Application Layer
Part 6

Mark Allman
Case / ICSI

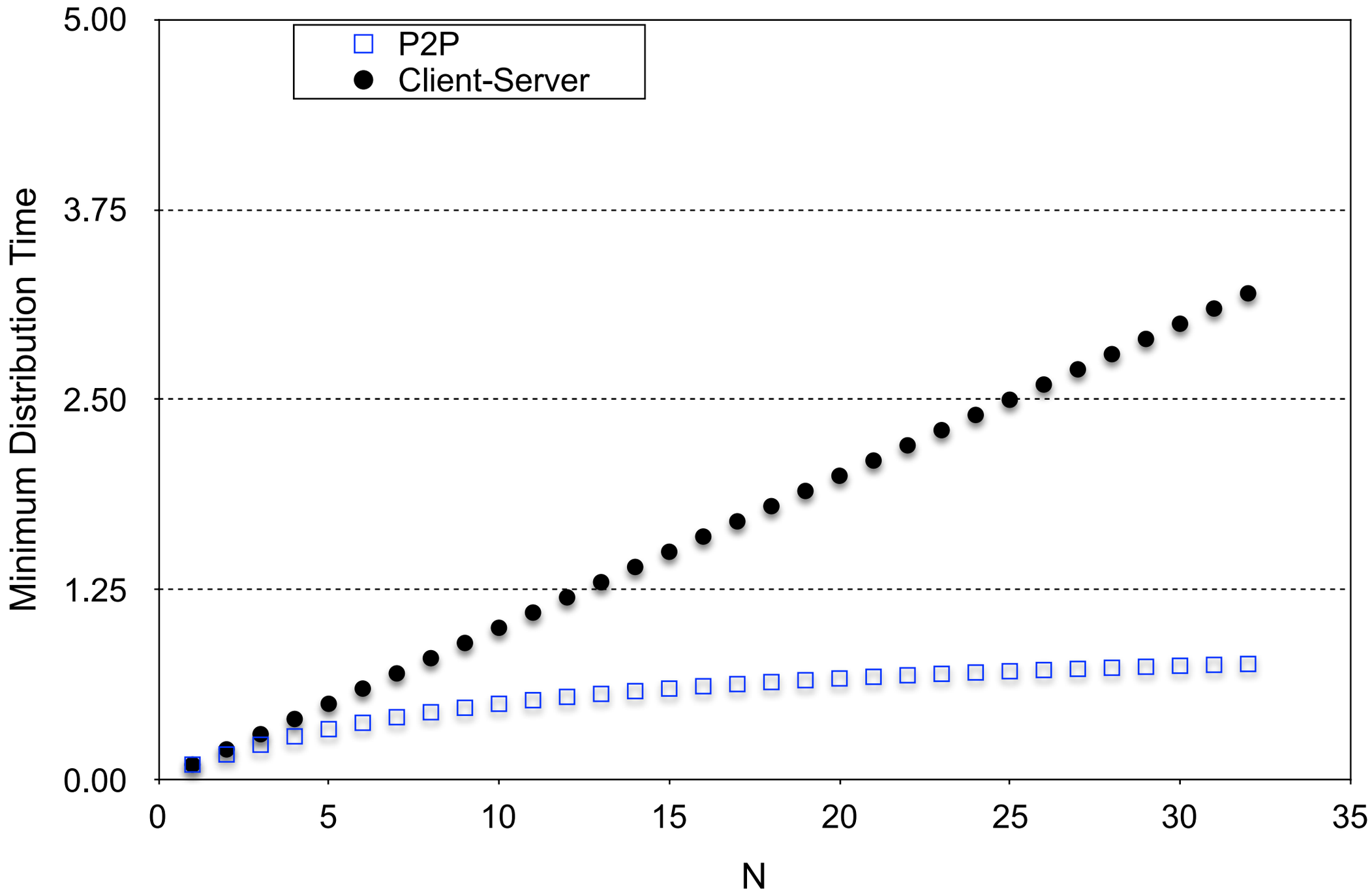
EECS 325/425
Fall 2018

"Now don't you call James Bond or Secret Agent Man,
'Cause they can't do it Like I Can …"

Many of these slides are more-or-less directly from the slide set developed by Jim Kurose and Keith Ross for their book “Computer Networking: A Top Down Approach, 5th edition”.

