

# Networking 101

Ayelet Drazen

(Inspired by Stanford's CS144)

# Networking: game plan

1. Deconstructing the internet
2. Using traceroute
3. Exploring the problems with the internet

# The Basics



Client



Server



**Client**



**Server**



192.168.68.114

Client



Port: 655



8.8.8.8

Server



192.168.68.114



Port: 655

Client



Port: 80

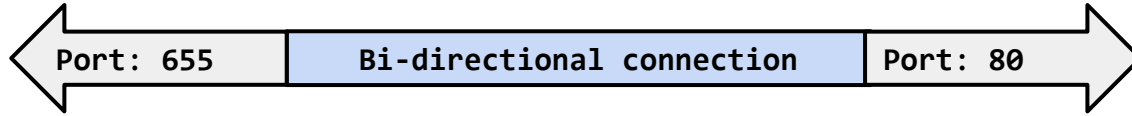


8.8.8.8

Server



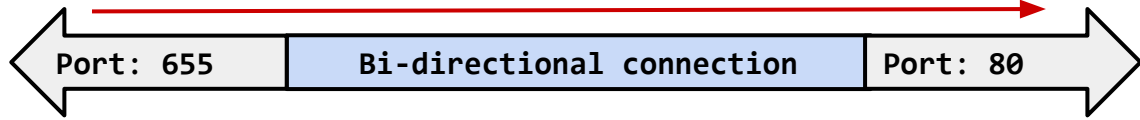
Client



Server



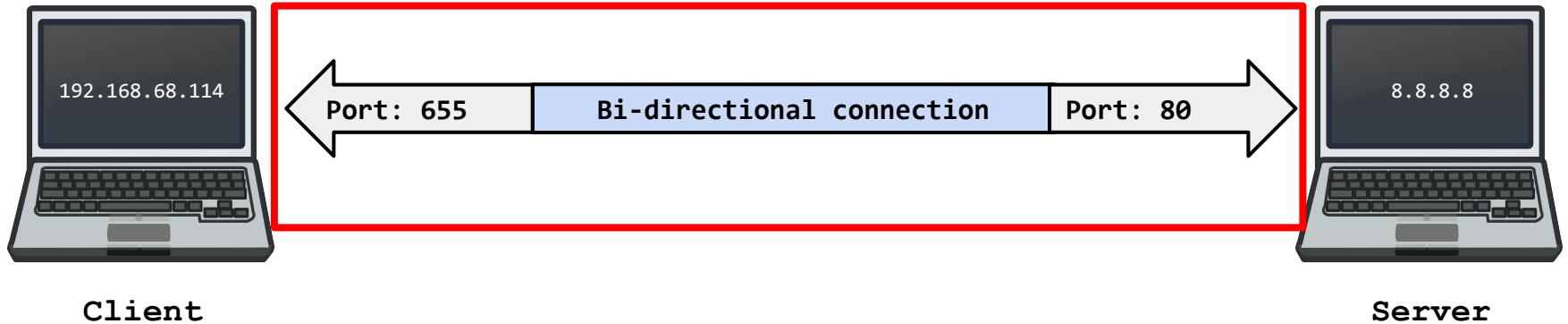
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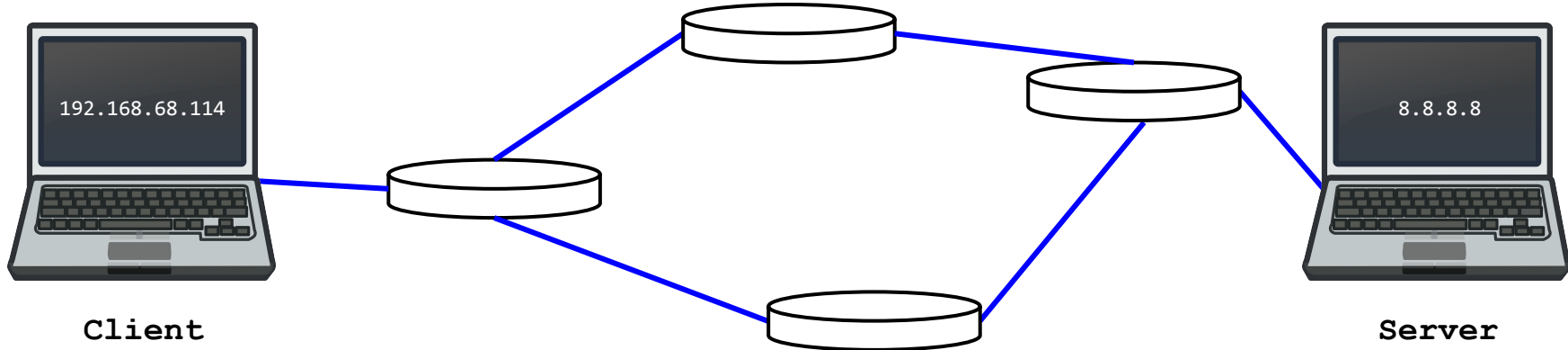


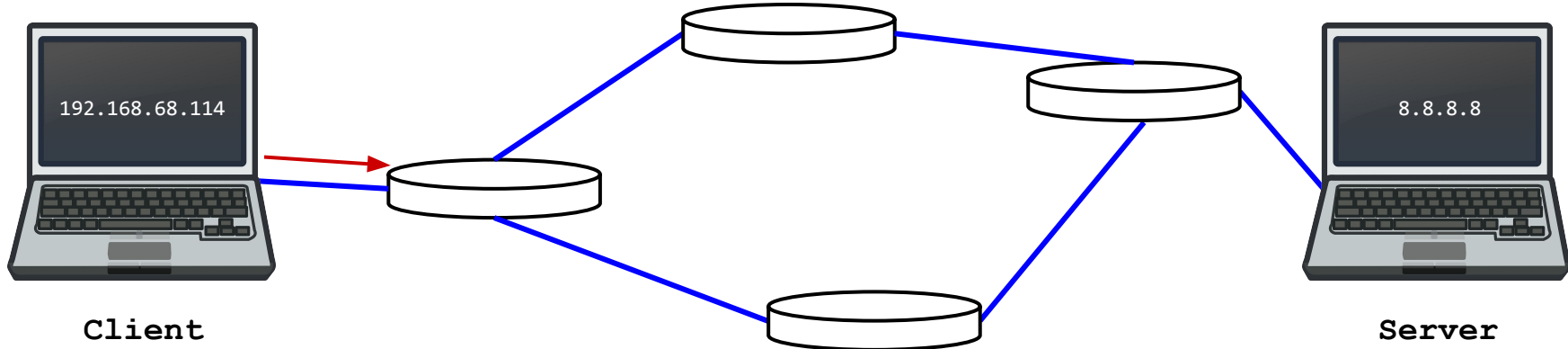
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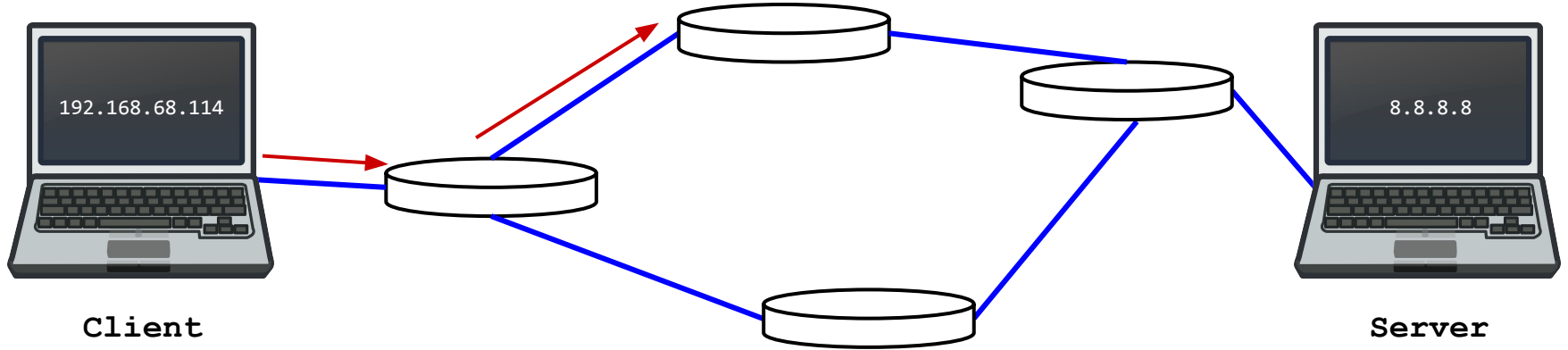


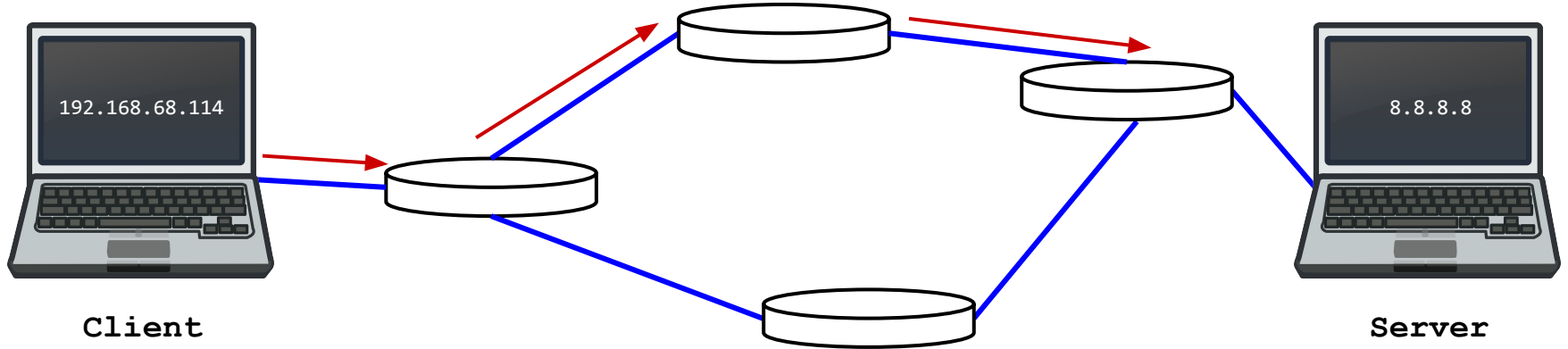
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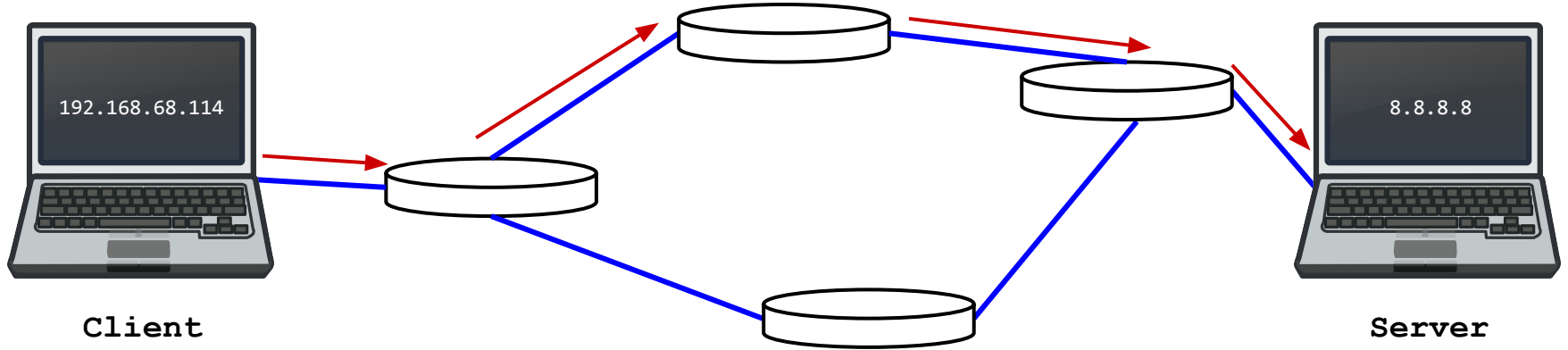




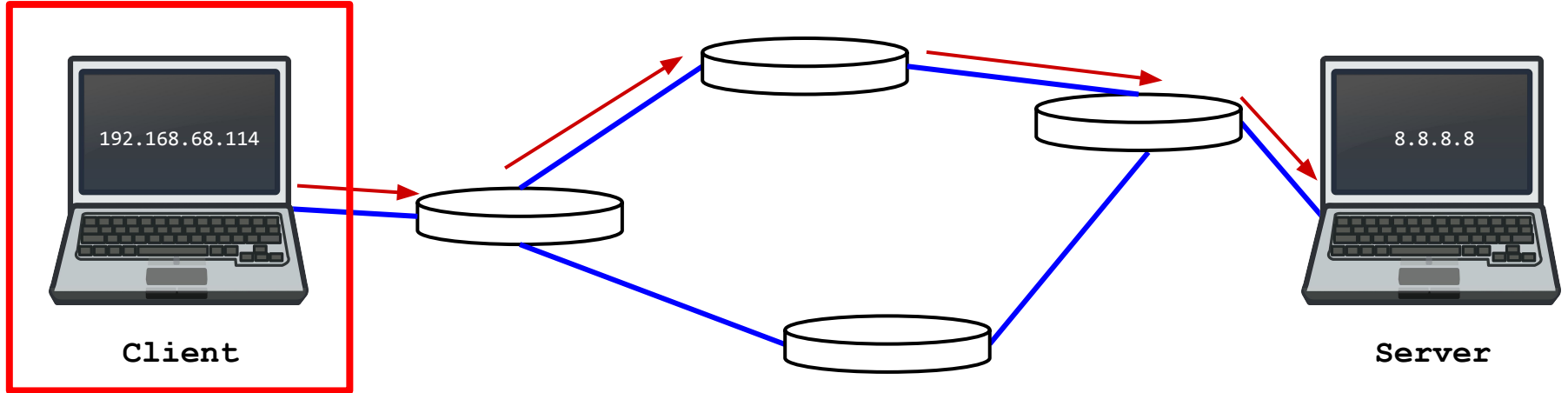


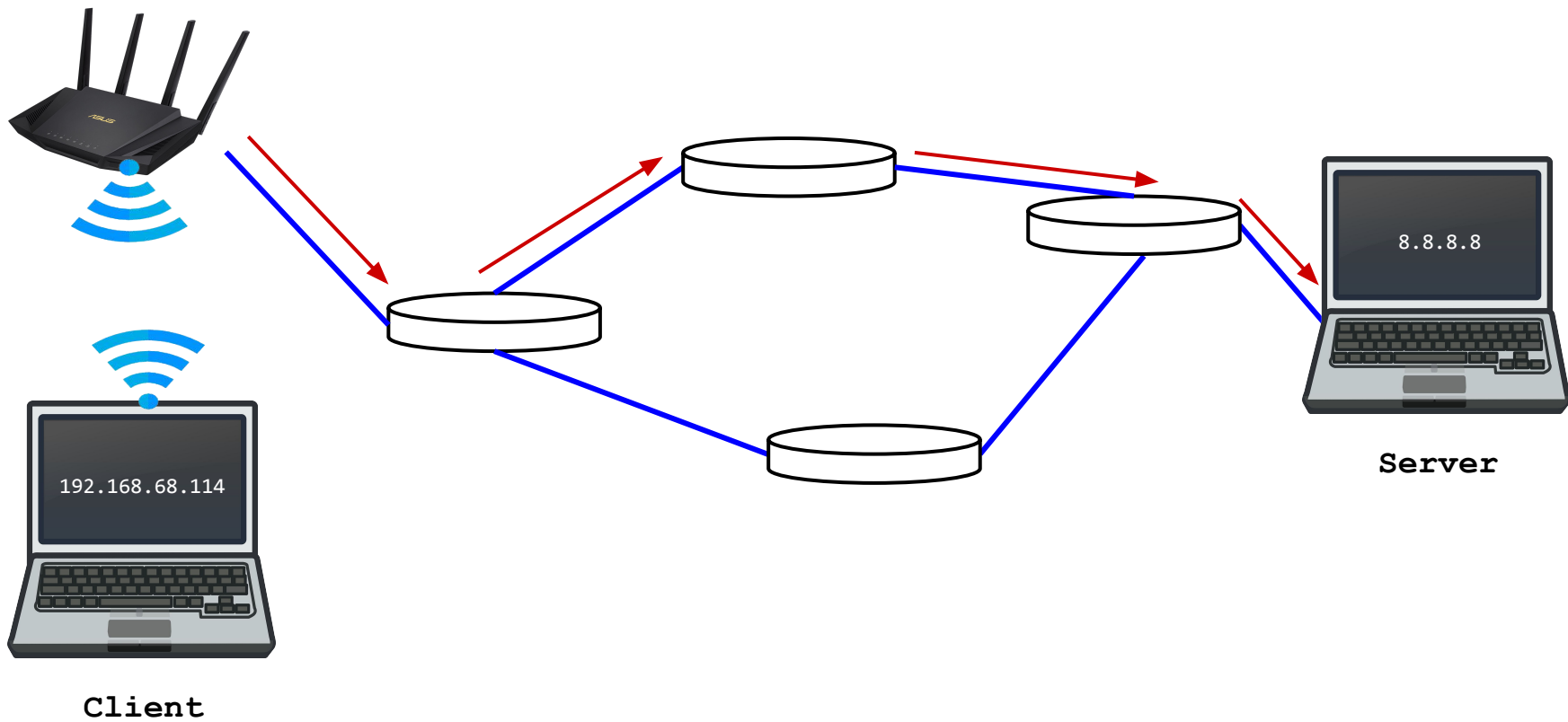






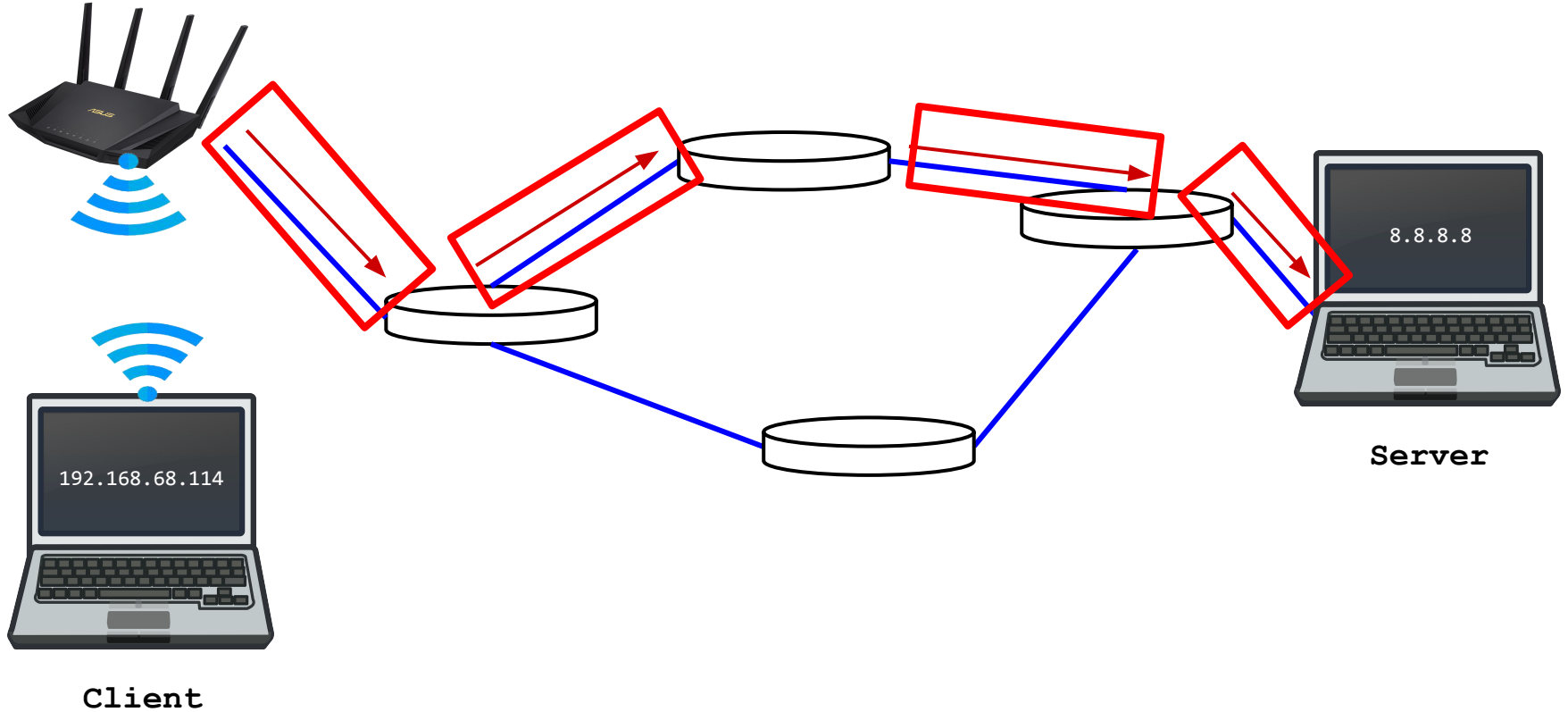
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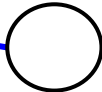
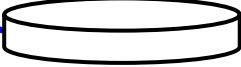
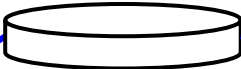
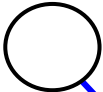




