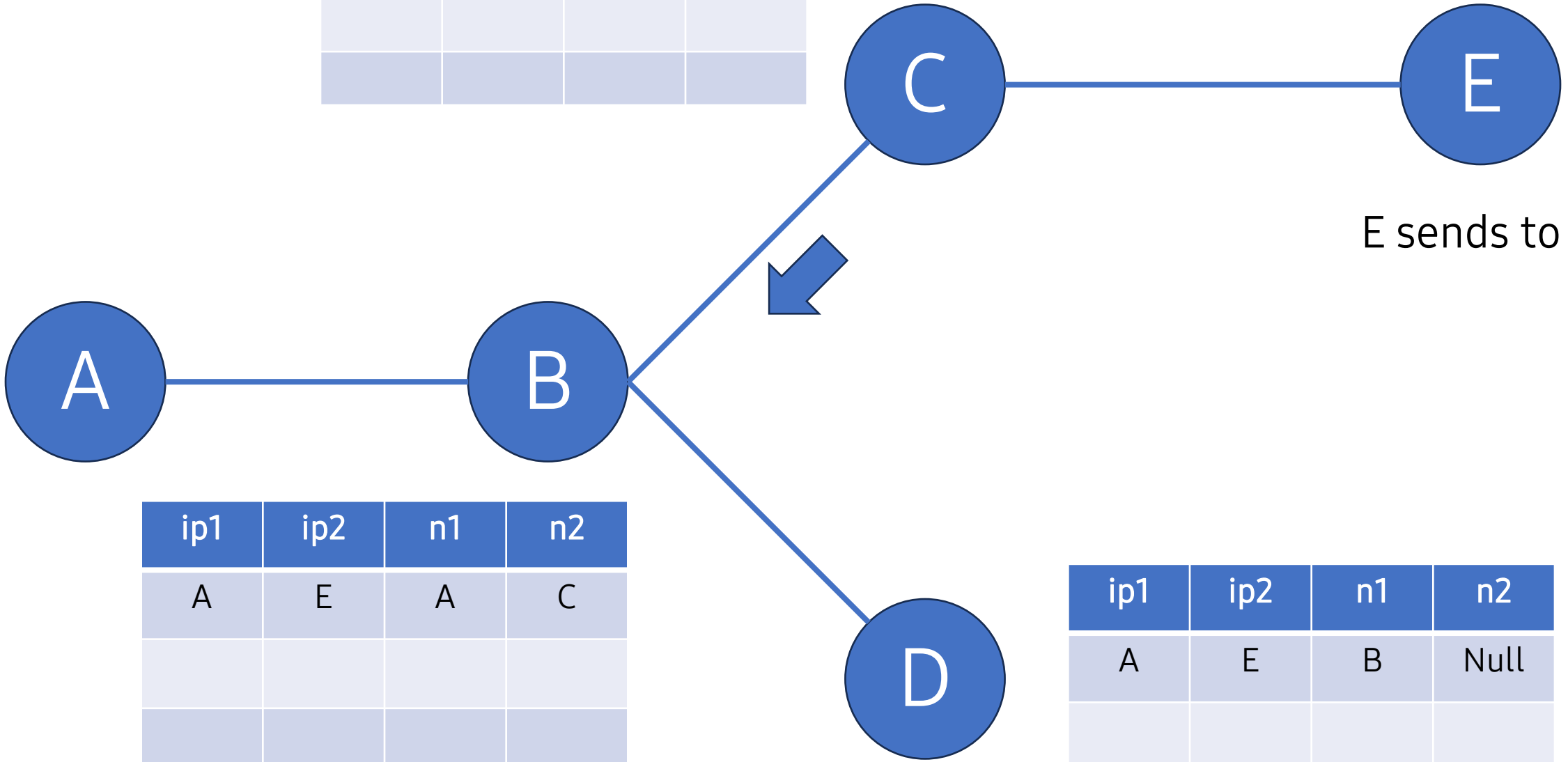
ip1	ip2	n1	n2
A	E	B	E



ip1	ip2	n1	n2
A	E	A	Null

ip1	ip2	n1	n2
A	E	B	Null

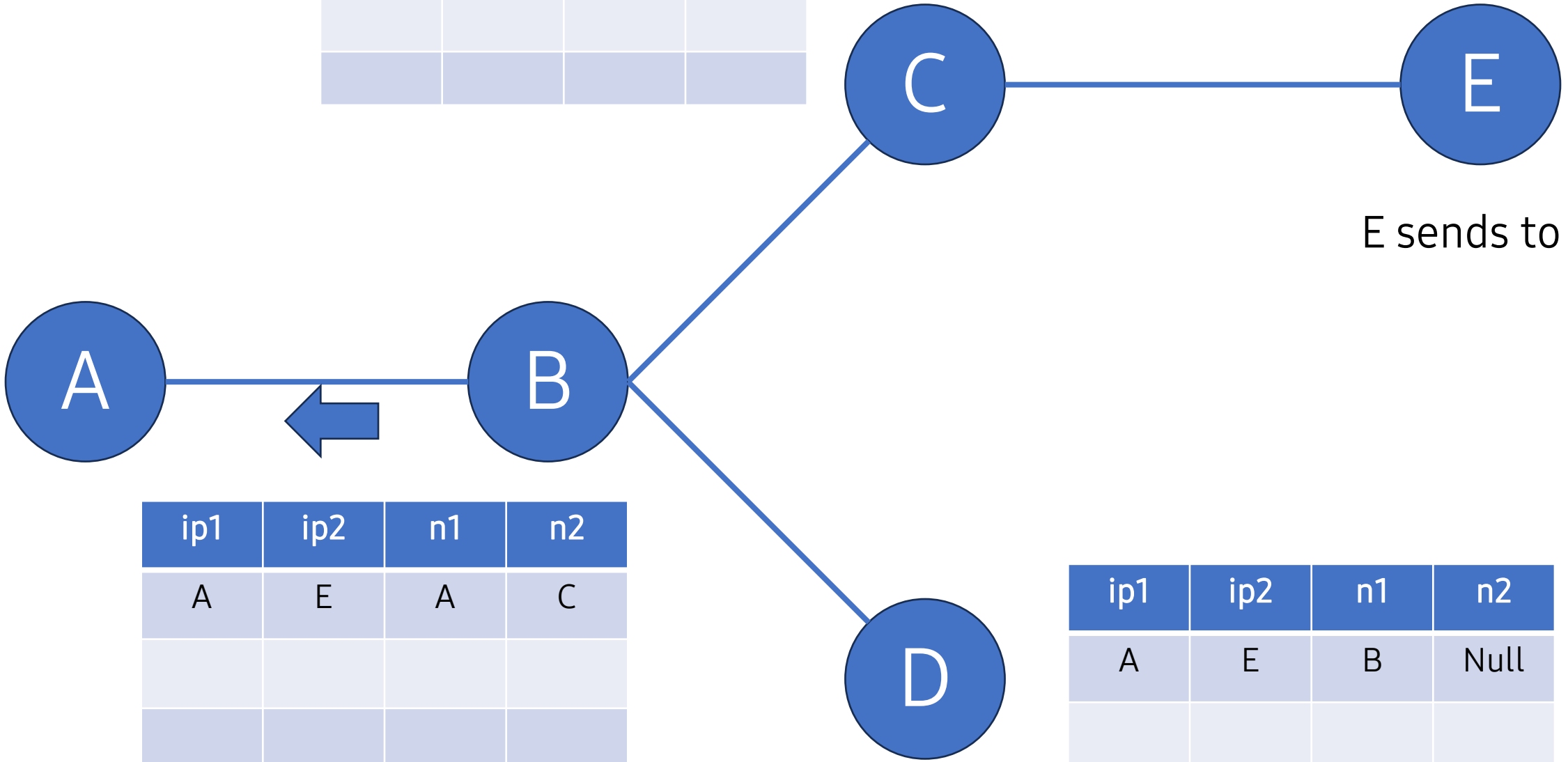
ip1	ip2	n1	n2
A	E	B	E



ip1	ip2	n1	n2
A	E	A	C

ip1	ip2	n1	n2
A	E	B	Null

ip1	ip2	n1	n2
A	E	B	E



ip1	ip2	n1	n2
A	E	A	C

ip1	ip2	n1	n2
A	E	B	Null