The slides have been lightly adapted for Mark Allman’s EECS 325/425 Computer Networks class at Case Western Reserve University.

Server-client vs. P2P: example



File distribution: BitTorrent

P2P file distribution

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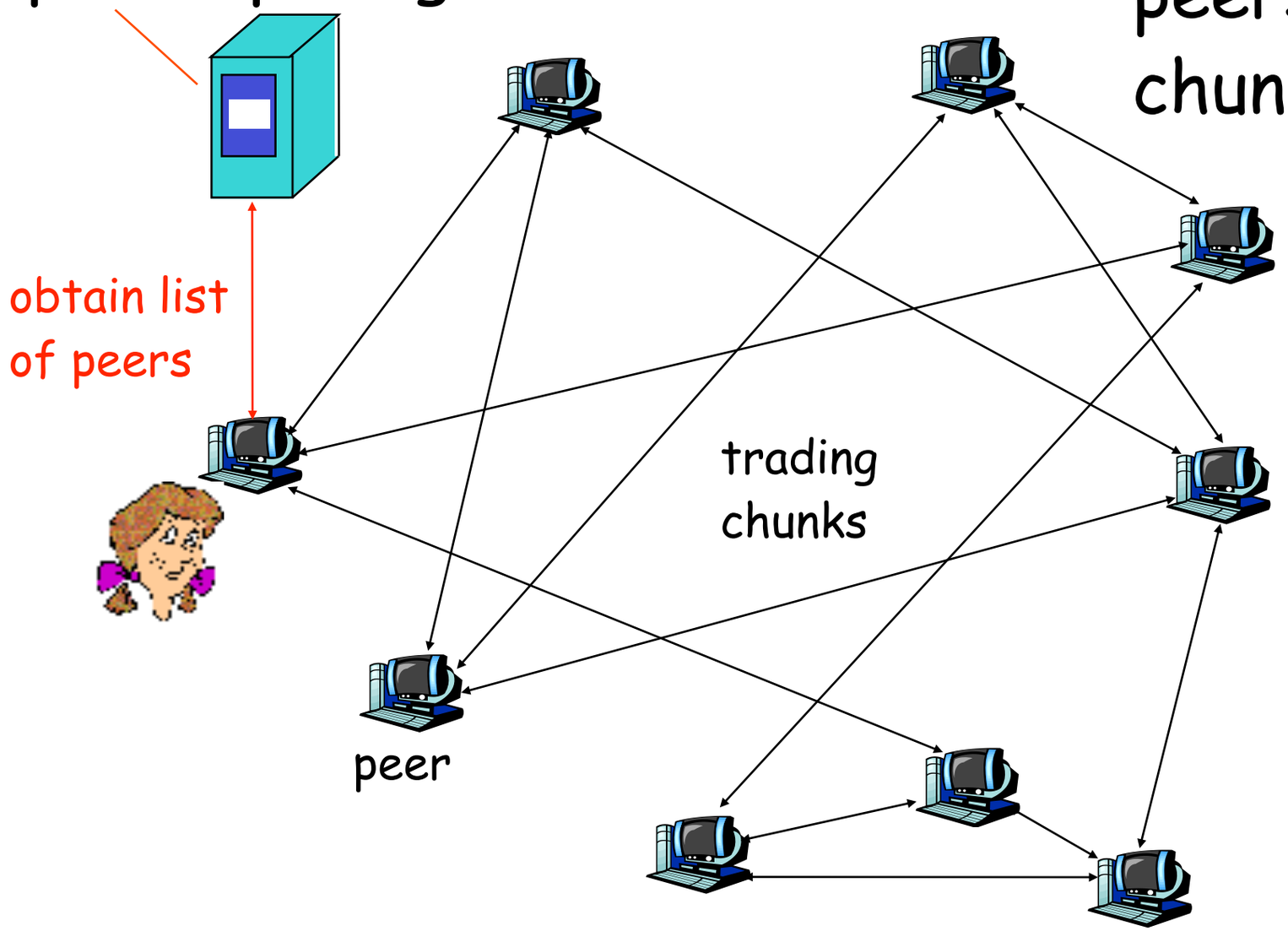
P2P file distribution