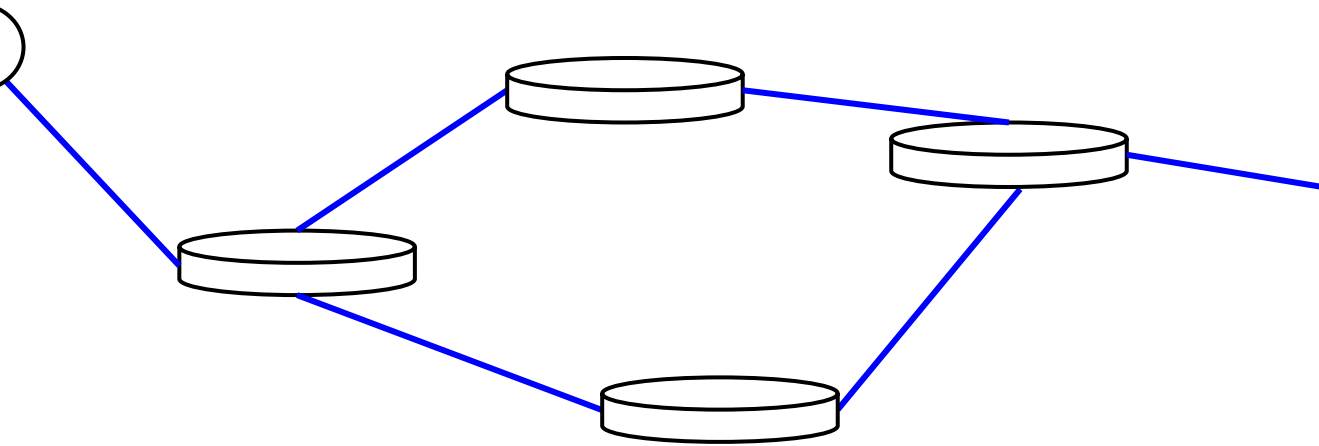
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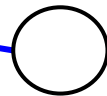
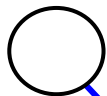
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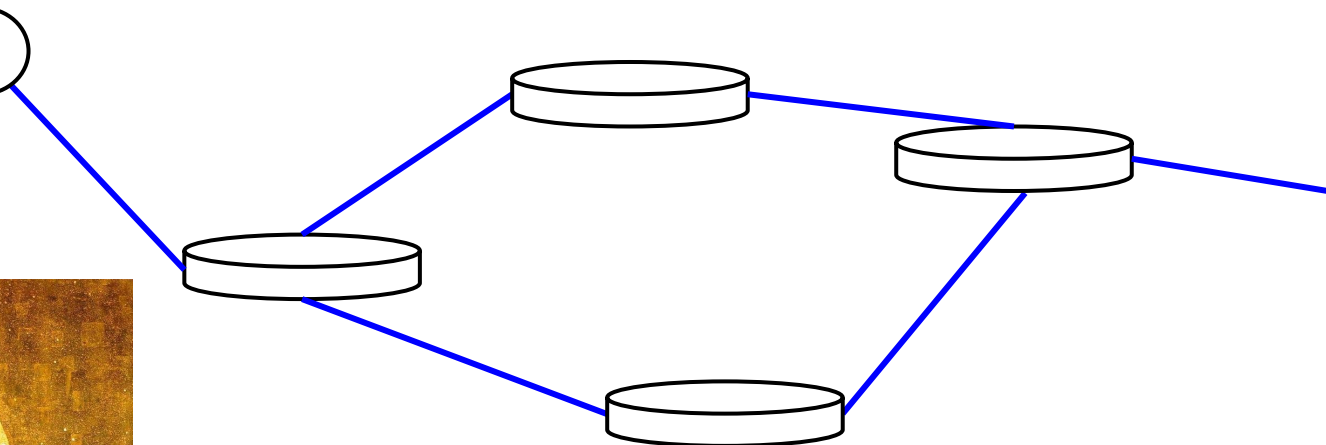
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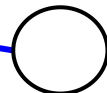
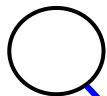
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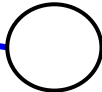
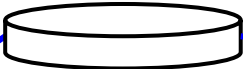
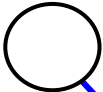
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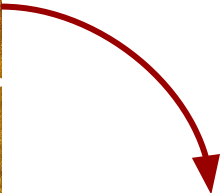
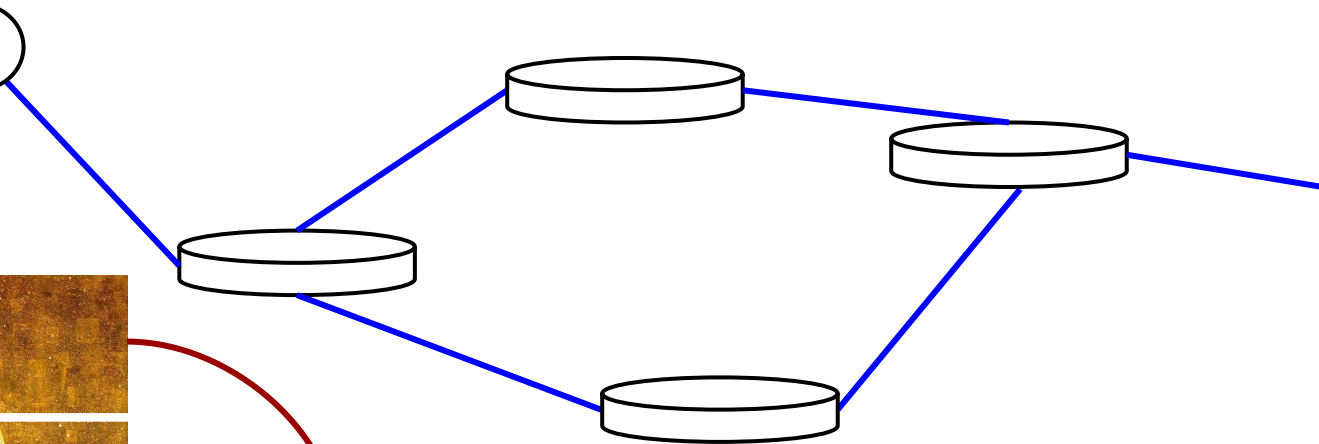
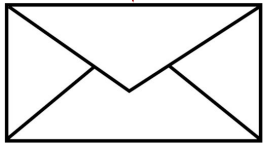
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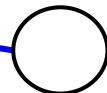
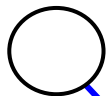
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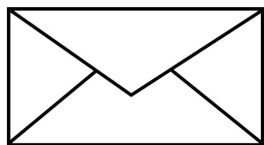
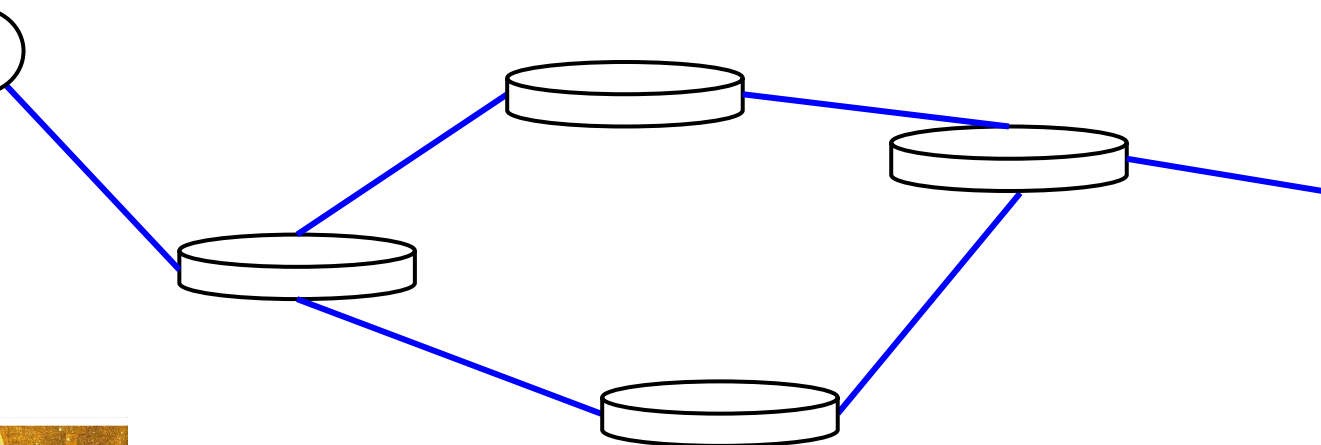
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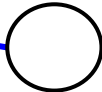
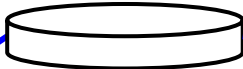
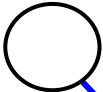
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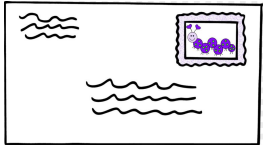
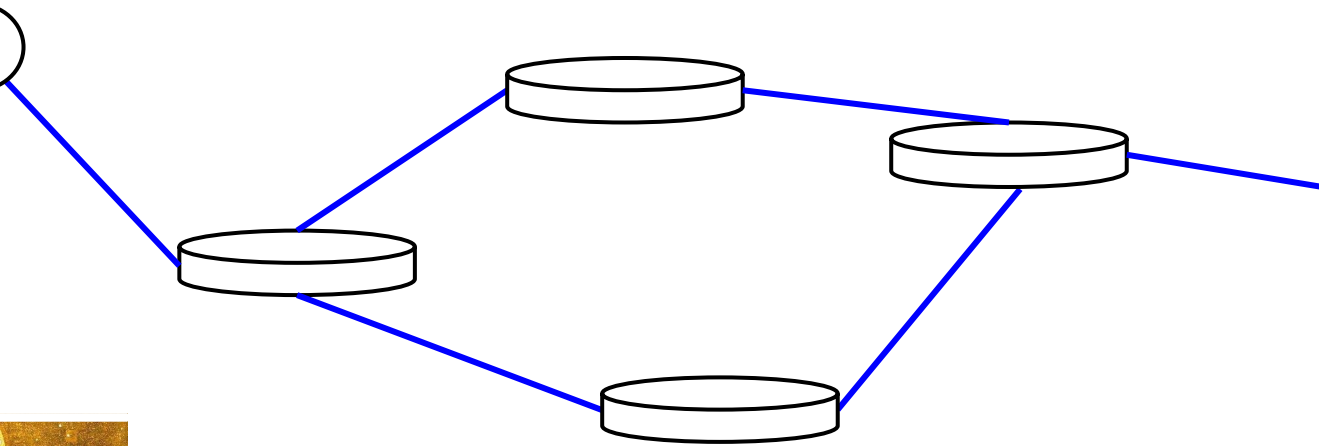
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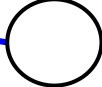
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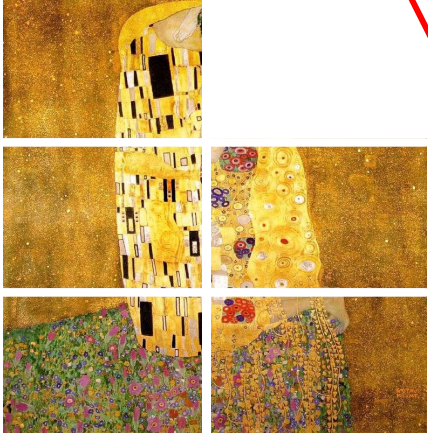
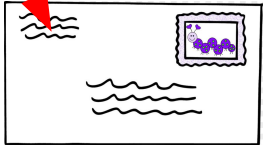
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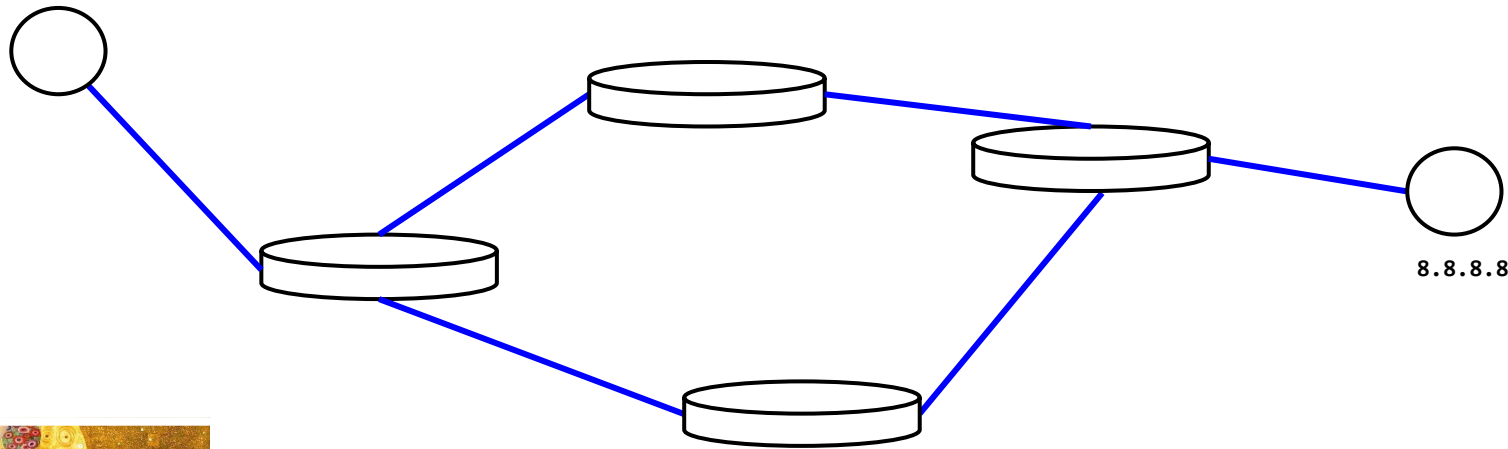


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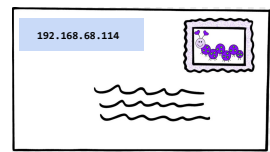
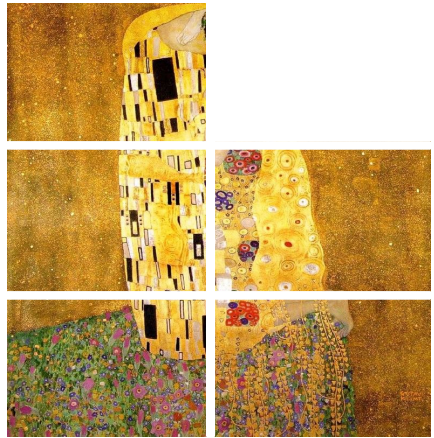




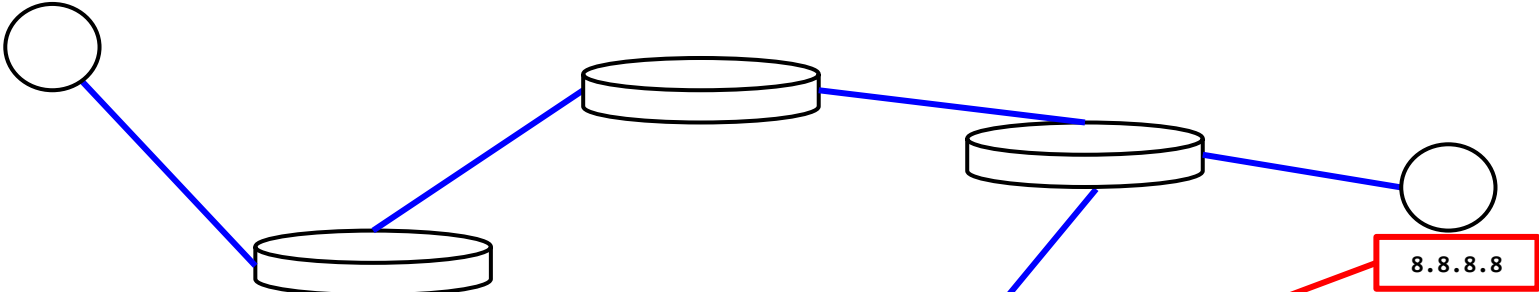
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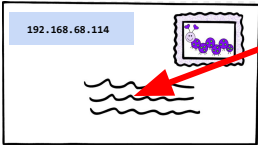
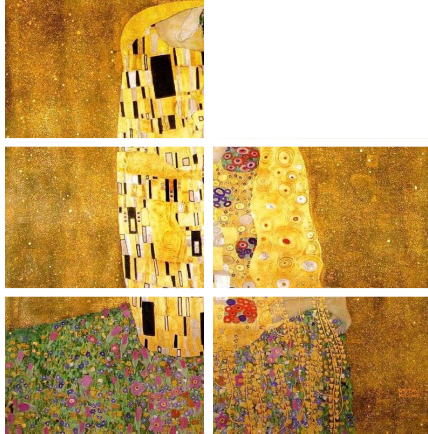
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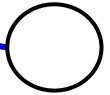
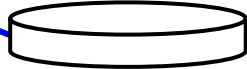
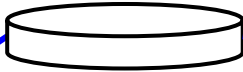
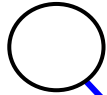
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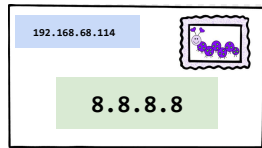
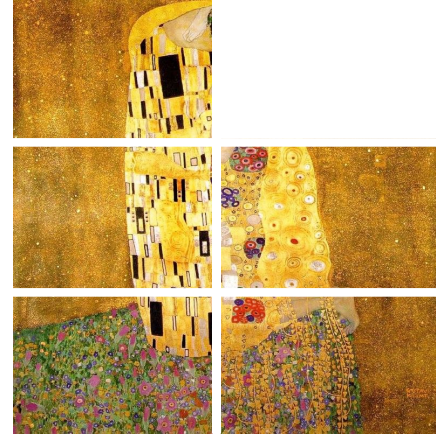
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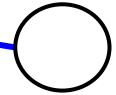
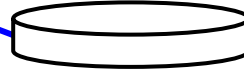
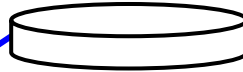
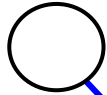
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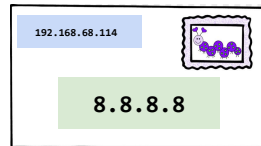
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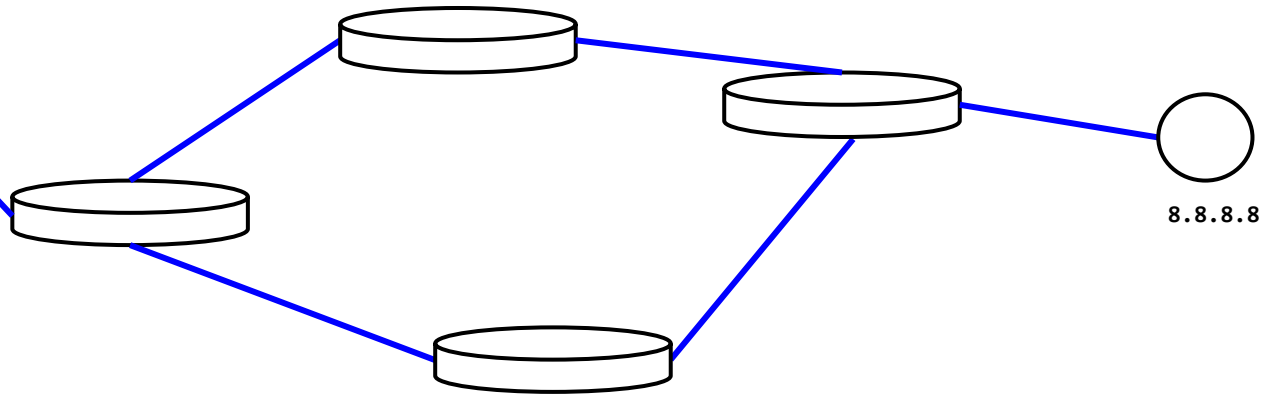


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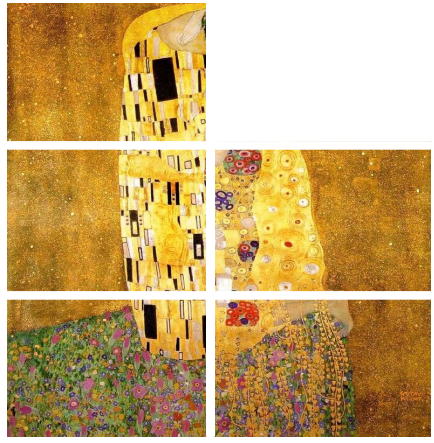
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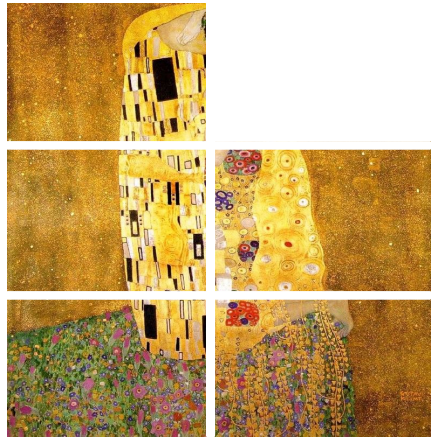
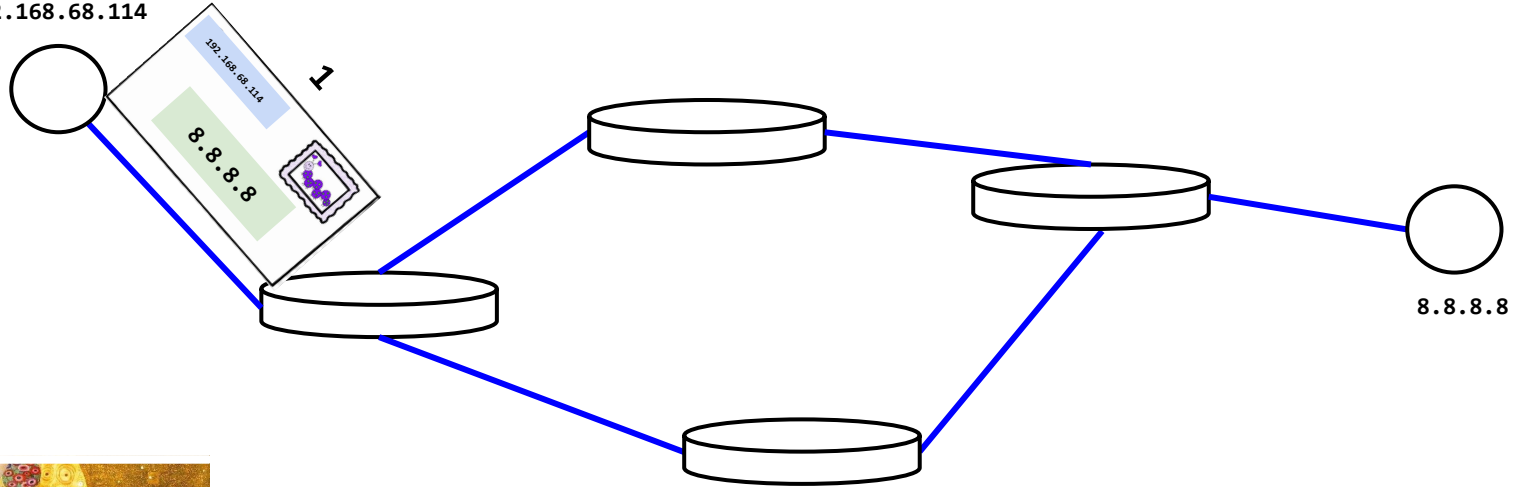
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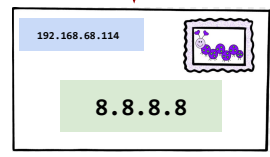
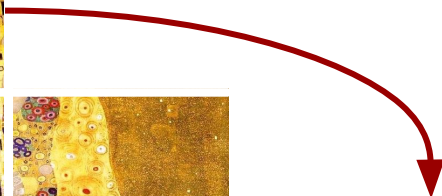
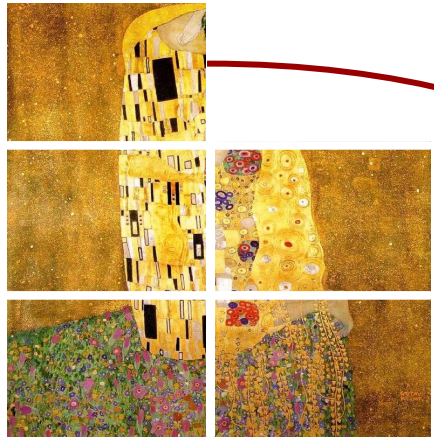
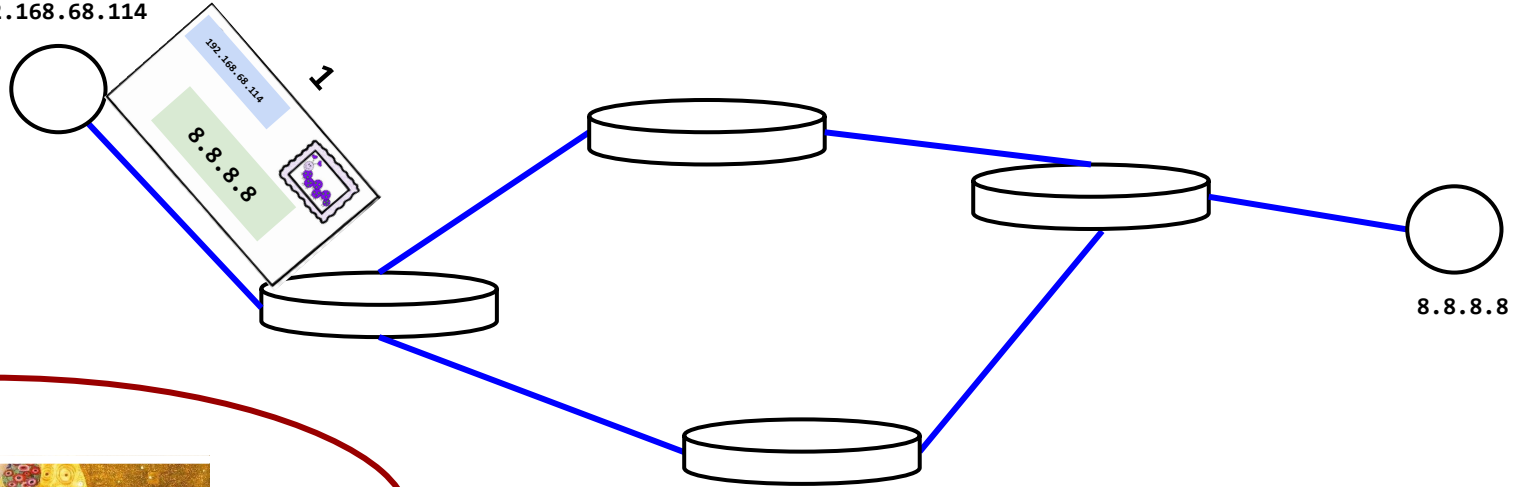
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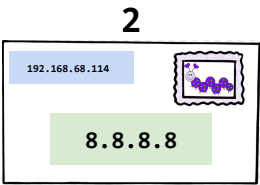
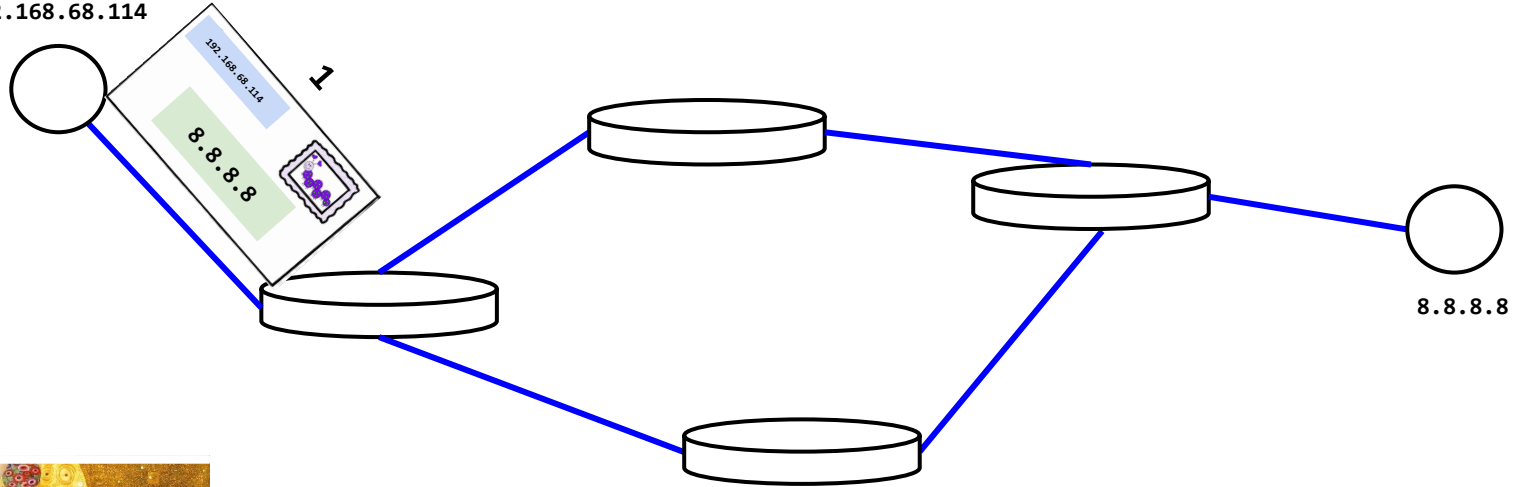
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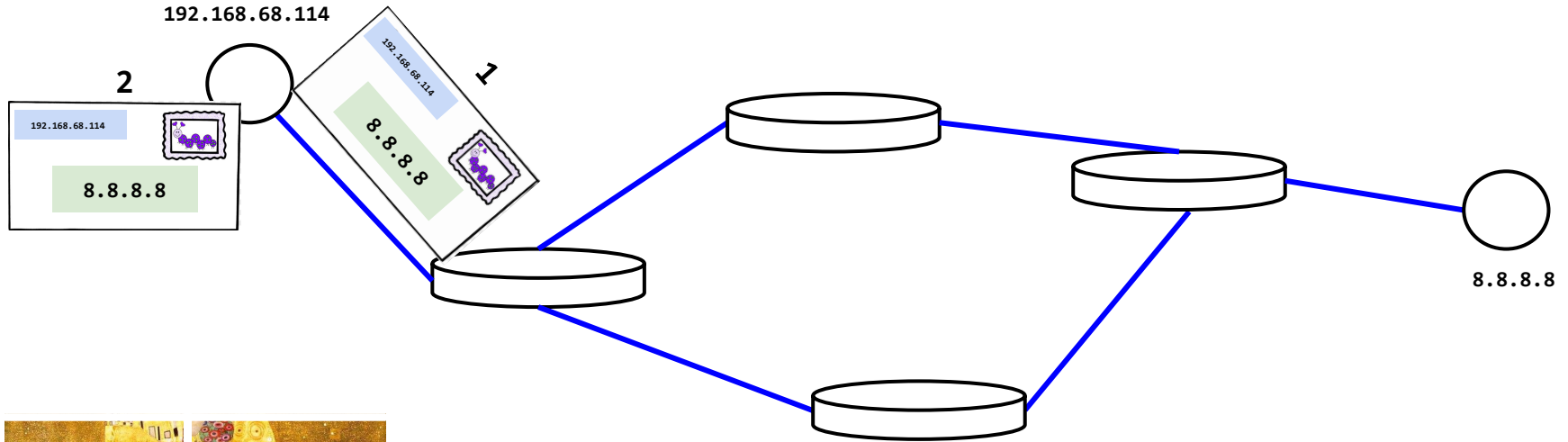
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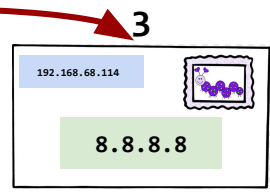
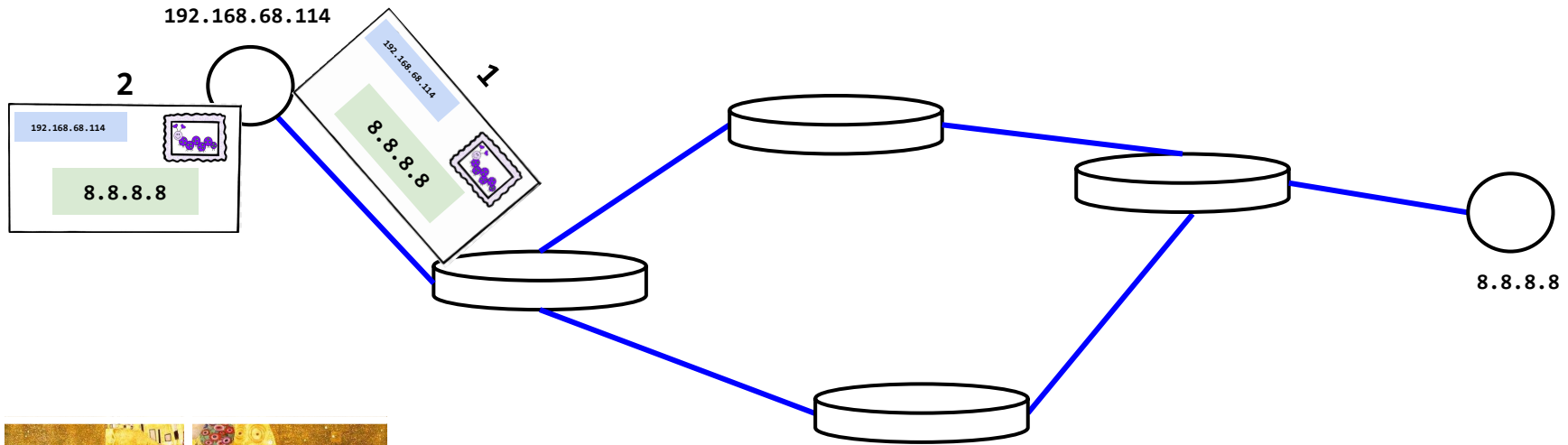


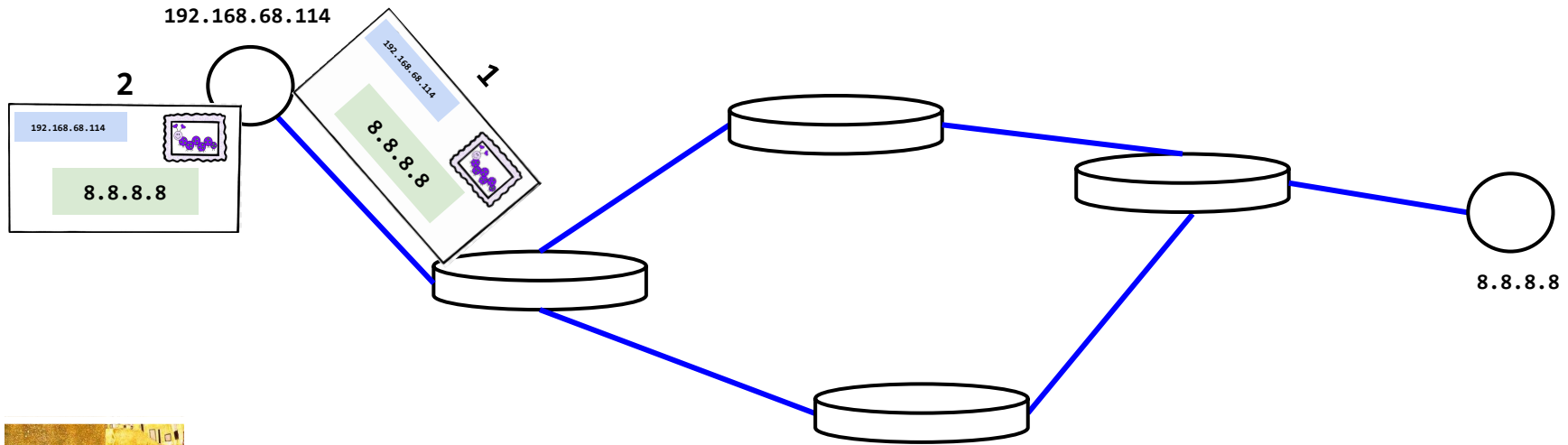
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**2**

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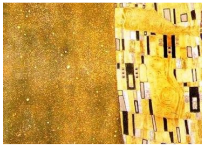
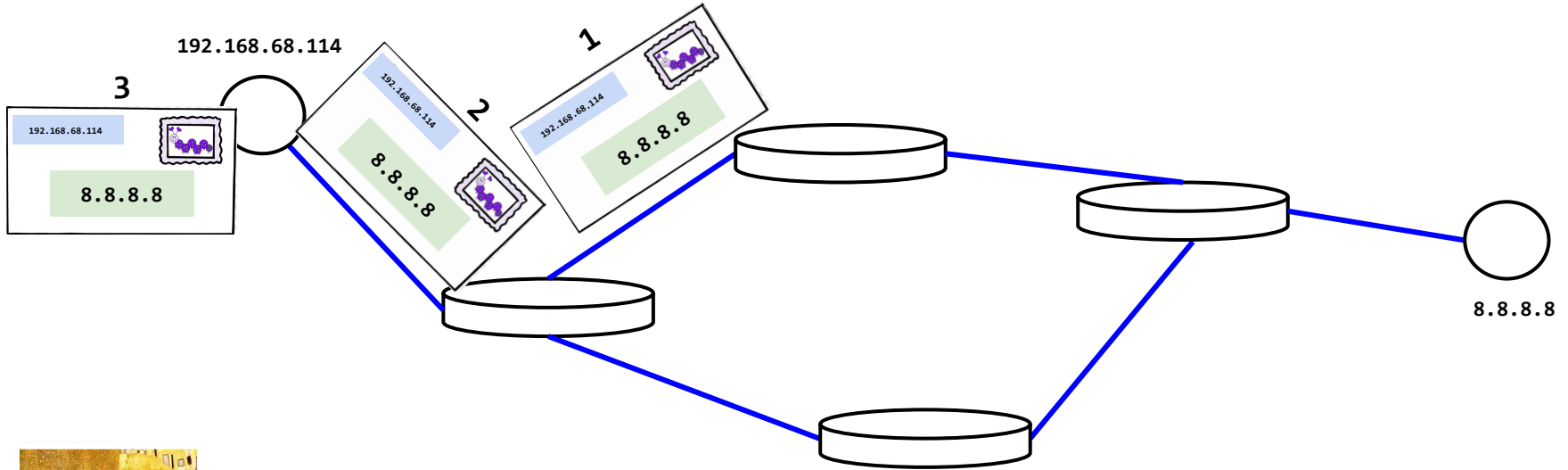
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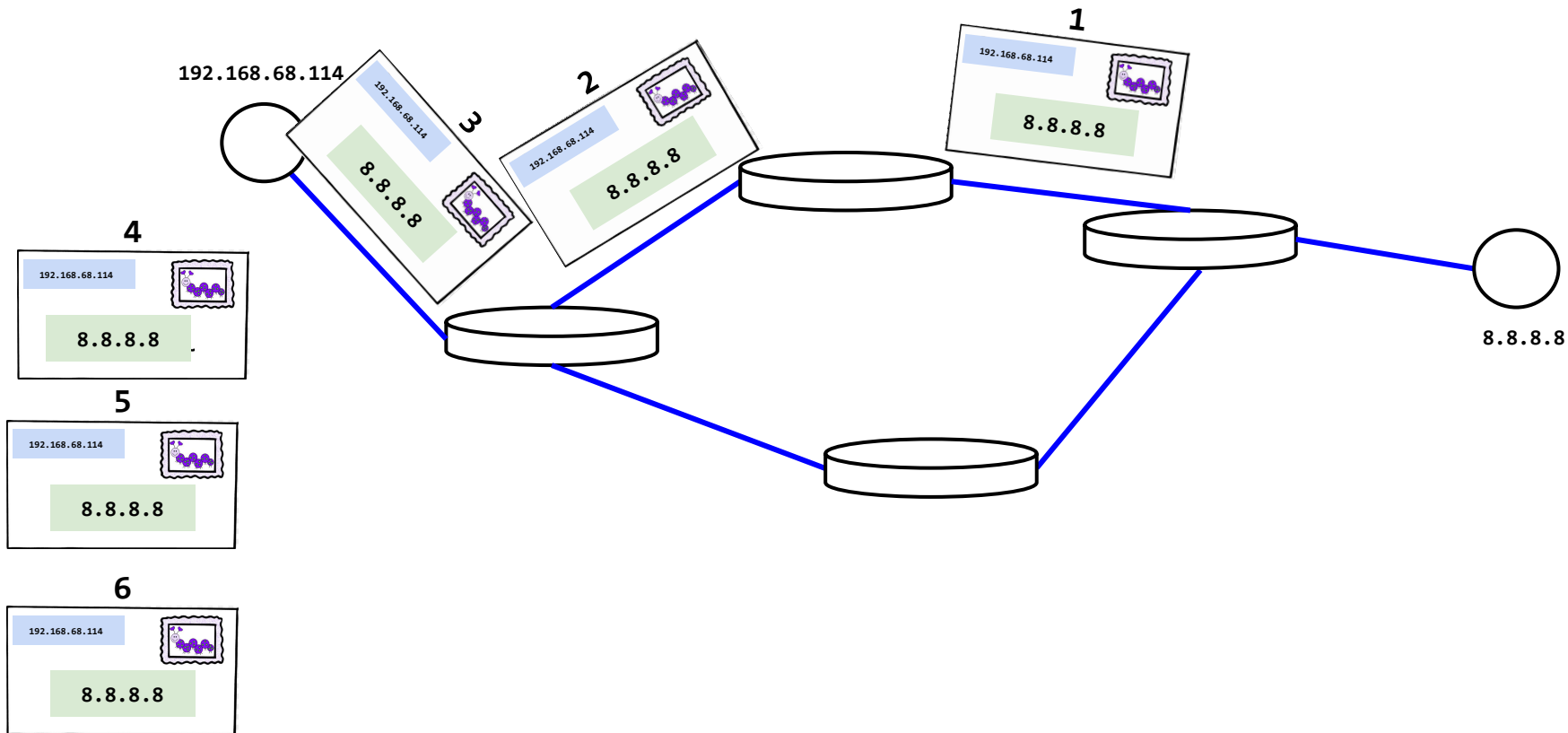
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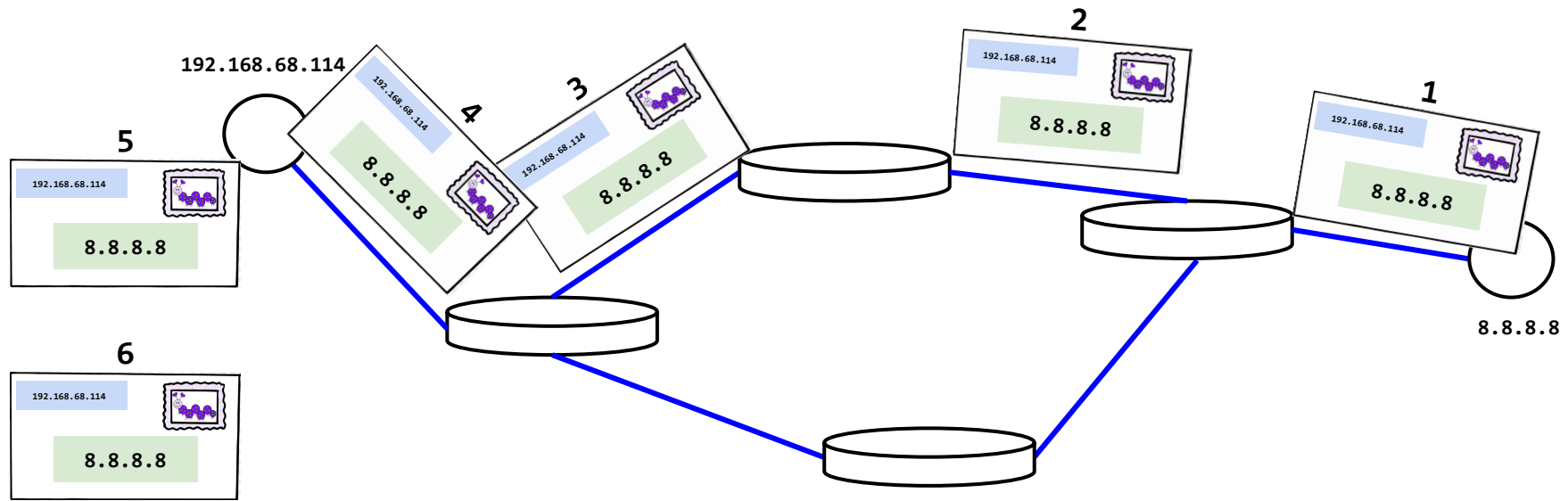
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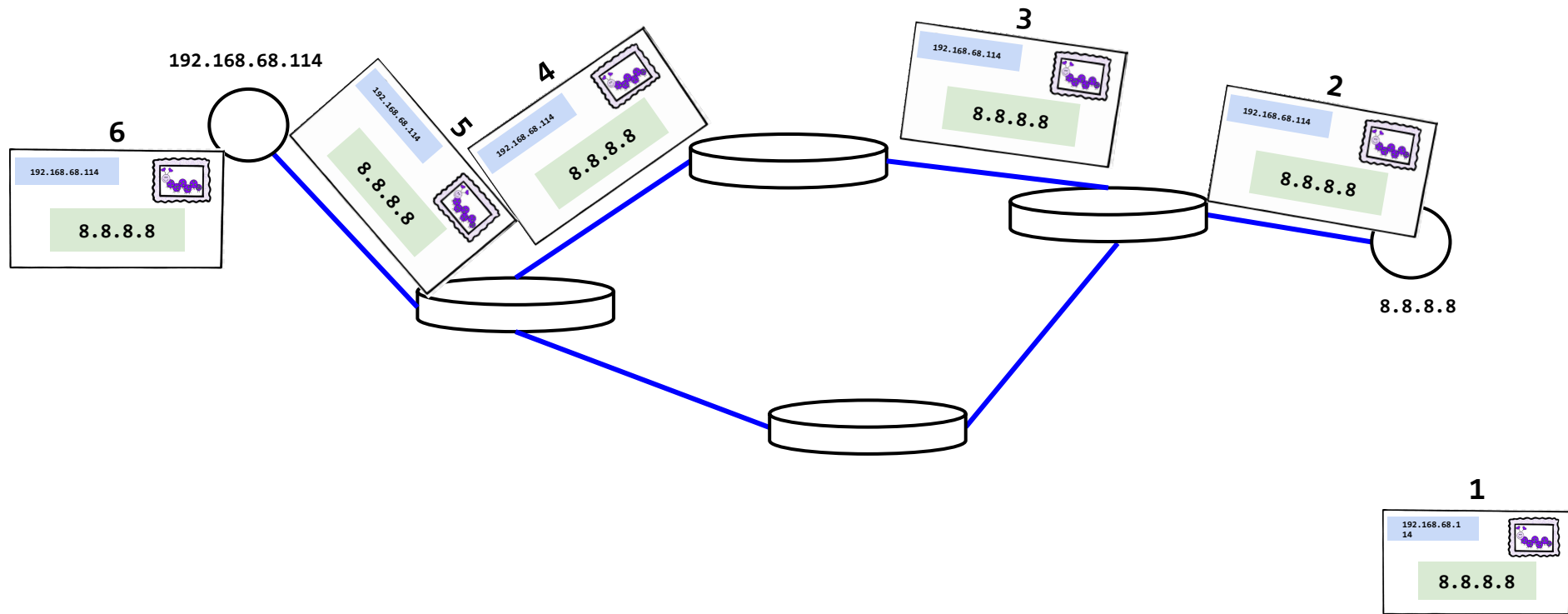
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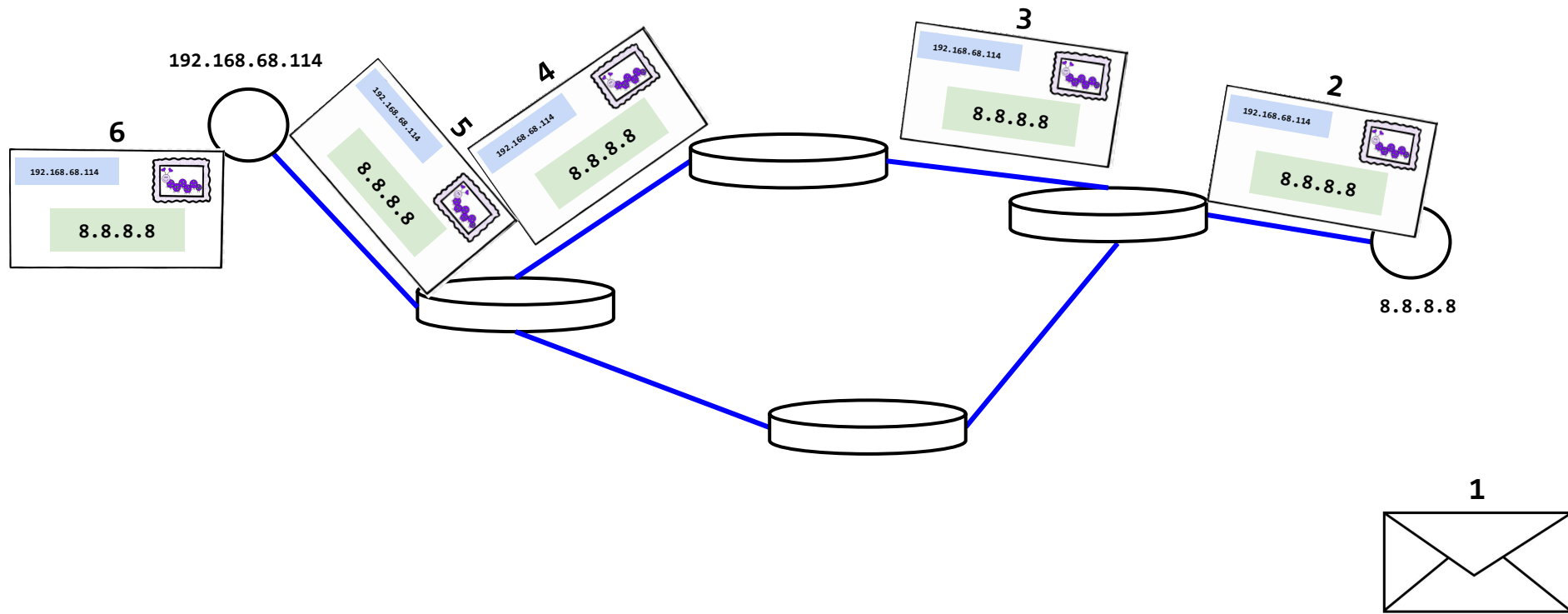