tracker: tracks peers participating in torrent

torrent: group of peers exchanging chunks of a file



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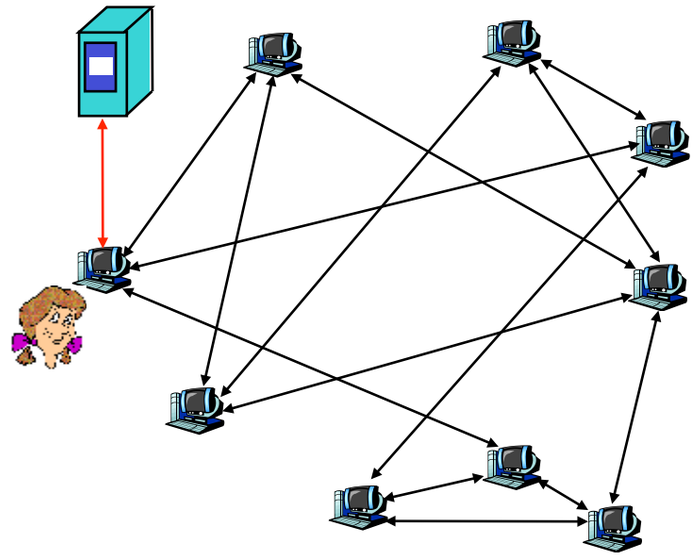

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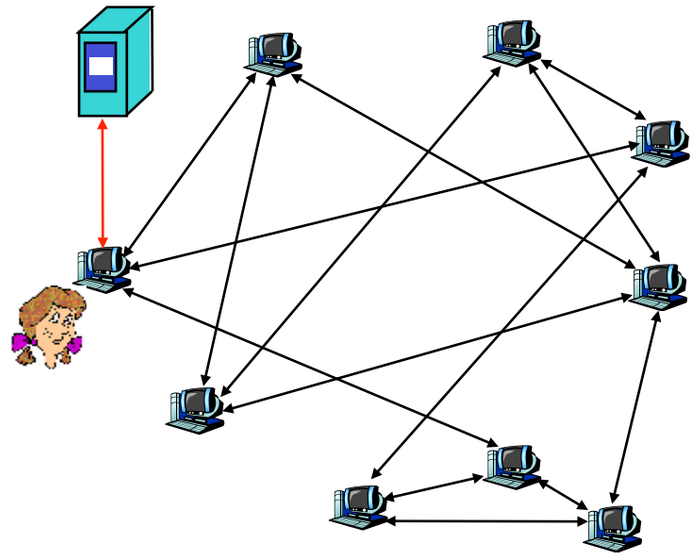
- file divided into 256KB chunks.



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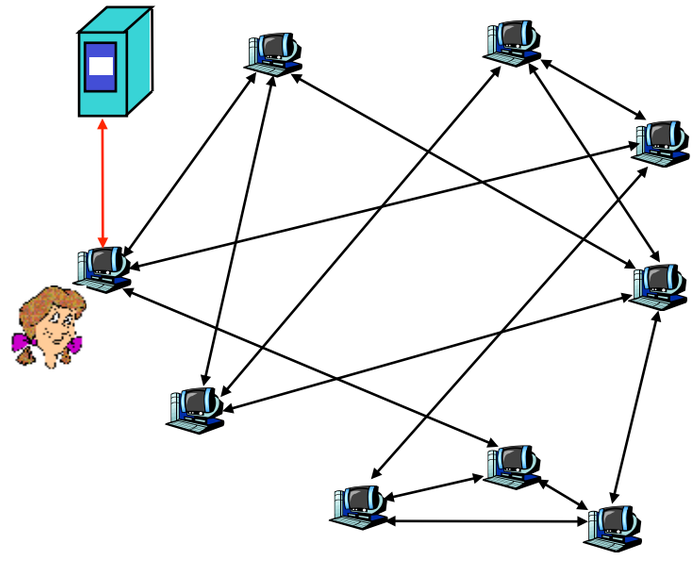