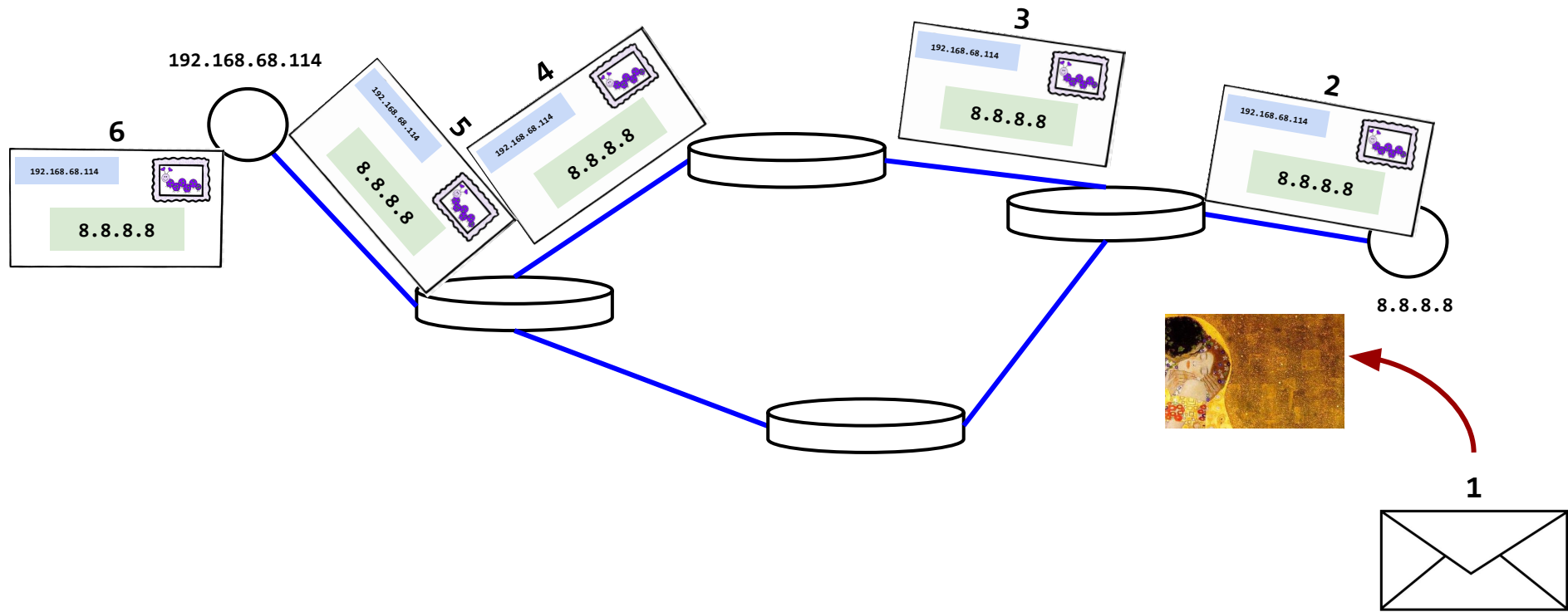


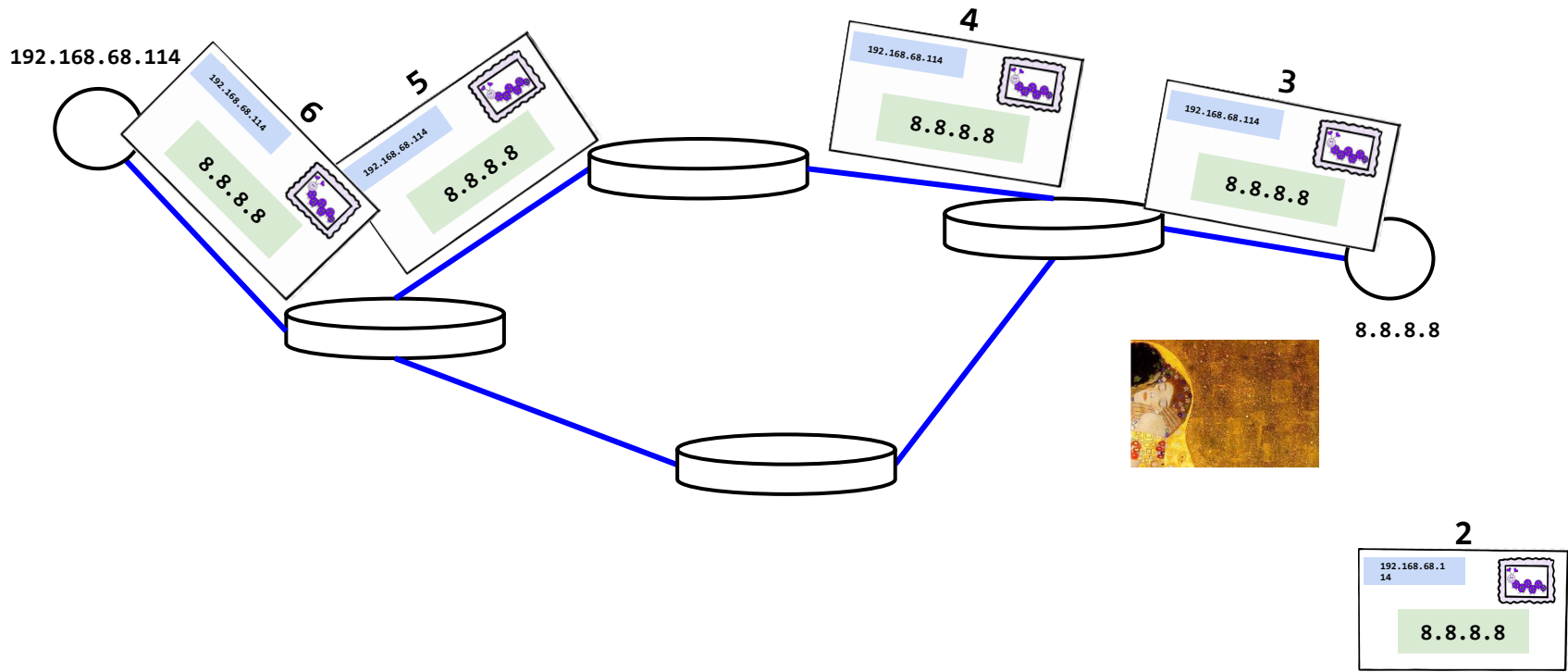


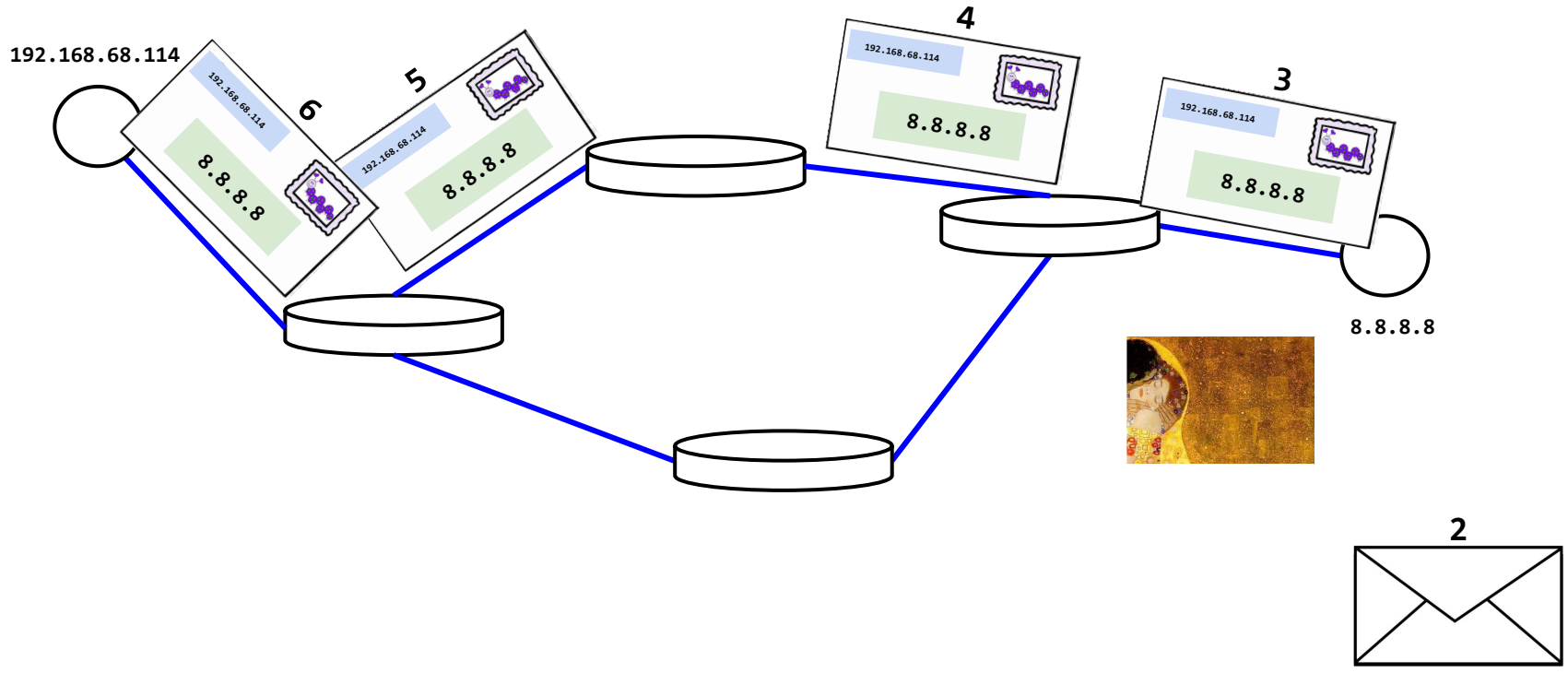


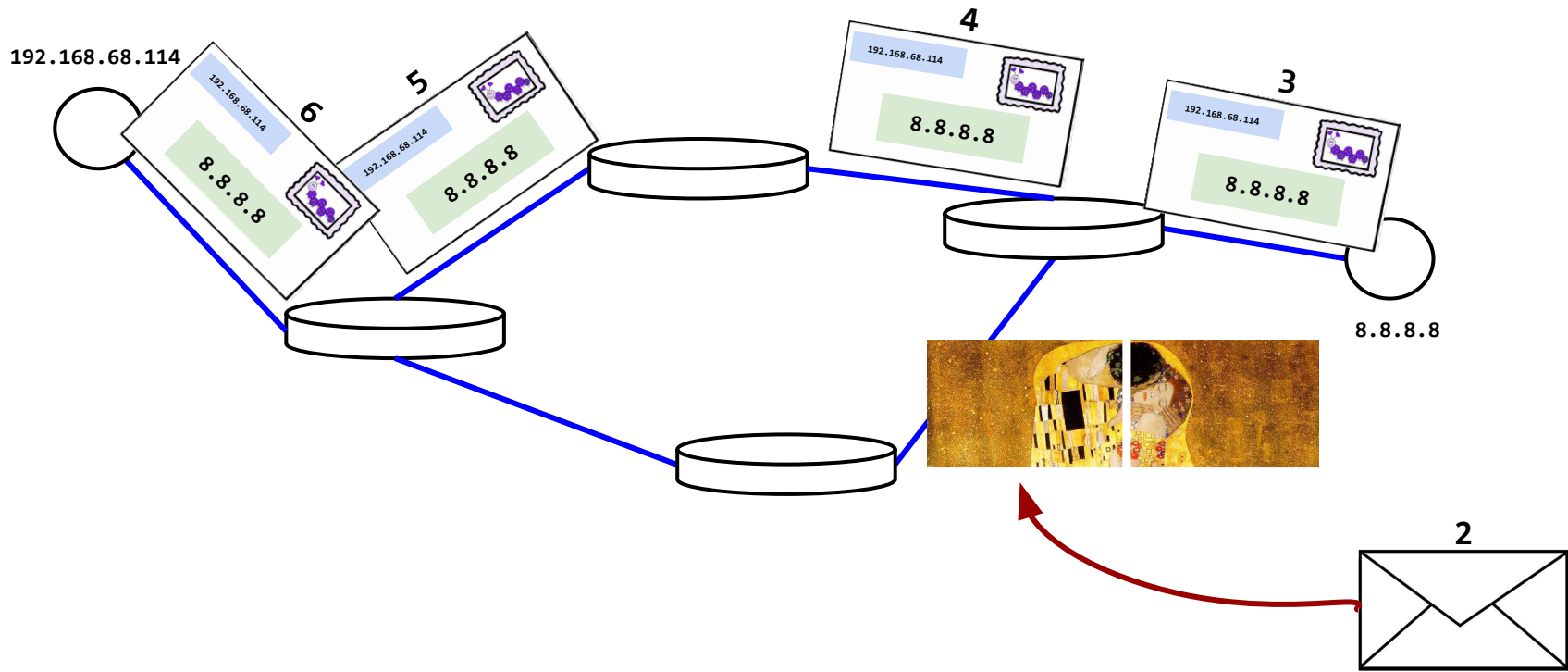




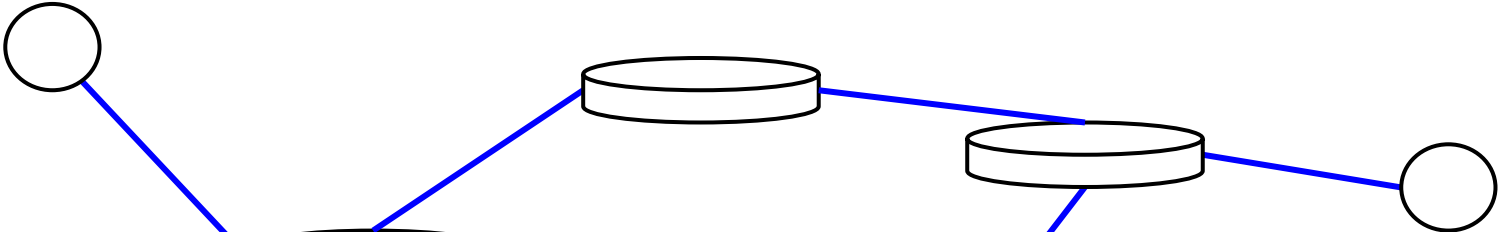








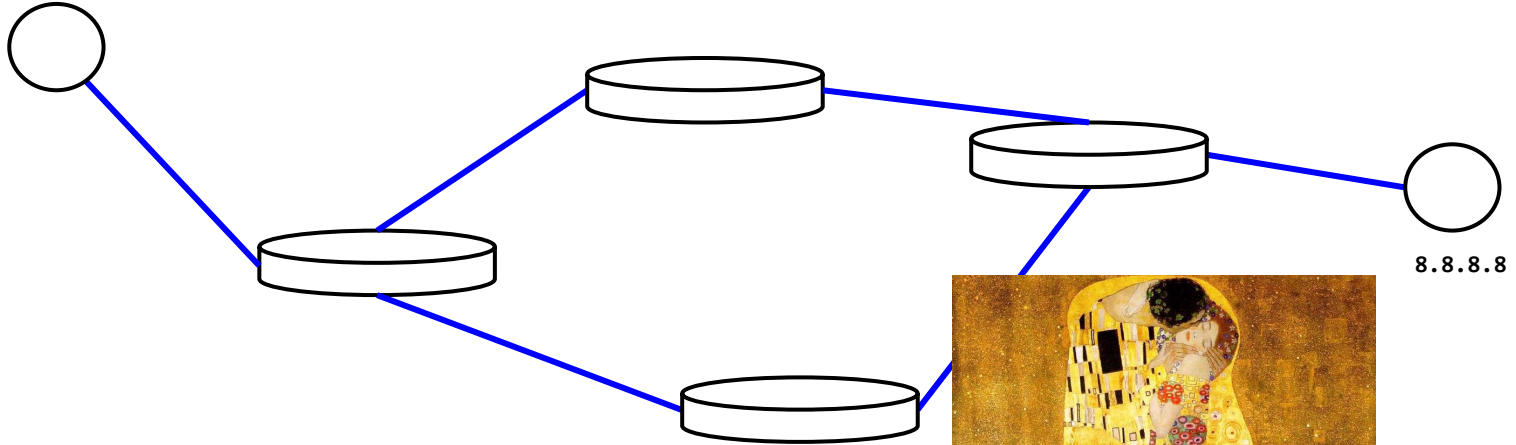
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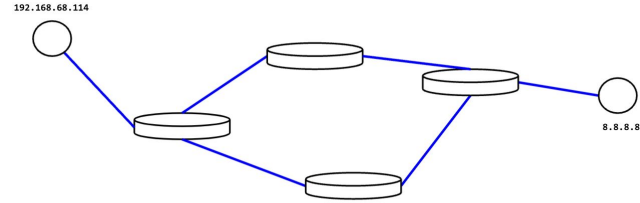


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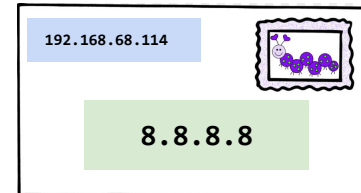


# Summary so far

1. Two computers communicate with each other using a network of routers.
2. As data is sent across the internet, it is put into “packets” that have a source IP address and a destination IP address.



1



# Traceroute

**traceroute** is used to display possible paths from one IP address to another IP address across an internet network.

You can see the path **traceroute** takes and what routers it goes through.

(On Windows, use **tracert**)



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1. It doesn't promise to deliver packets in order
2. It doesn't promise to deliver packets on time or quickly

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If you remember one thing from this lecture today, it is that...

**the internet cannot be trusted.**

The internet makes a “best effort” attempt to deliver packets. This means that:

1. It doesn't promise to deliver packets in order
2. It doesn't promise to deliver packets on time or quickly
3. It doesn't even promise to deliver packets at all!

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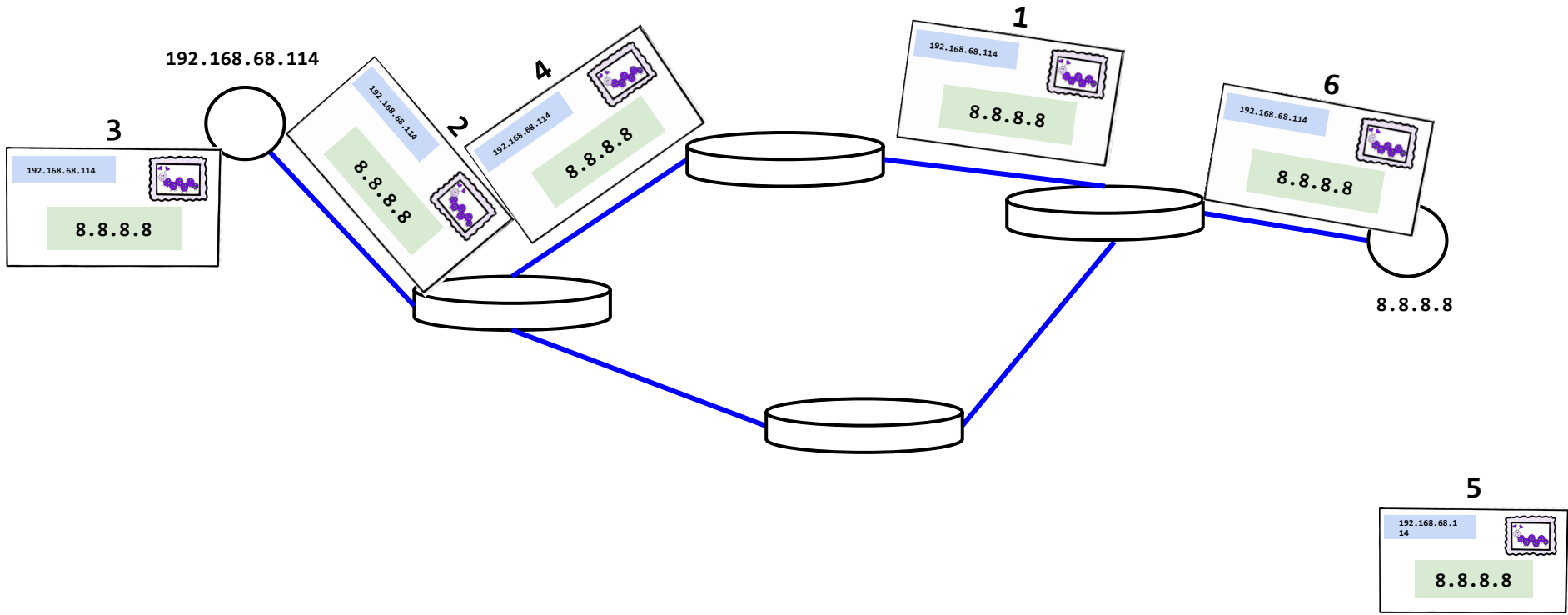
1. It doesn't promise to deliver packets in order
2. It doesn't promise to deliver packets on time or quickly
3. It doesn't even promise to deliver packets at all!

# The Caveat

The internet makes a “best effort” attempt to deliver packets. This means that:

1. **It doesn't promise to deliver packets in order**
2. It doesn't promise to deliver packets on time or quickly
3. It doesn't even promise to deliver packets at all!

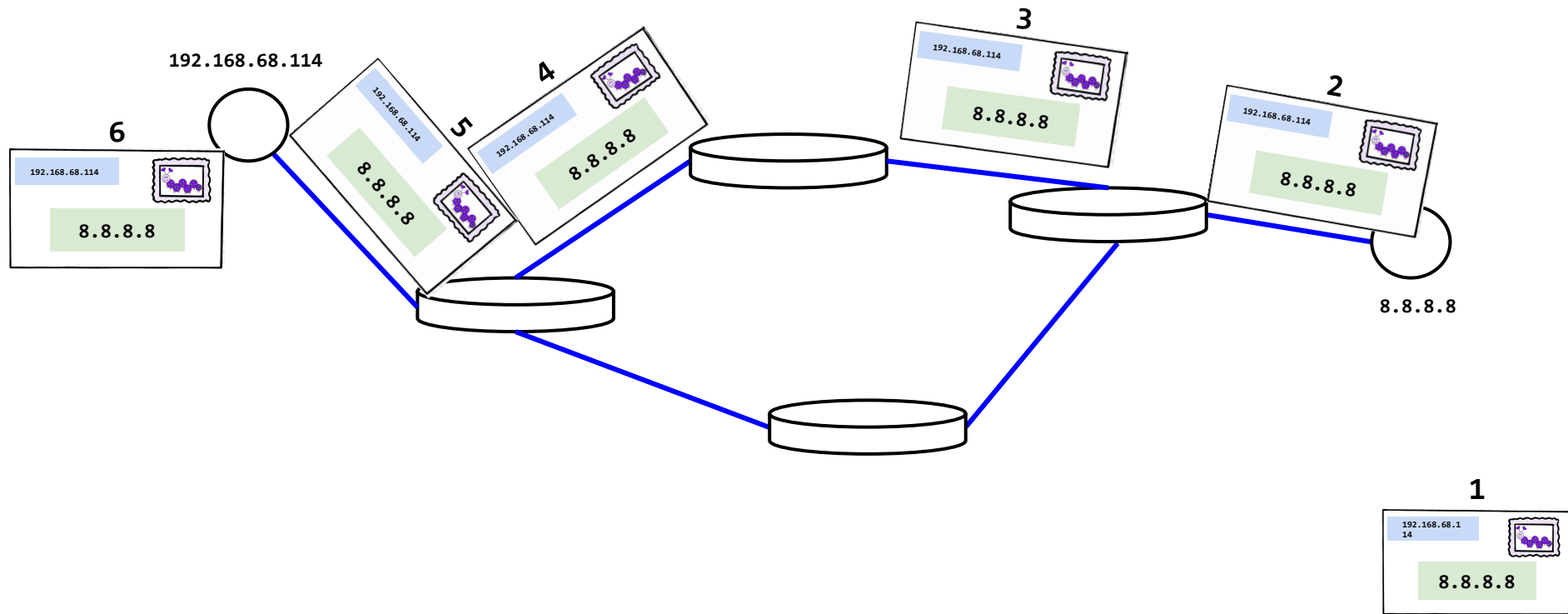


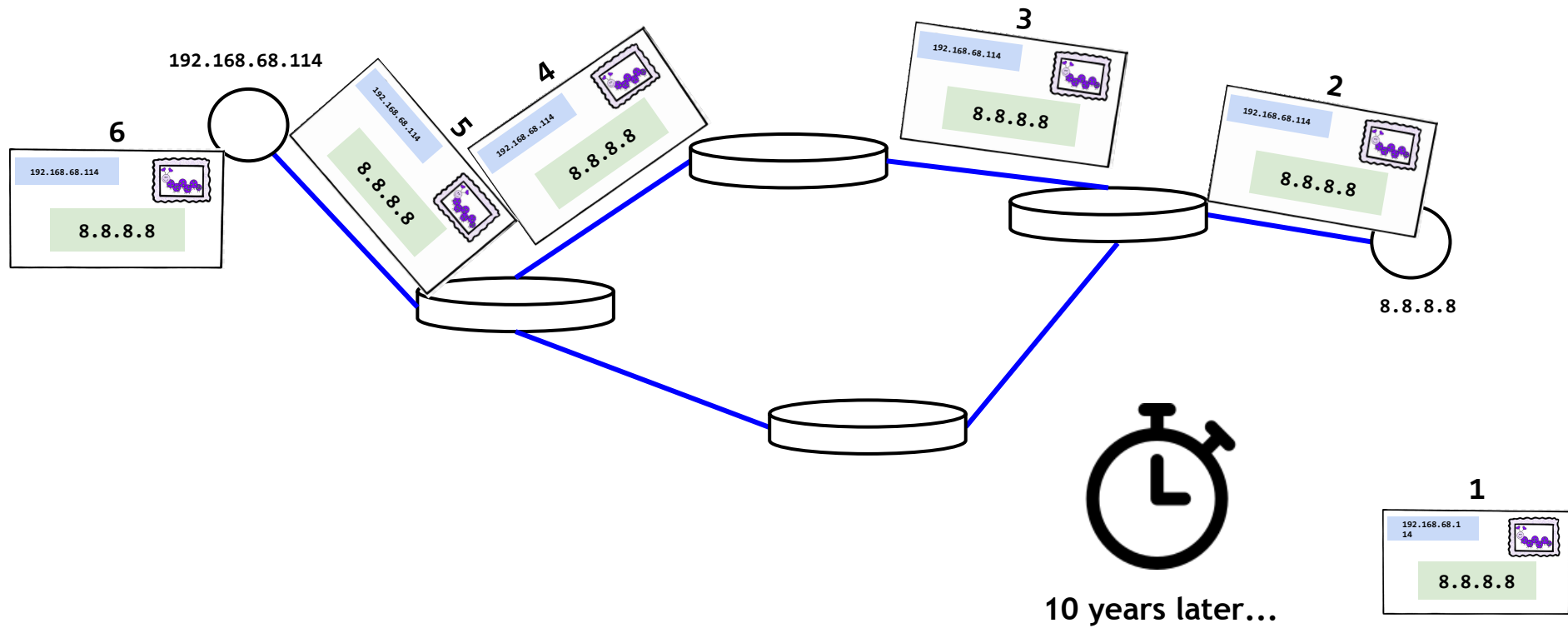


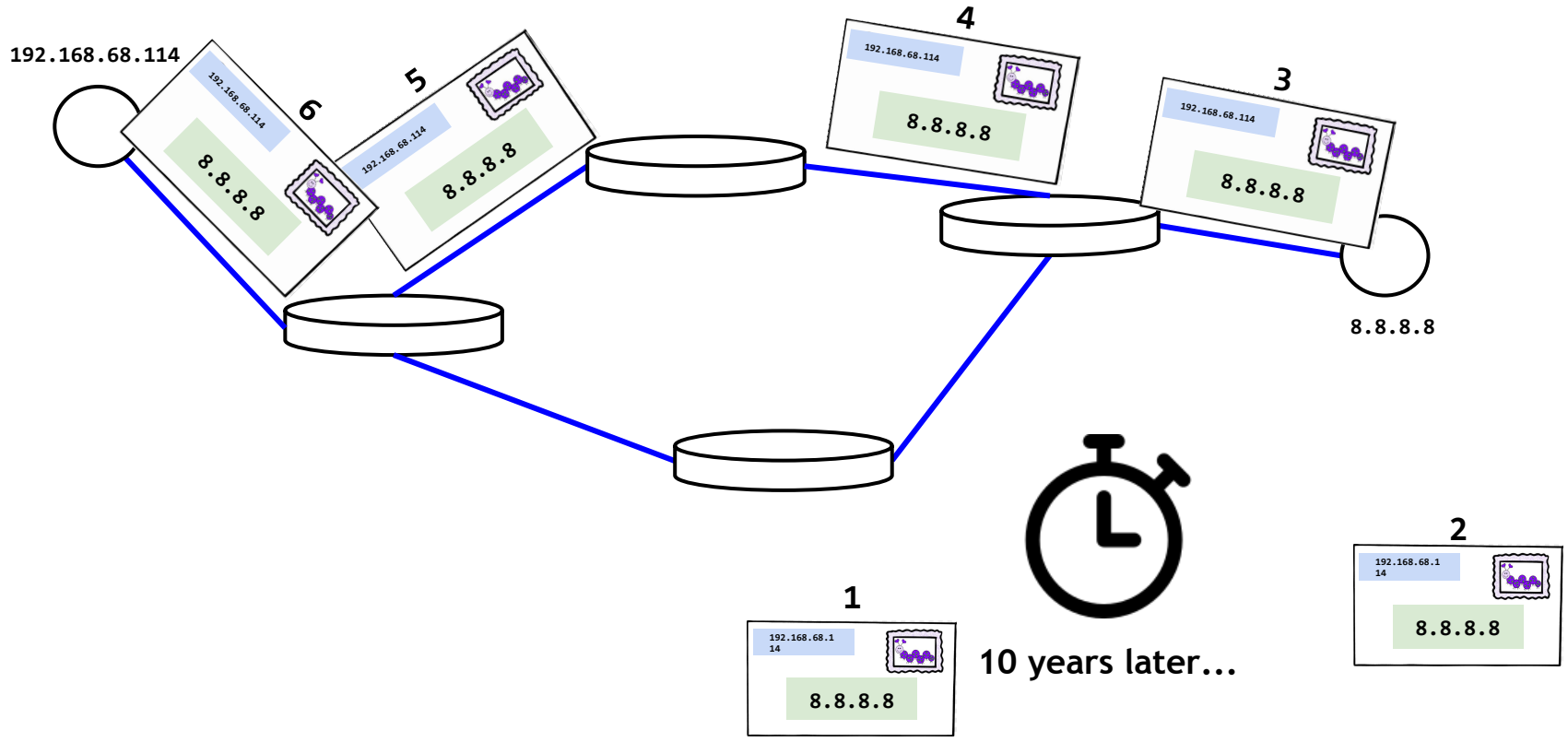
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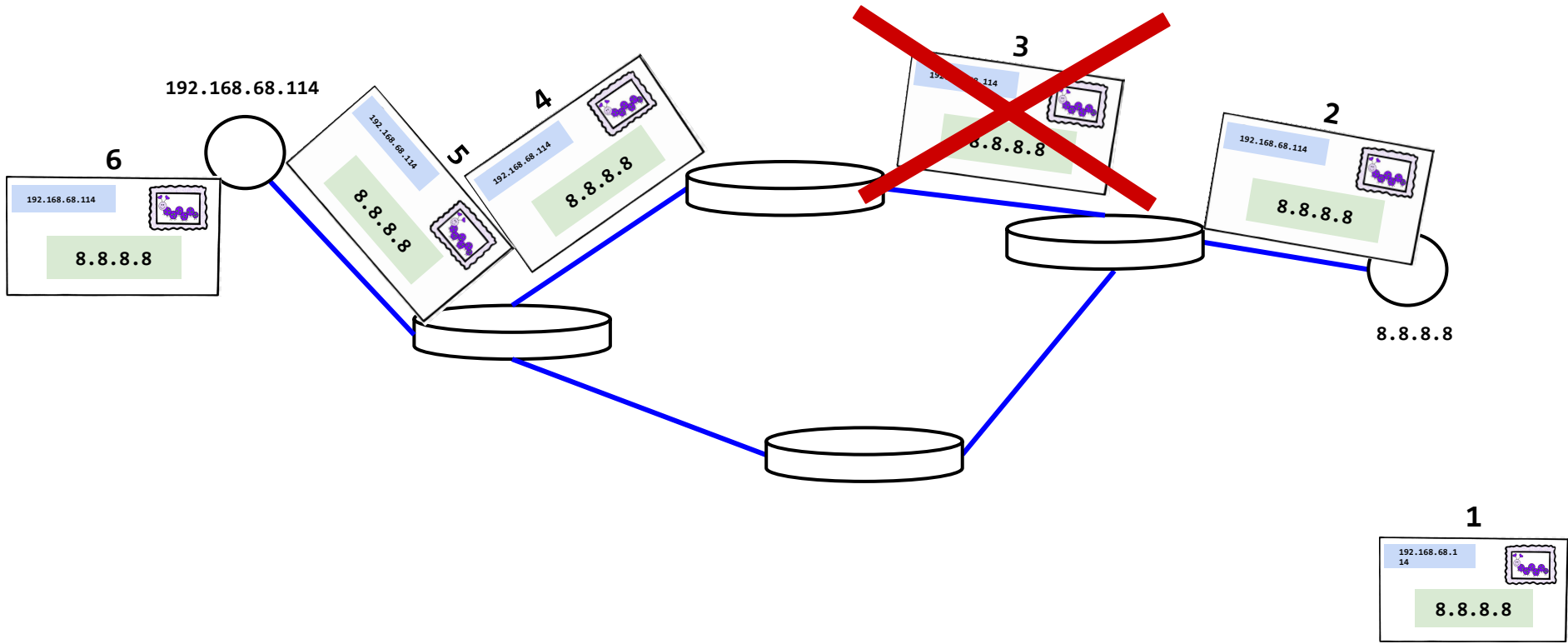


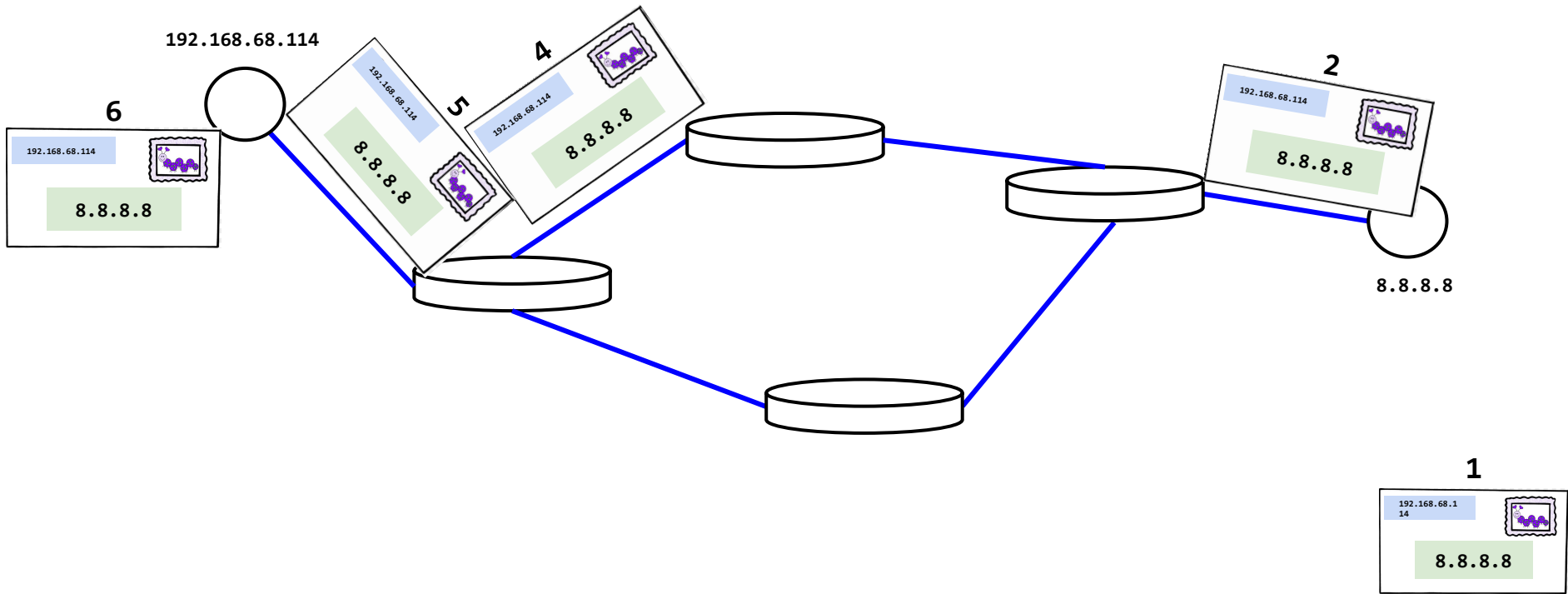


# The Caveat

The internet makes a “best effort” attempt to deliver packets. This means that:

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# Fixing the Internet

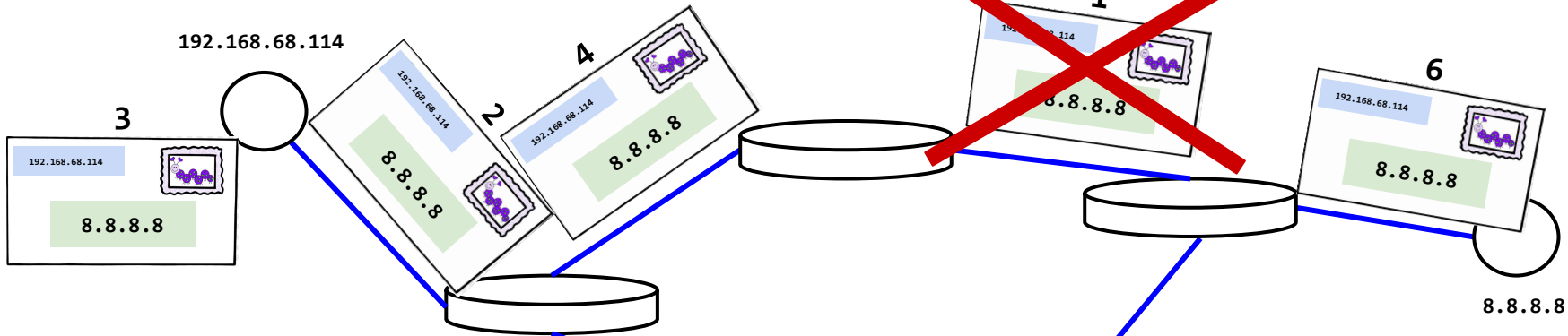
The internet makes a “best effort” attempt to deliver packets. This means that:

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**Given the problems with sending internet packets, how can we avoid these?**

**Big Assumption:** it doesn't cost much for us to send (or resend) a packet.

**Problem 1: Packets are dropped**

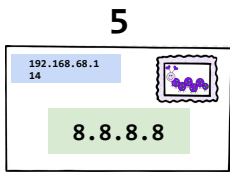


**Problem 2: Packets arrive out of order**

**Problem 3: Packets take a long time to arrive**



10 years later...



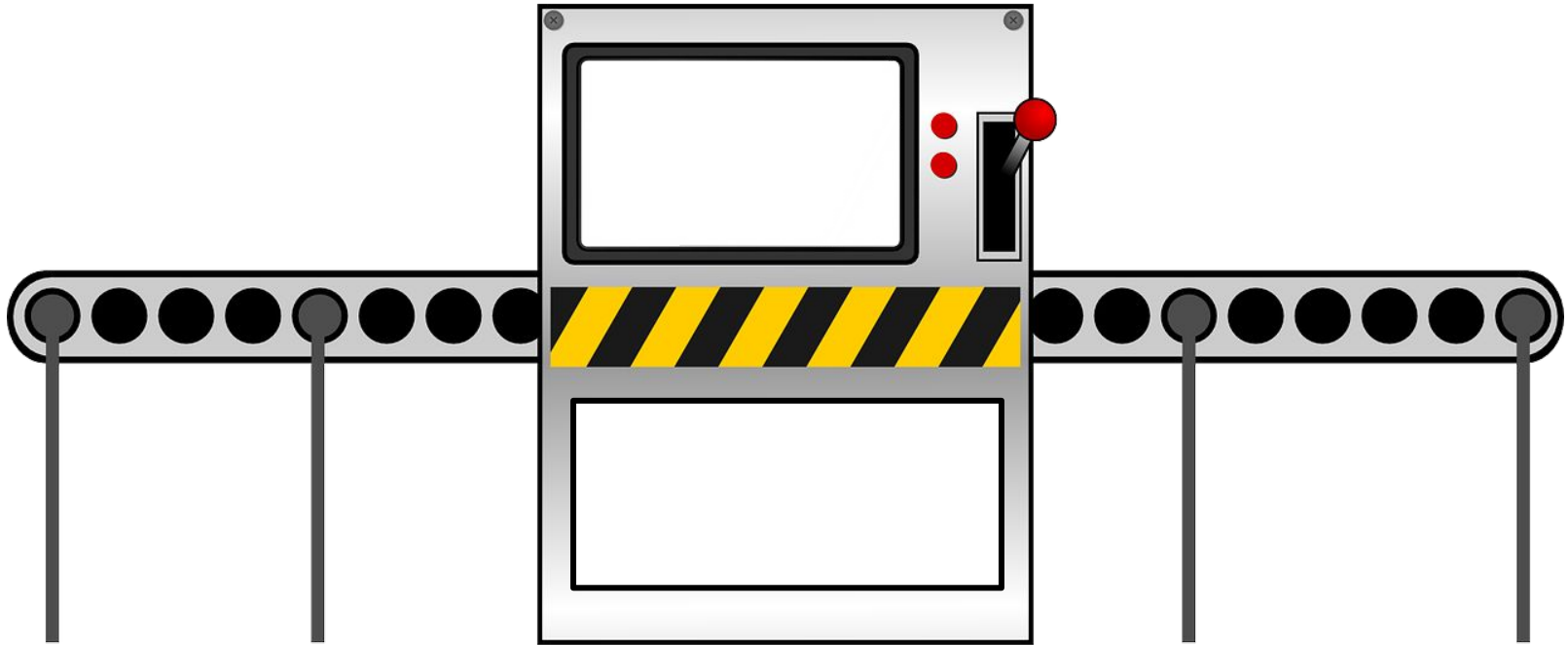
# TCP

TCP (Transmission Control Protocol) is a *reliable* byte stream of data.