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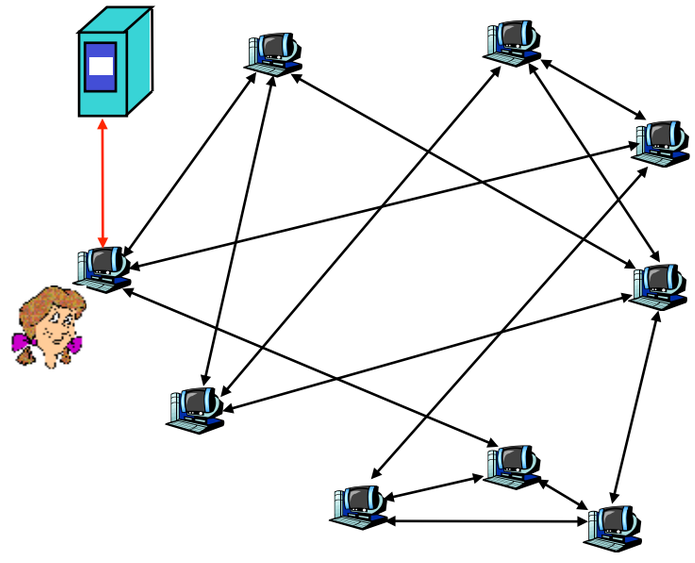

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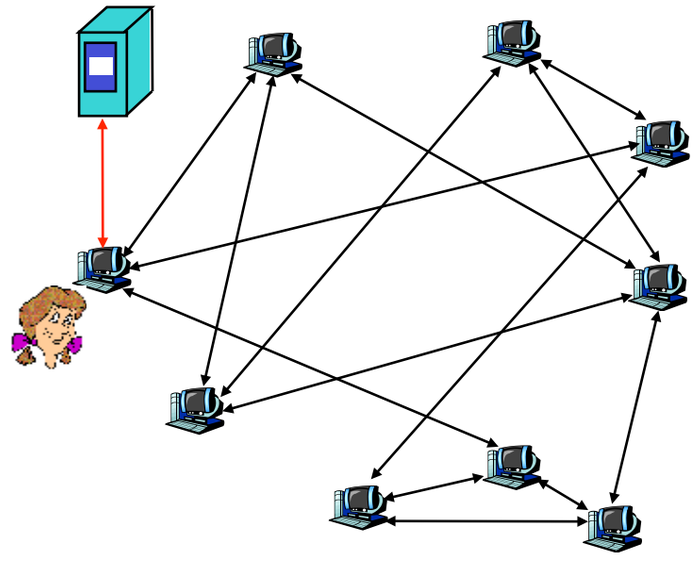

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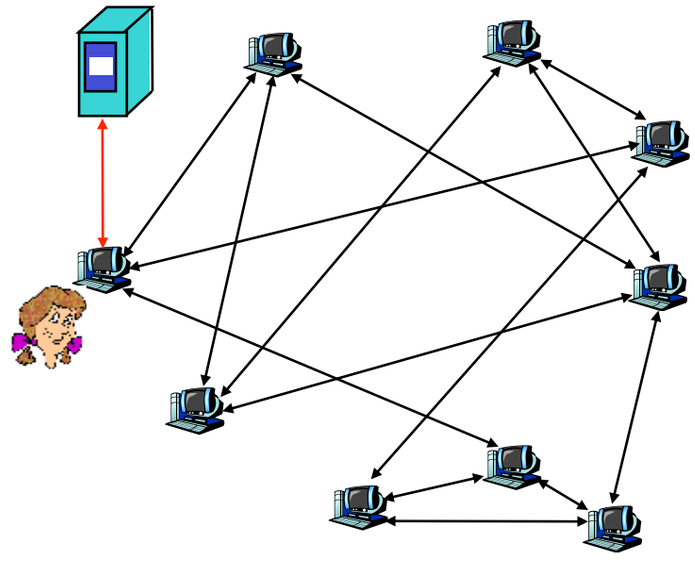

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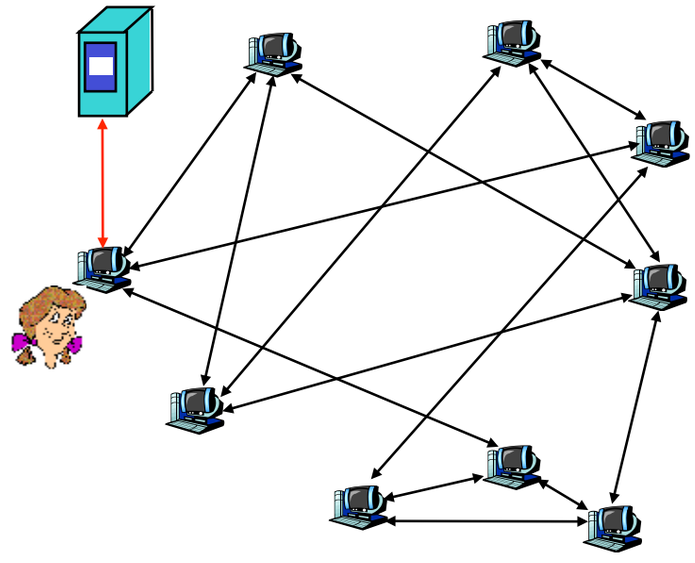