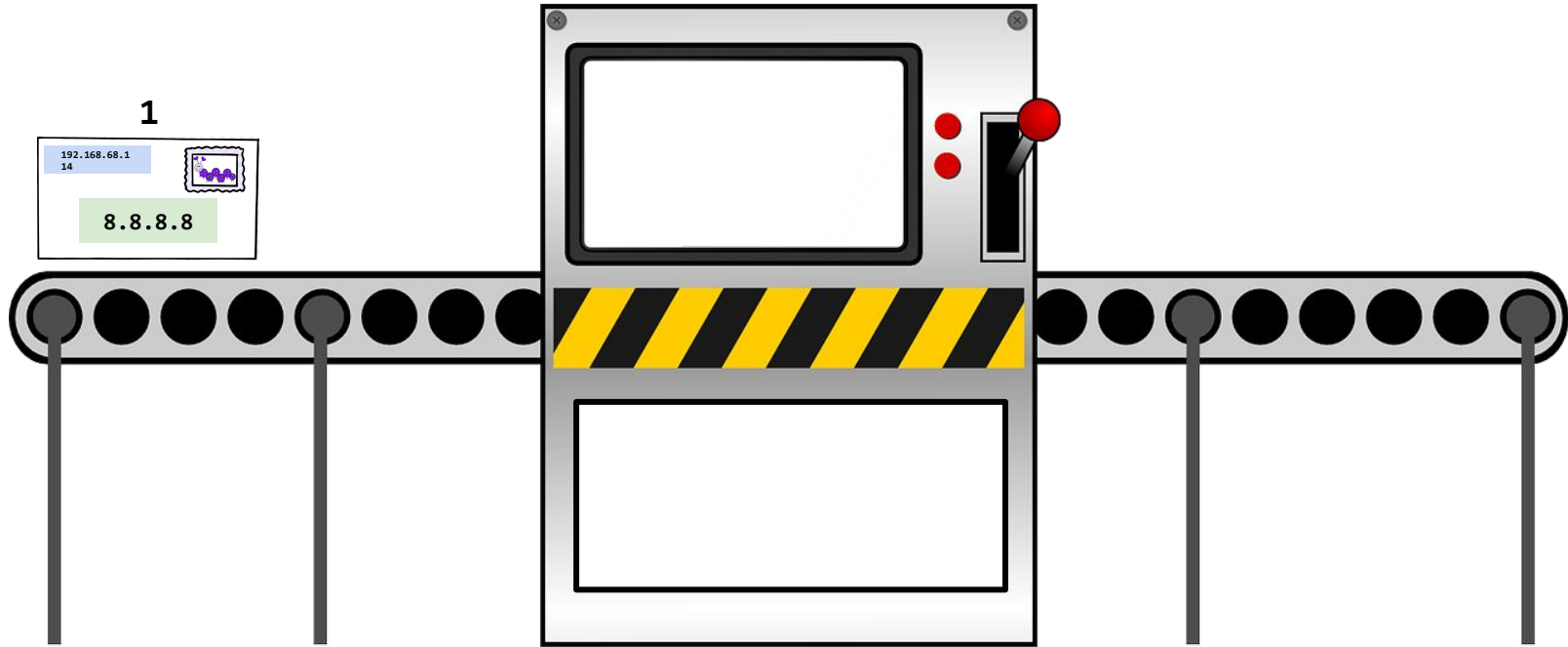
Now sending  
packet number: 1

Now accepting  
packet number: 1



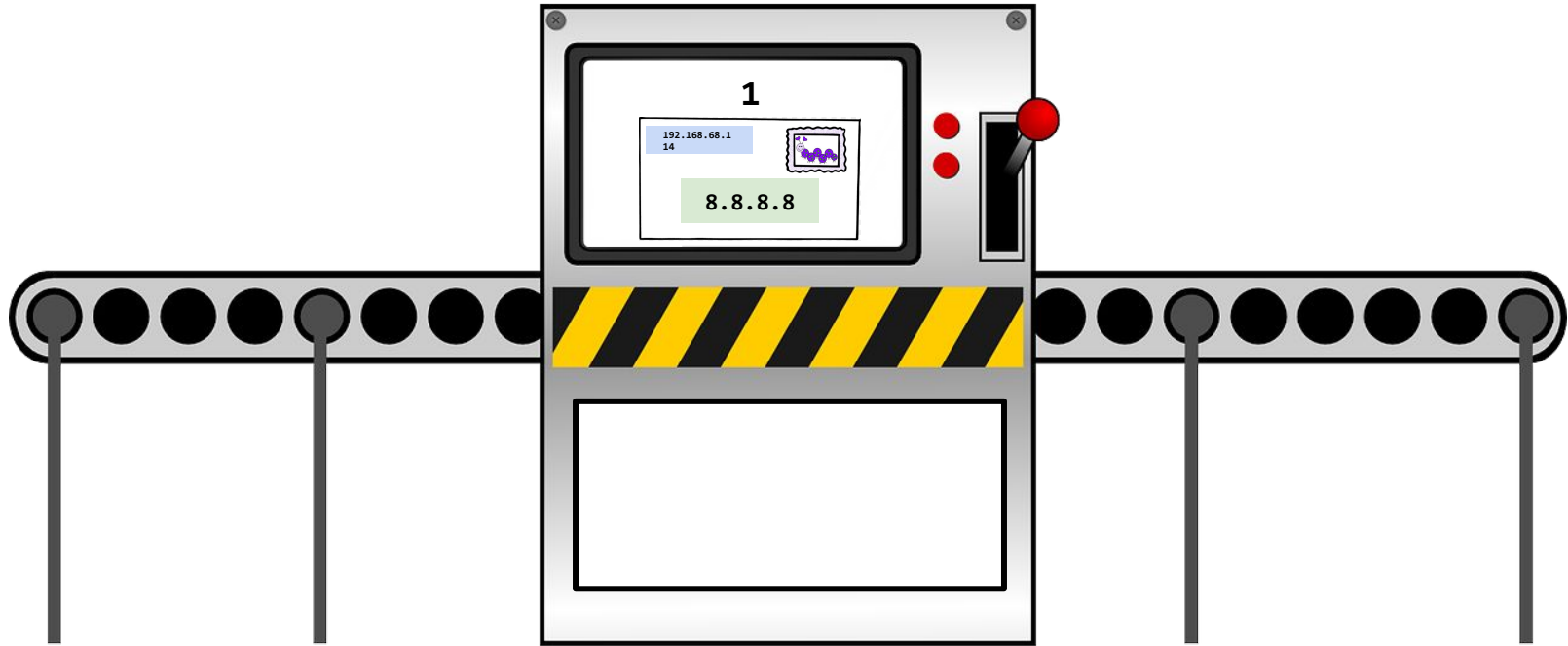
Now sending  
packet number: 1

Now accepting  
packet number: 1



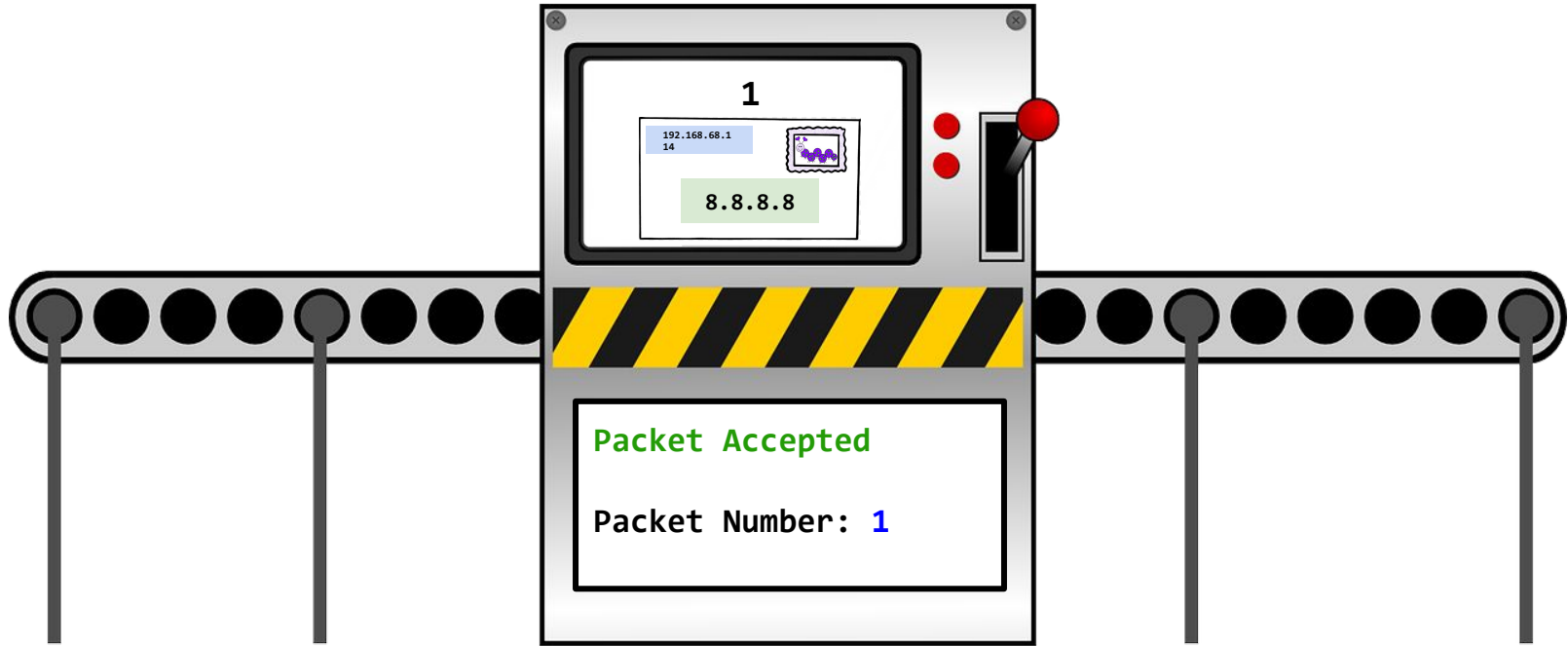
Now sending  
packet number: 1

Now accepting  
packet number: 1



Now sending  
packet number: 1

Now accepting  
packet number: 1

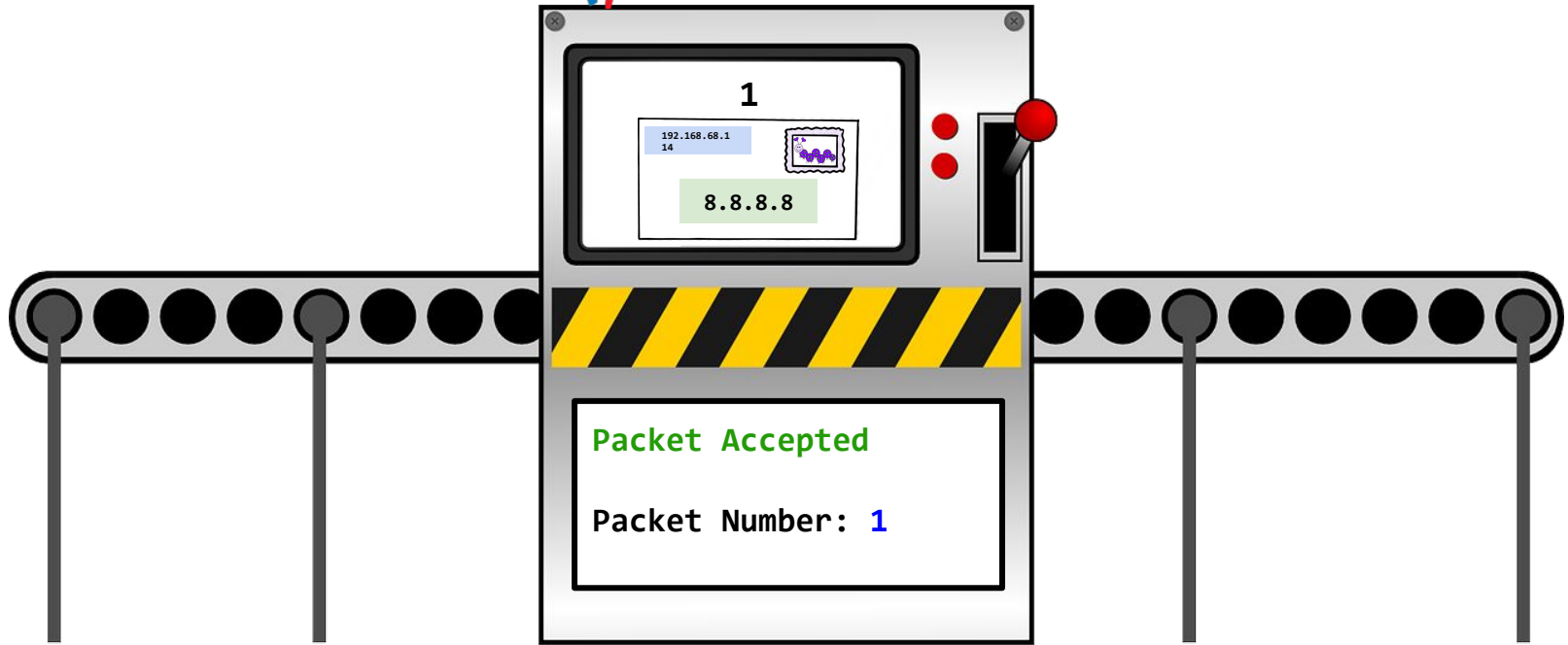


Now sending  
packet number: 1



Packet  
Accepted

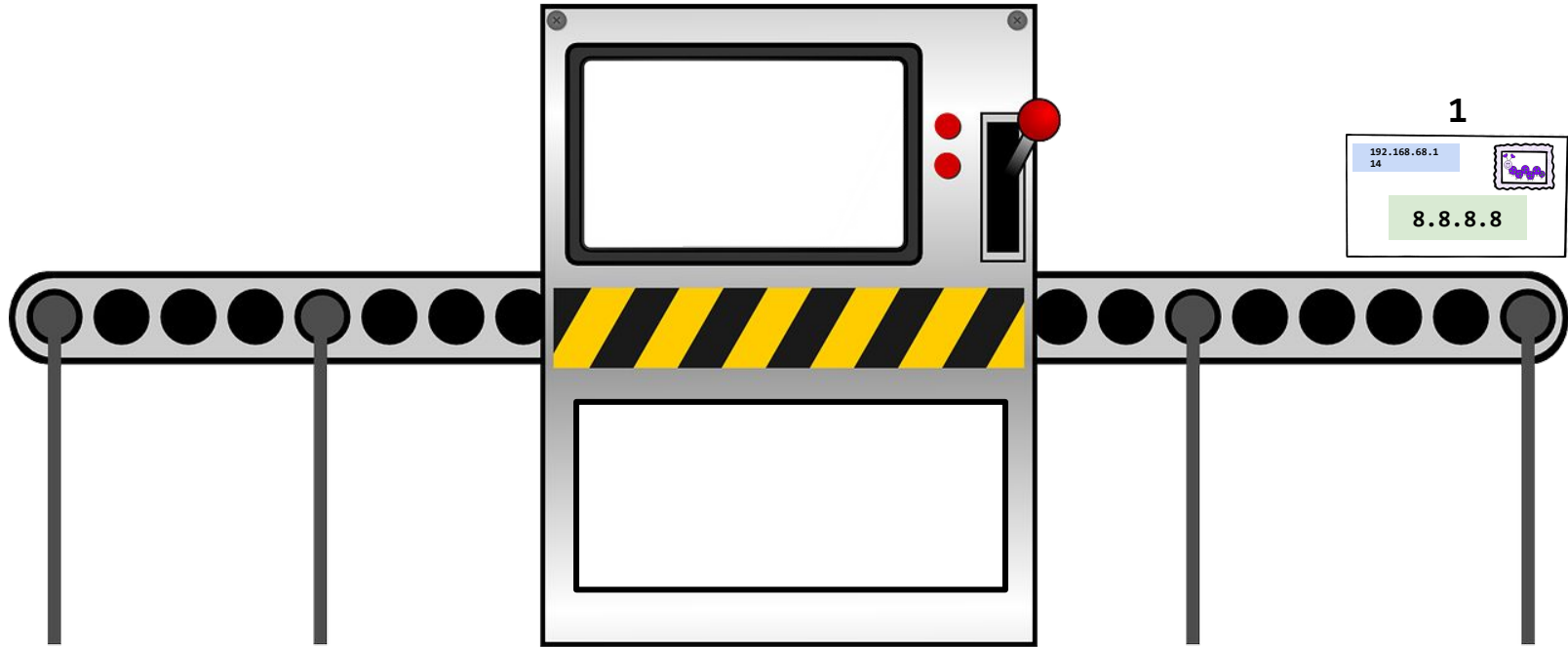
Now accepting  
packet number: 1





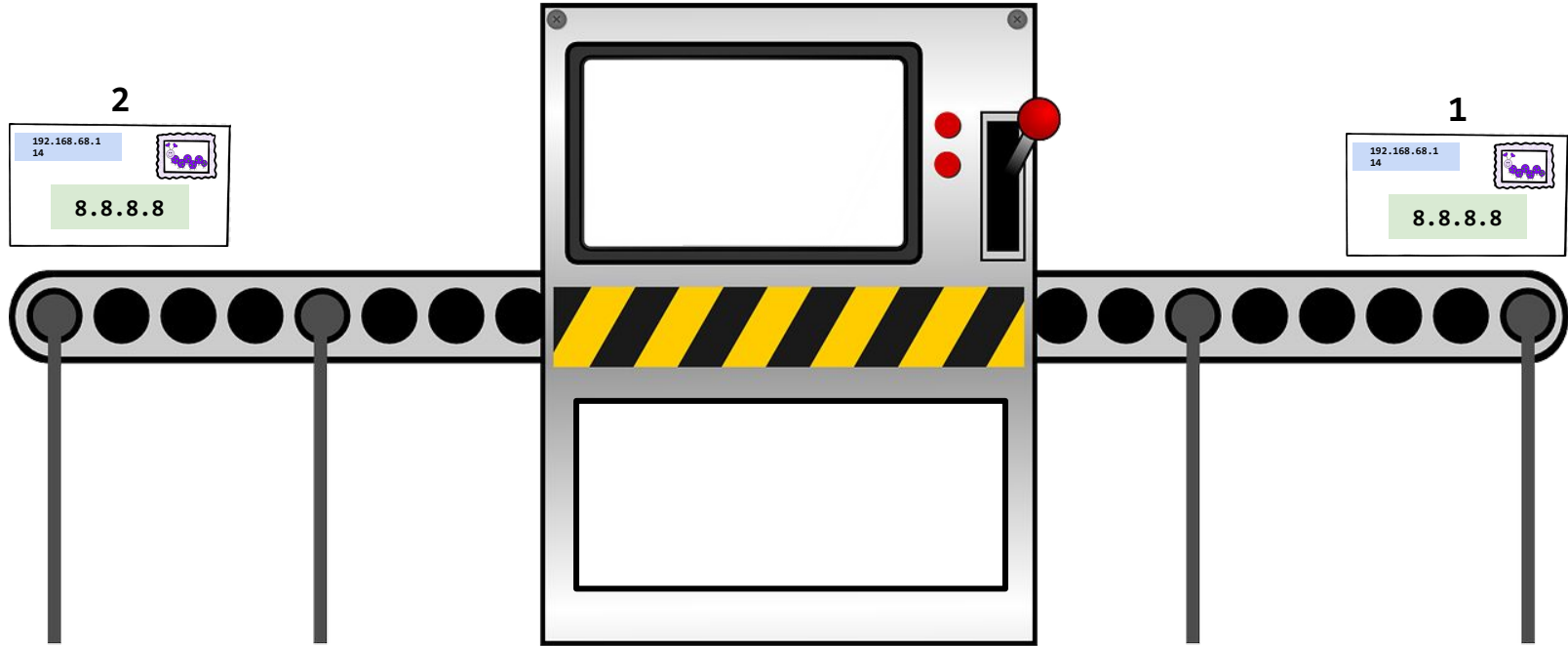
Now sending  
packet number: 2

Now accepting  
packet number: 2



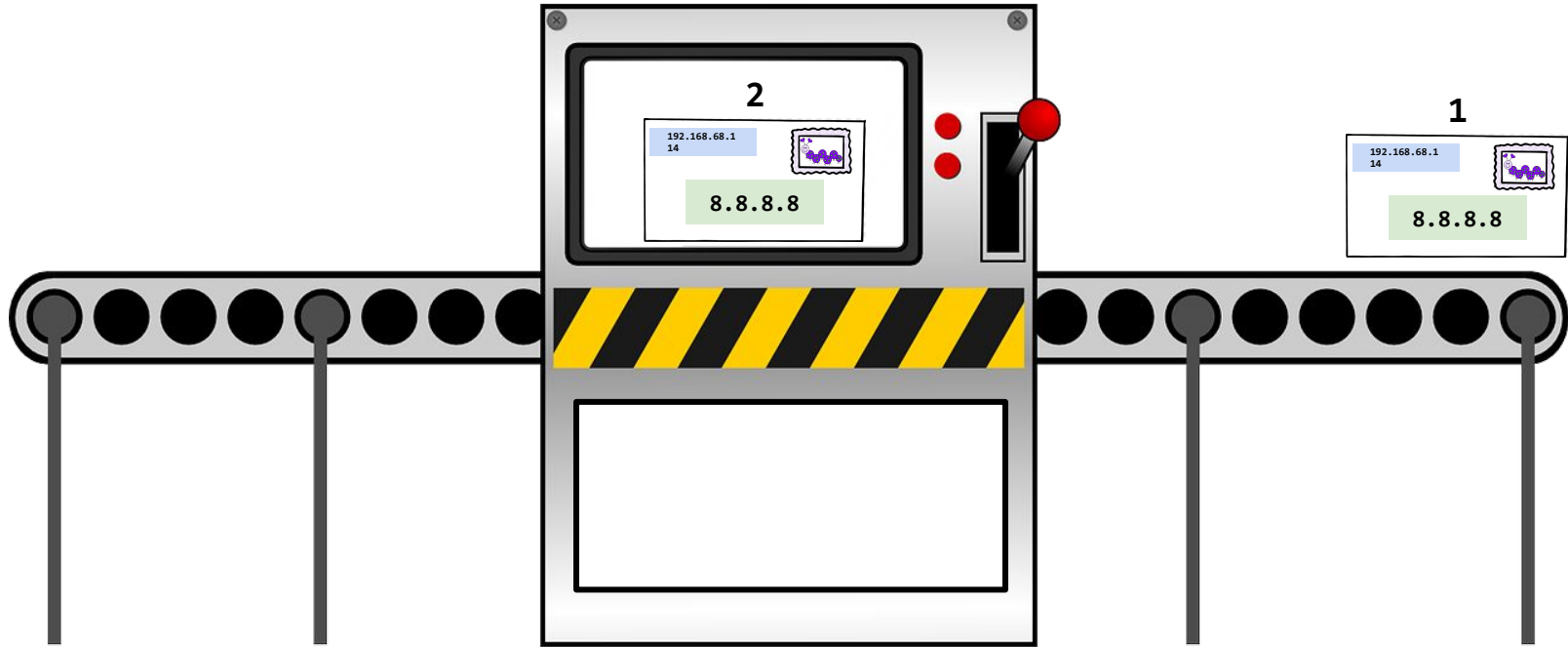
Now sending  
packet number: 2

Now accepting  
packet number: 2



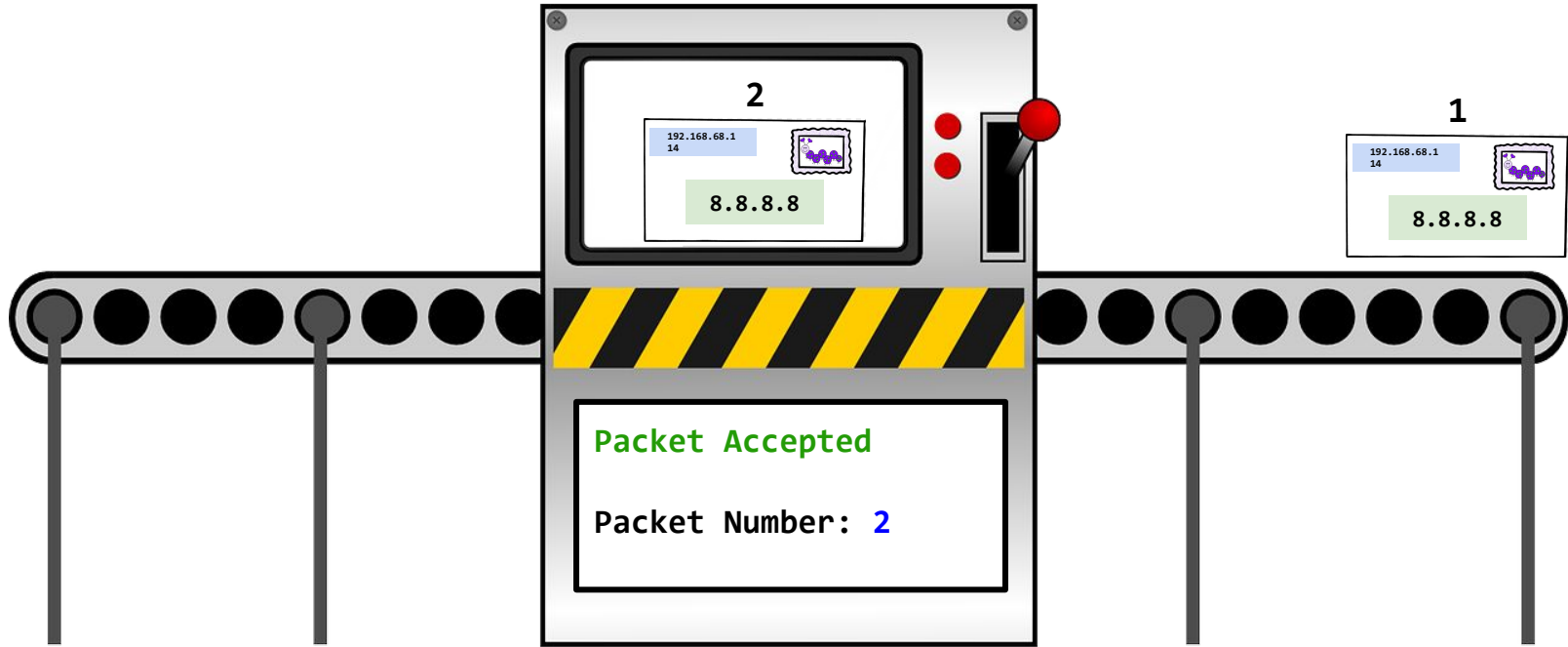
Now sending  
packet number: 2

Now accepting  
packet number: 2



Now sending  
packet number: 2

Now accepting  
packet number: 2

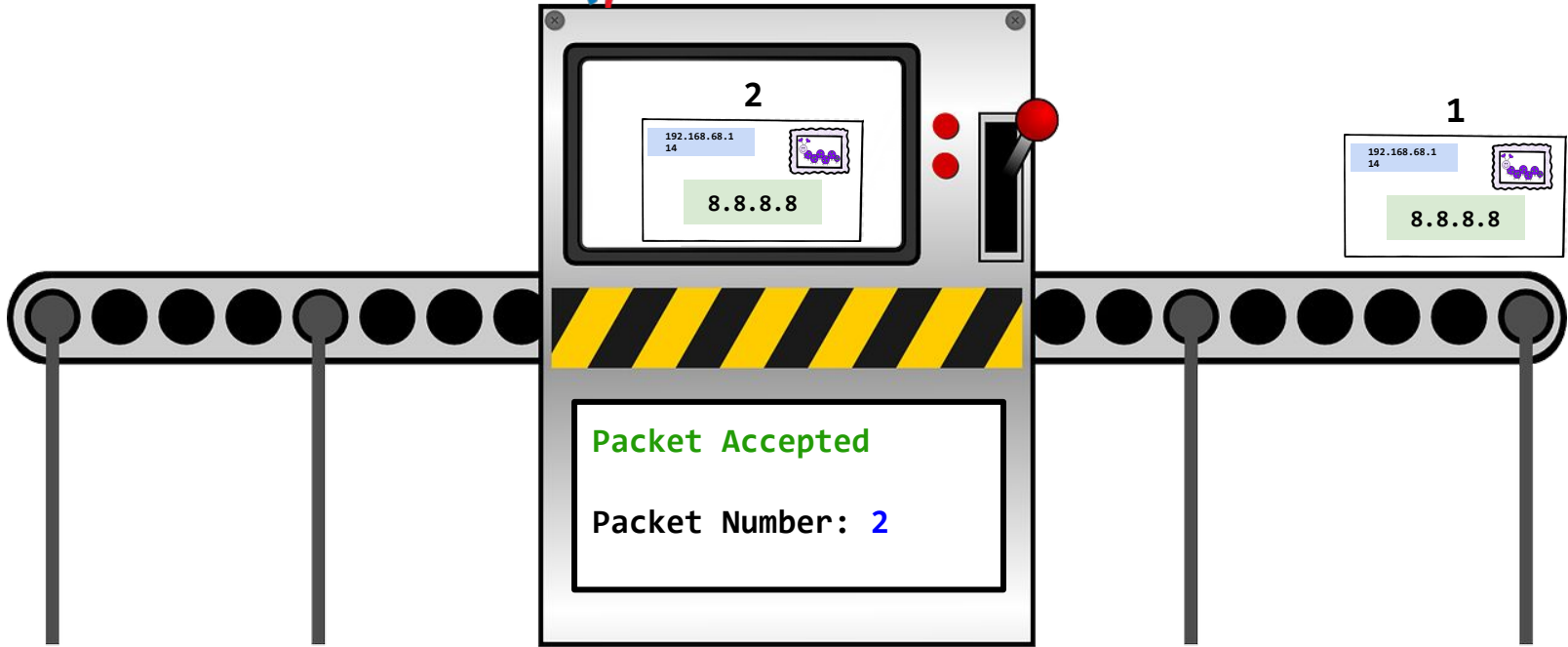


Now sending  
packet number: 2