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- once peer has entire file, it may (selfishly) leave or (altruistically) remain

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Sending Chunks: tit-for-tat

- Alice sends chunks to four neighbors currently sending her chunks at the highest rate
  - re-evaluate top 4 every 10 secs
- every 30 secs: randomly select another peer, starts sending chunks
  - newly chosen peer may join top 4
  - "optimistically unchoke"

BitTorrent (3)

- rough sketch

- why 30sec? why 256KB? why 4 neighbors?

Distributed Hash Table (DHT)

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- peers can also insert (key, value) peers

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  - Each identifier can be represented by n bits.
- require each key to be an integer in same range.
- to get integer keys, hash original key.
  - e.g., key = h("Led Zeppelin IV")
  - this is why they call it a distributed "hash" table

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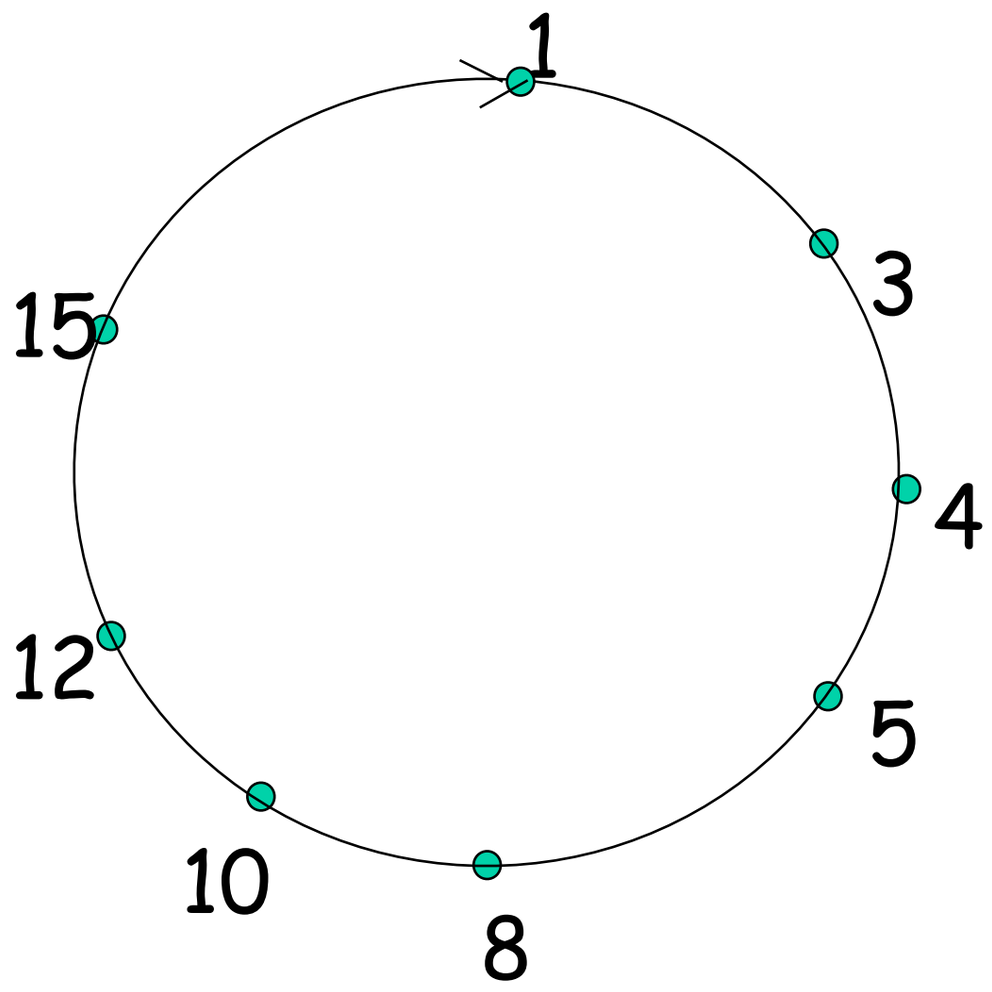
- convention in lecture: closest is the immediate successor of the key.
- e.g.,: n=4; peers: 1,3,4,5,8,10,12,14;
  - key = 13, then successor peer = 14
  - key = 15, then successor peer = 1

Circular DHT (1)



- each peer only aware of immediate successor and predecessor.
- "overlay network"

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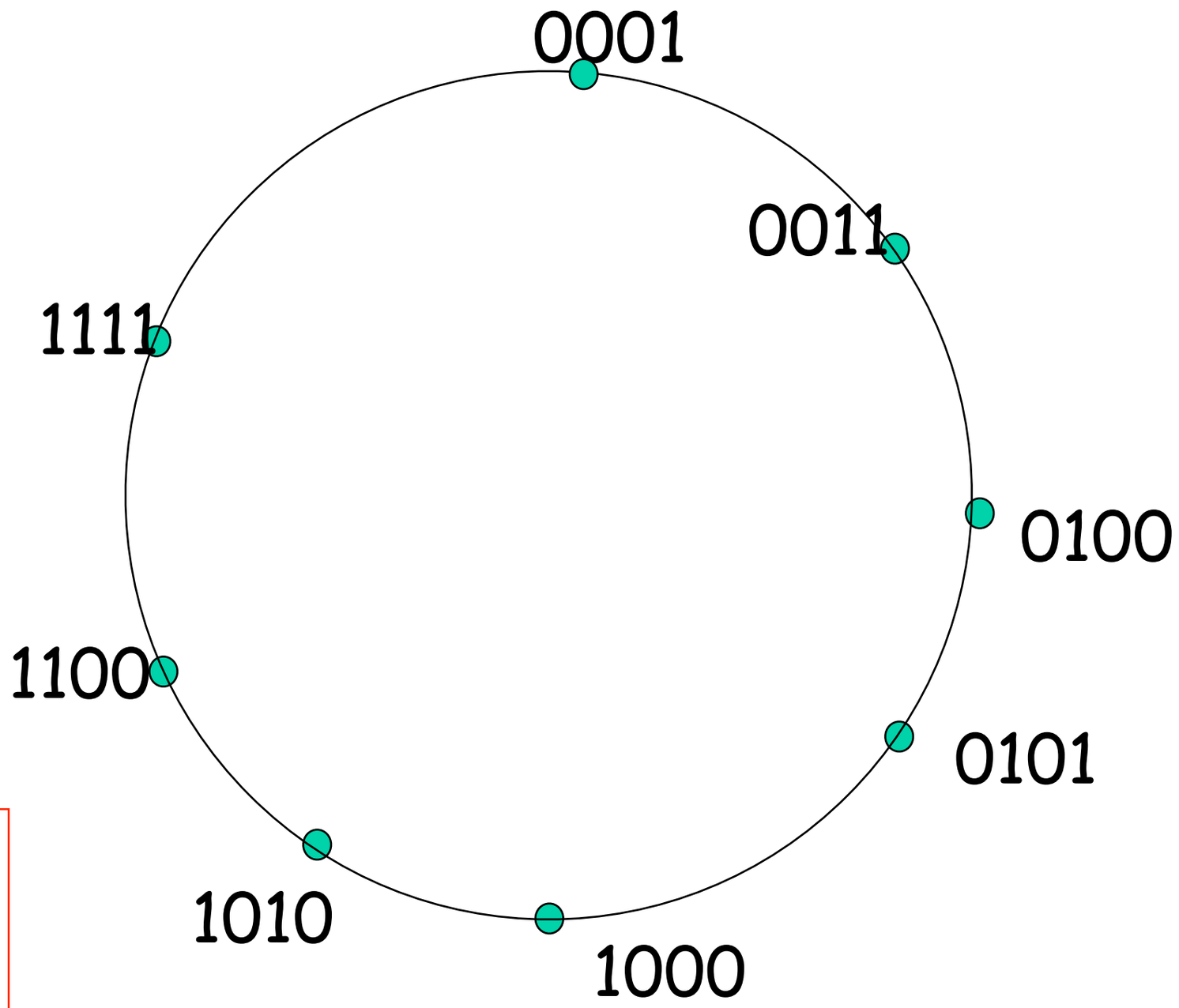