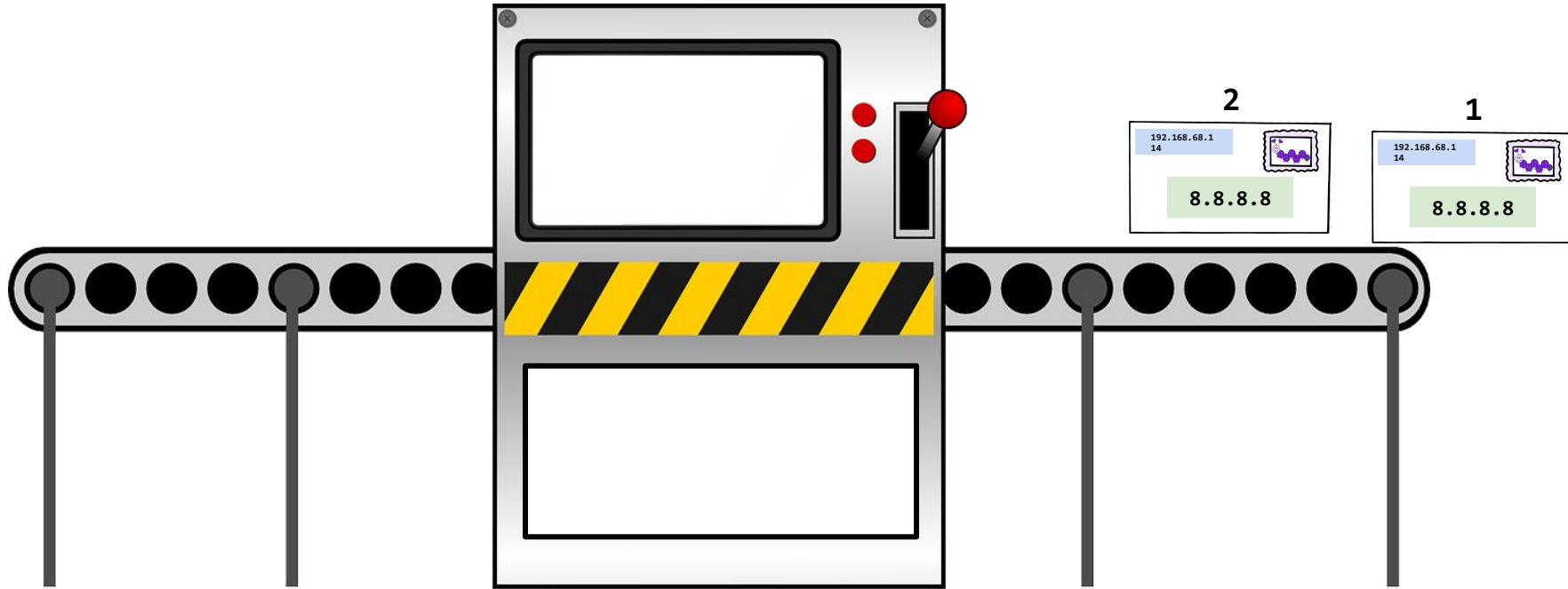
Packet  
Accepted

Now accepting  
packet number: 2



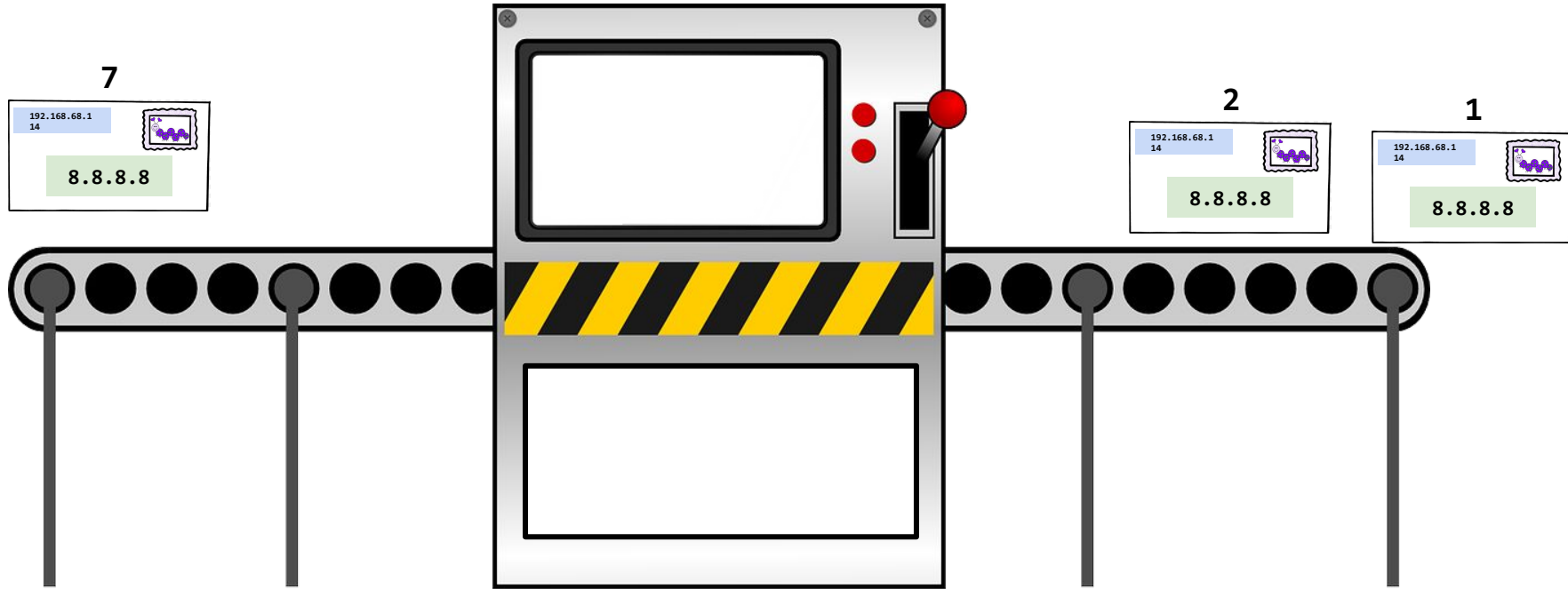
Now sending  
packet number: 3

Now accepting  
packet number: 3



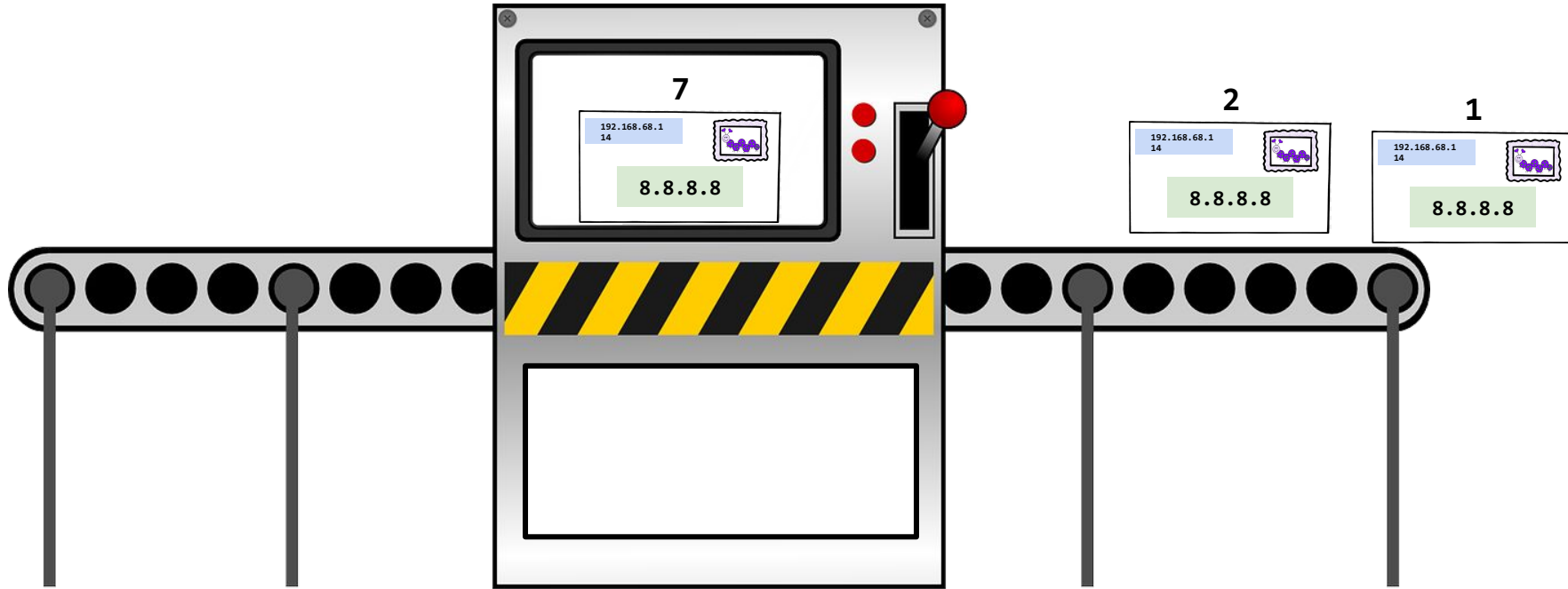
Now sending  
packet number: 7

Now accepting  
packet number: 3



Now sending  
packet number: 7

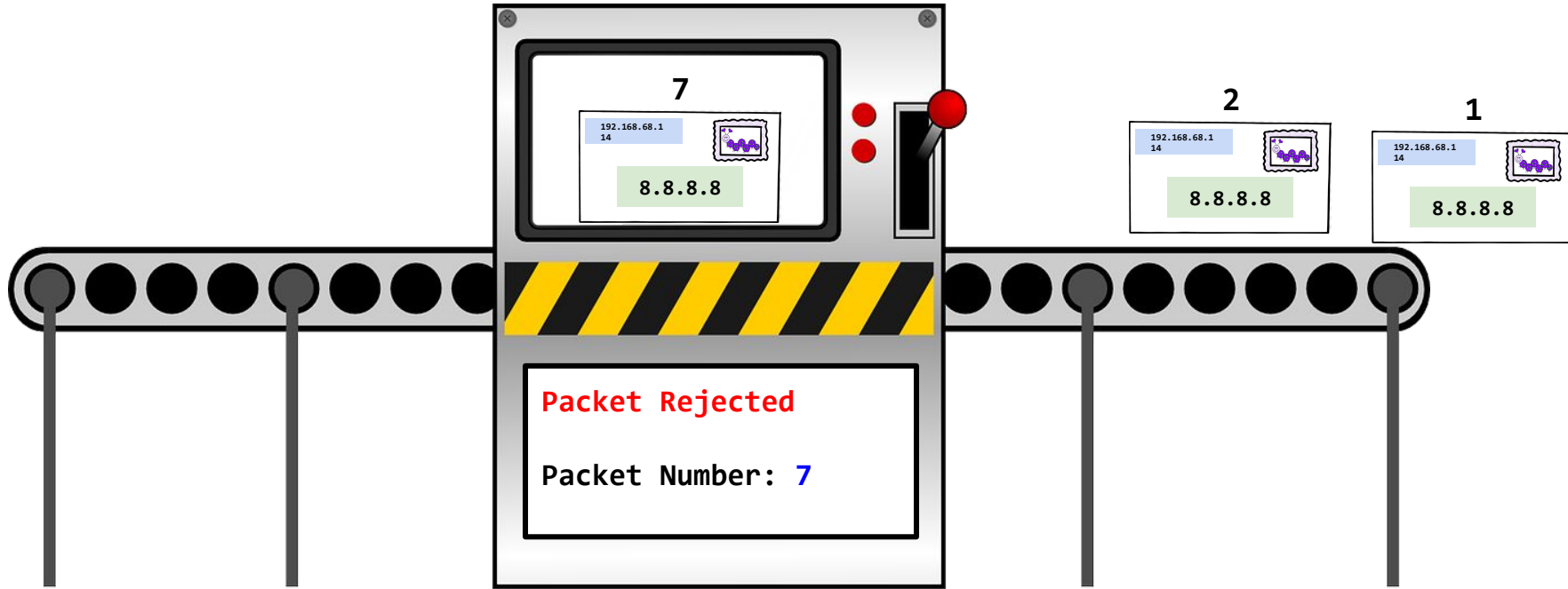
Now accepting  
packet number: 3





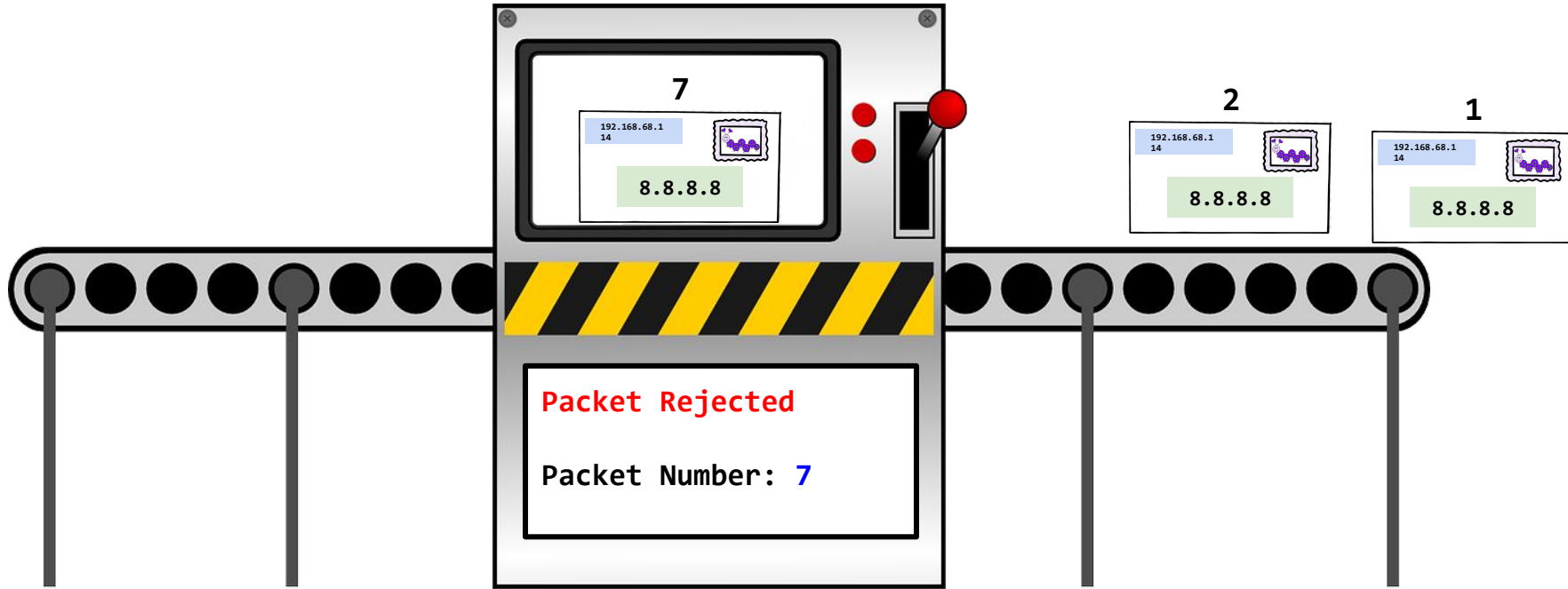
Now sending  
packet number: 7

Now accepting  
packet number: 3



Now sending  
packet number: 7

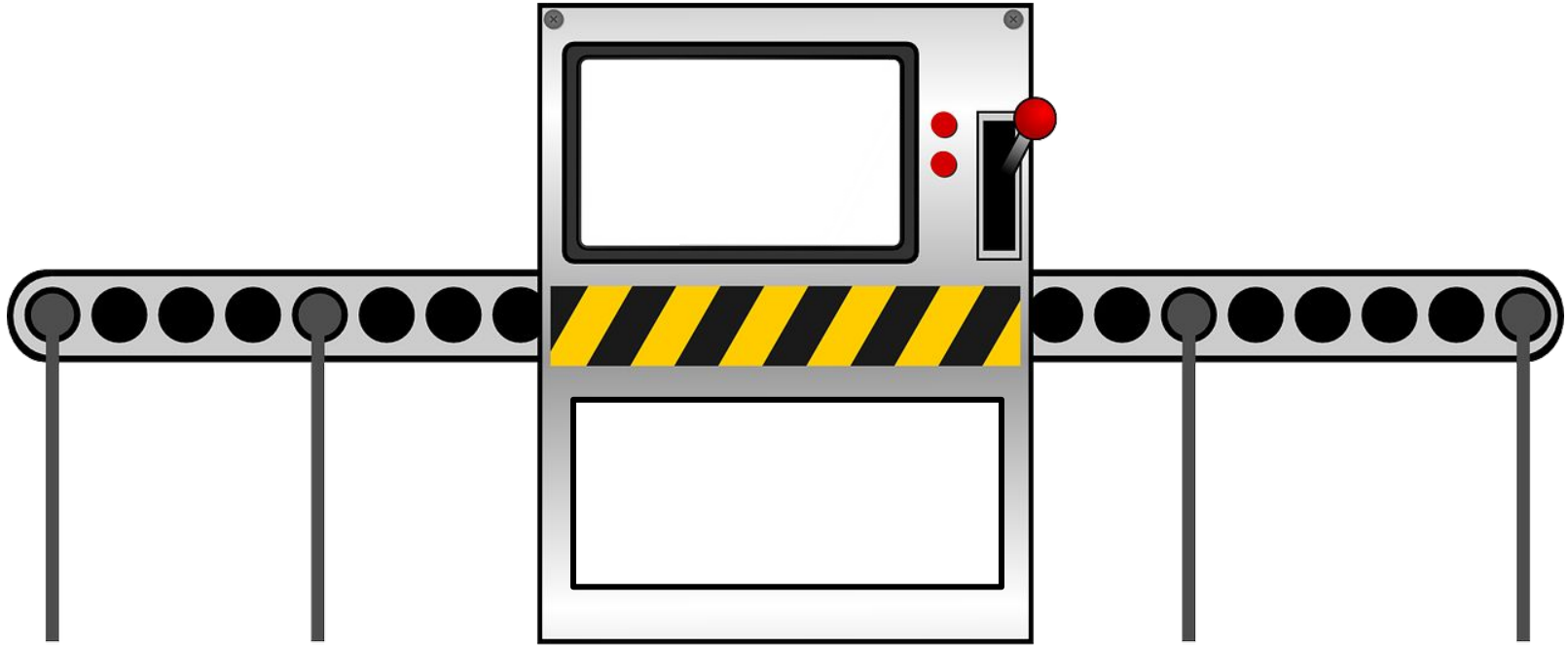
Now accepting  
packet number: 3



# Real TCP

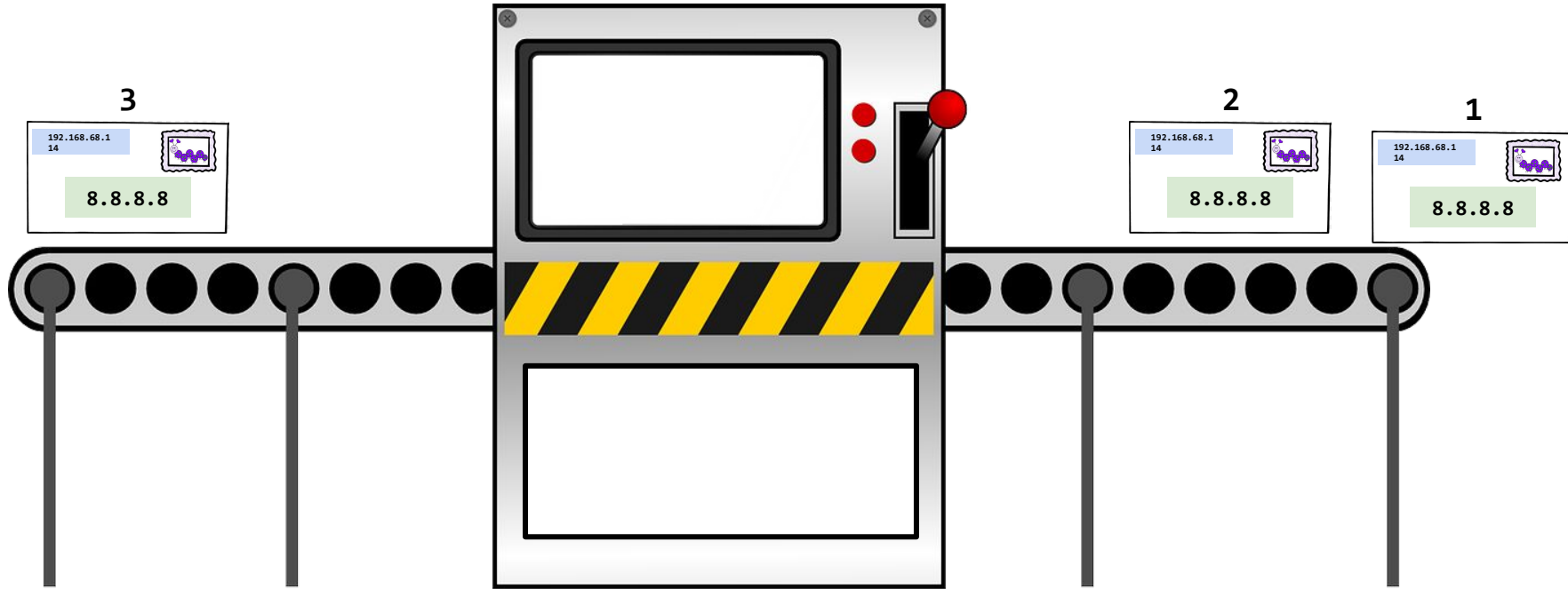
Now sending  
packet number: 1-10

Now accepting  
packet number: 1



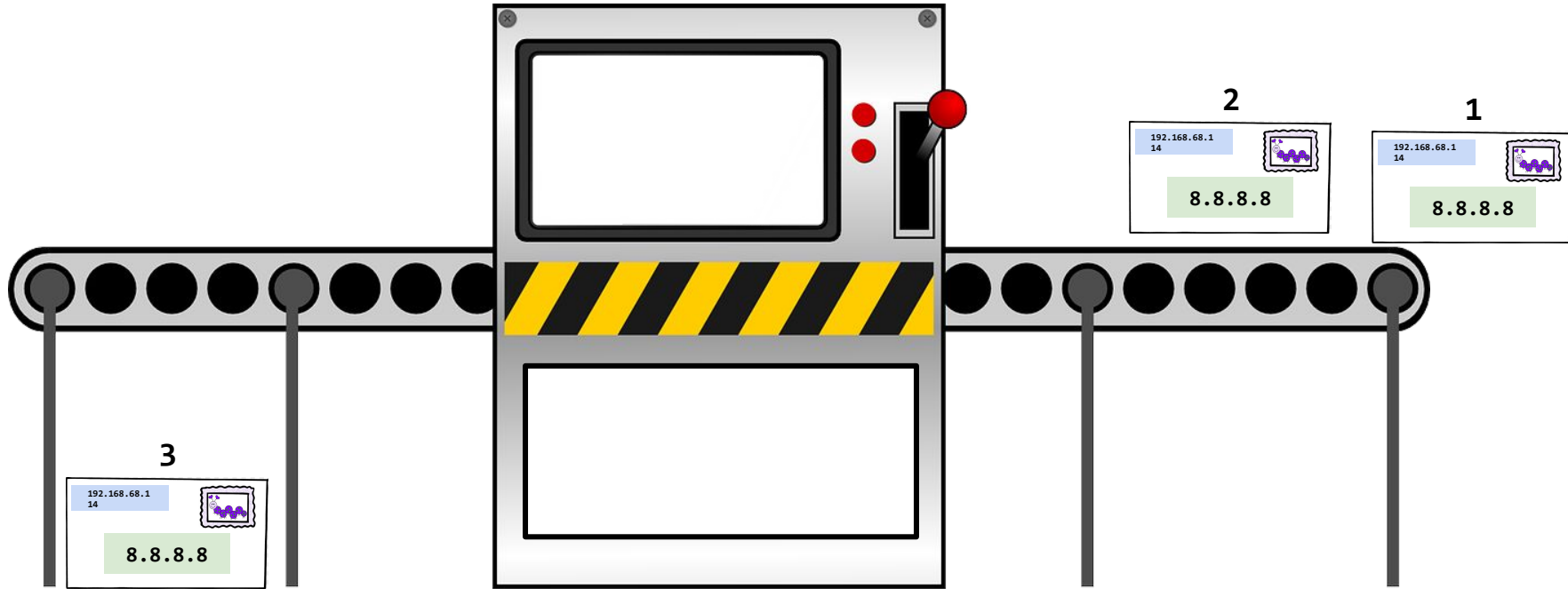
Now sending  
packet number: 3

Now accepting  
packet number: 3



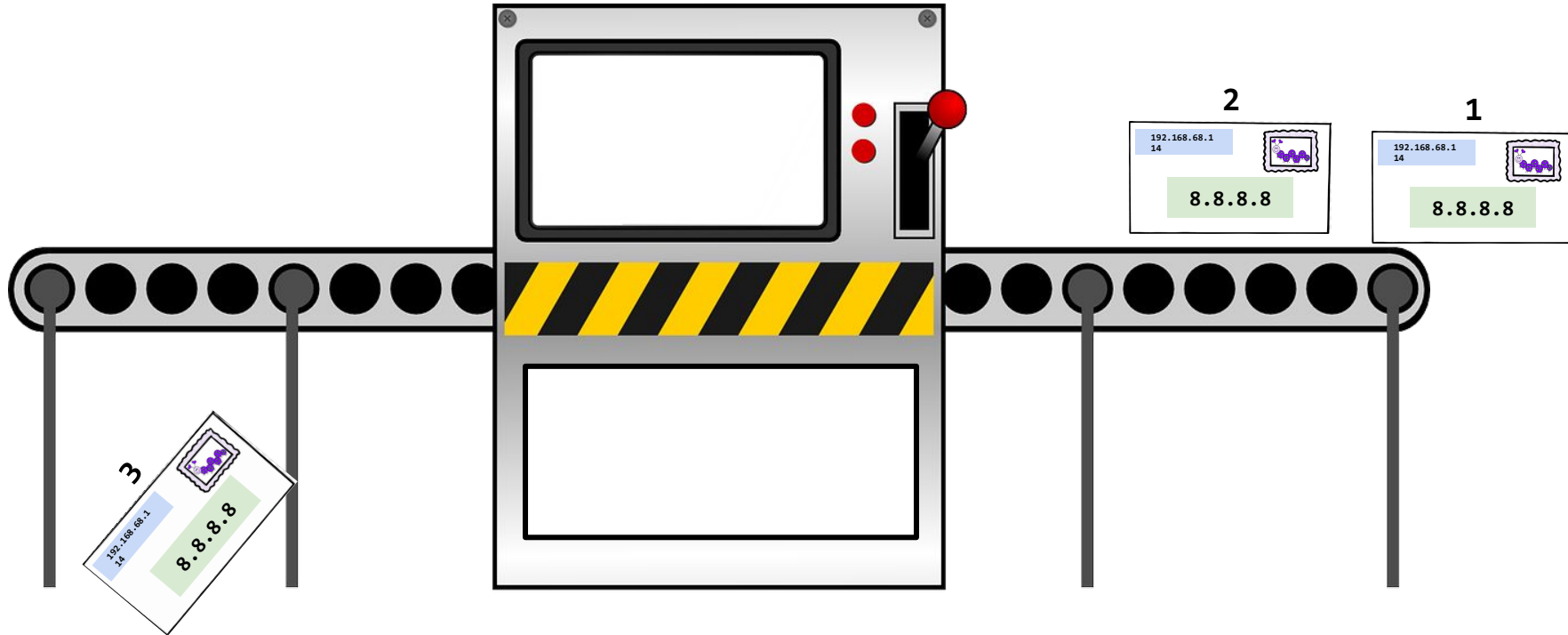
Now sending  
packet number: 3

Now accepting  
packet number: 3



Now sending  
packet number: 3

Now accepting  
packet number: 3



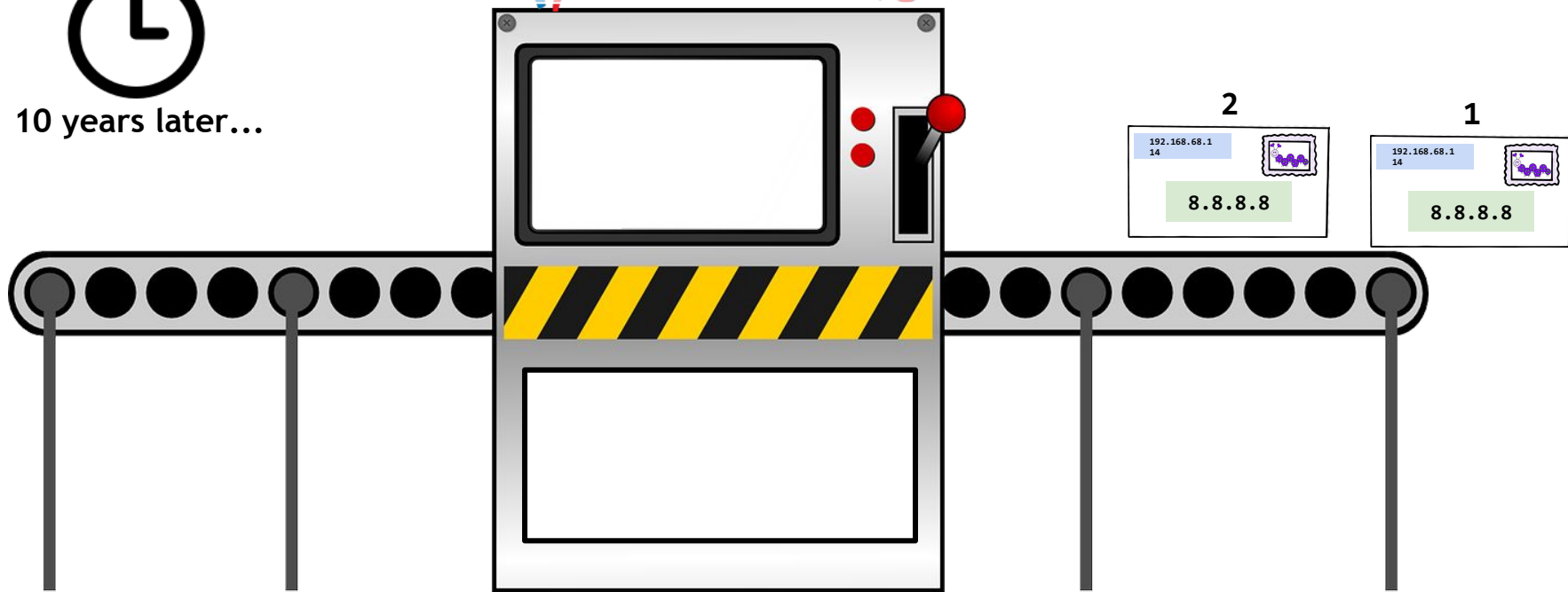
Now sending  
packet number: 3



10 years later...

Packet  
Accepted

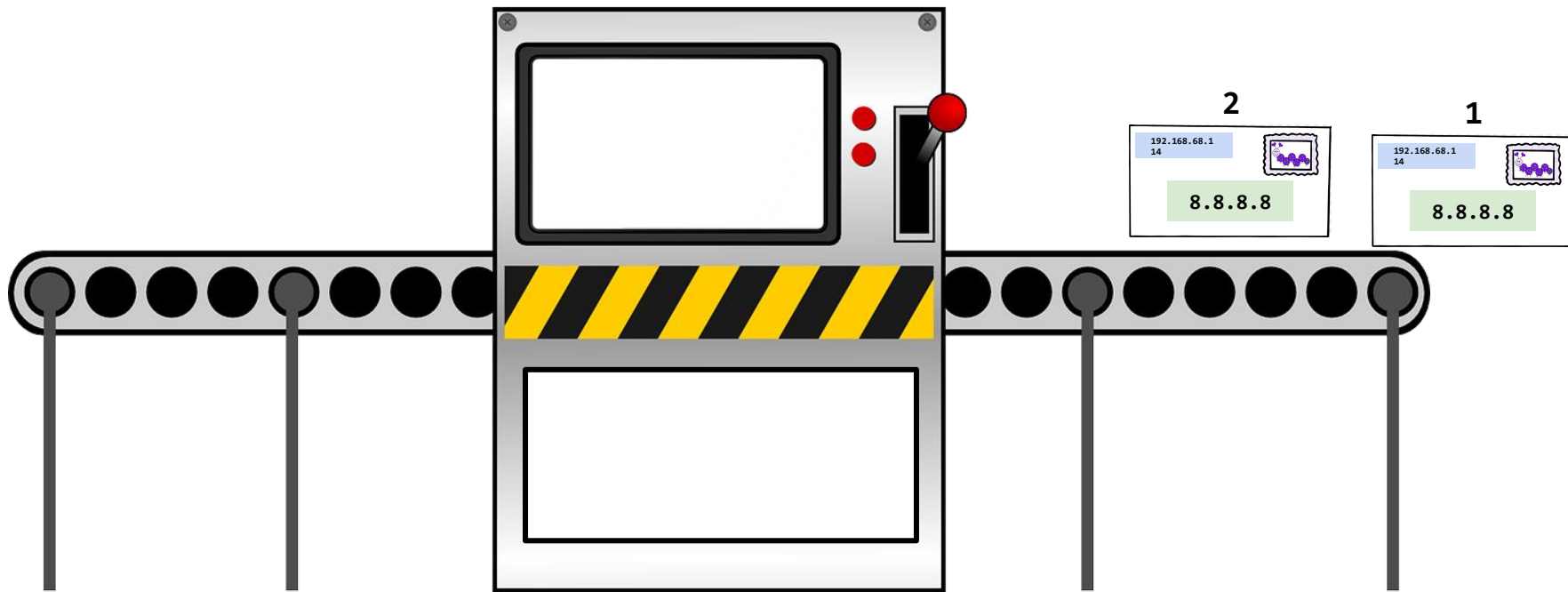
Now accepting  
packet number: 3



Now sending  
packet number: 3

Packet must have  
been lost...

Now accepting  
packet number: 3

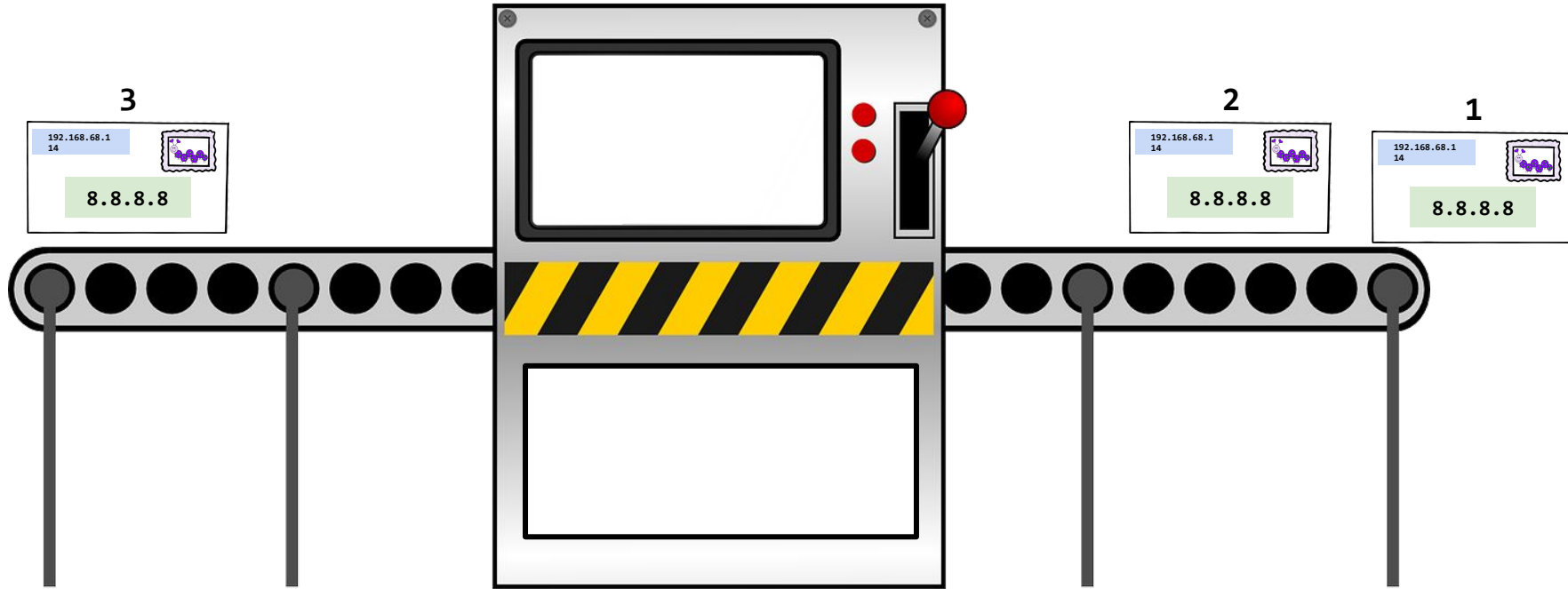




Now sending  
packet number: 3

Packet must have  
been lost...

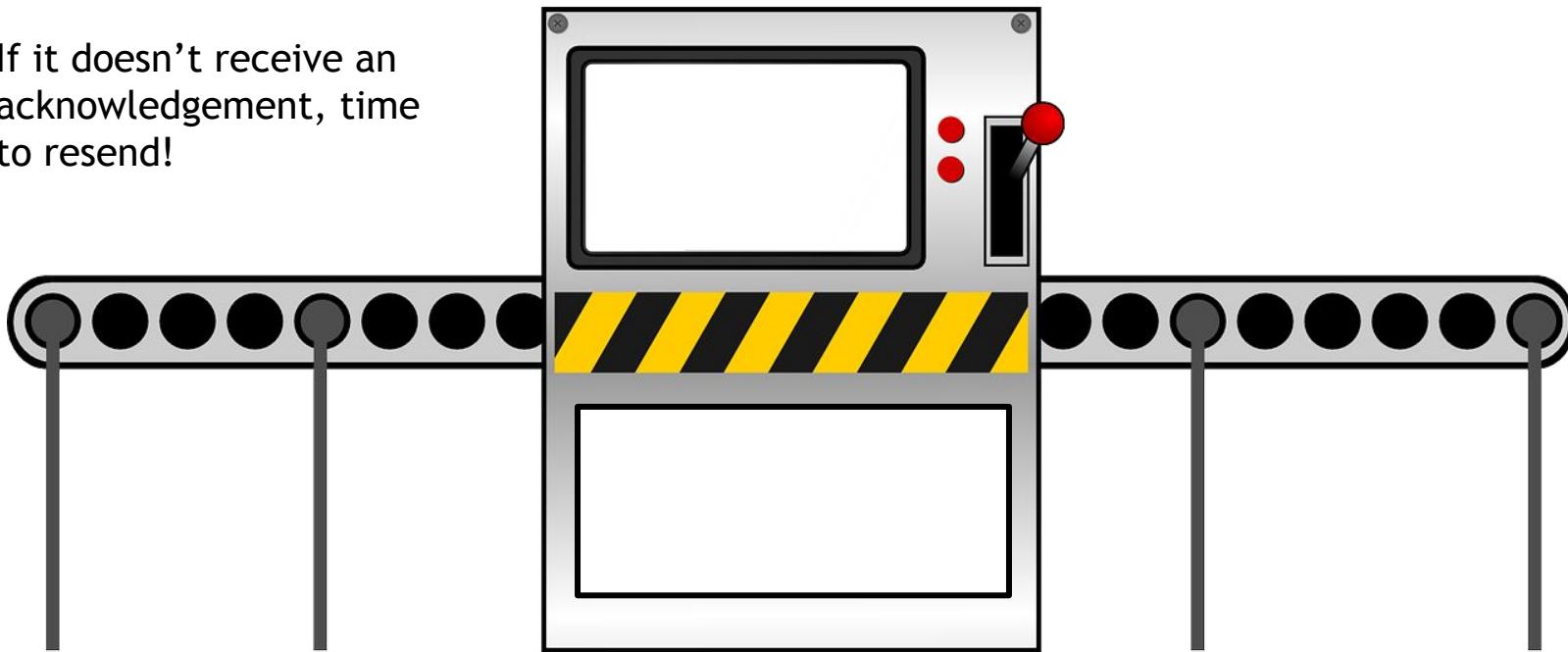
Now accepting  
packet number: 3



# Real TCP

The sender keeps track of a timeout period and can retransmit packets.

If it doesn't receive an acknowledgement, time to resend!



# Open problems in networking

1. How many segments should the sender send at a time?
  - a. Too few, and the network is underutilized
  - b. Too many, and the sender overwhelms the network
2. How should a sender determine when to retransmit a segment?
  - a. Too early, and the sender is wasting network resources retransmitting data that the sender already received
  - b. Too late, and latency is increased