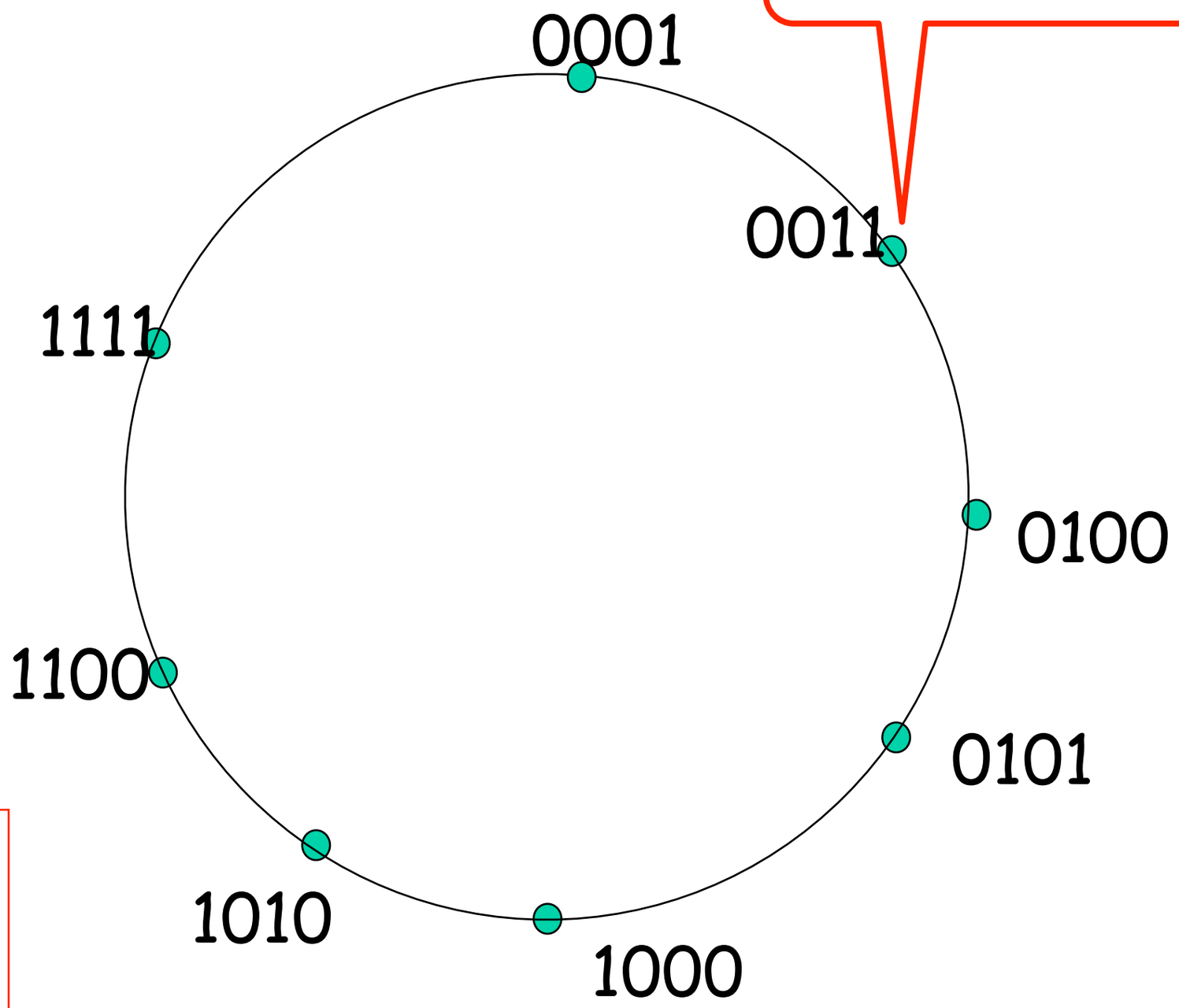


Define closest as closest successor

Circular DHT (2)

x = h("Led Zepplin IV")
x=1110
Who's resp. for 1110?



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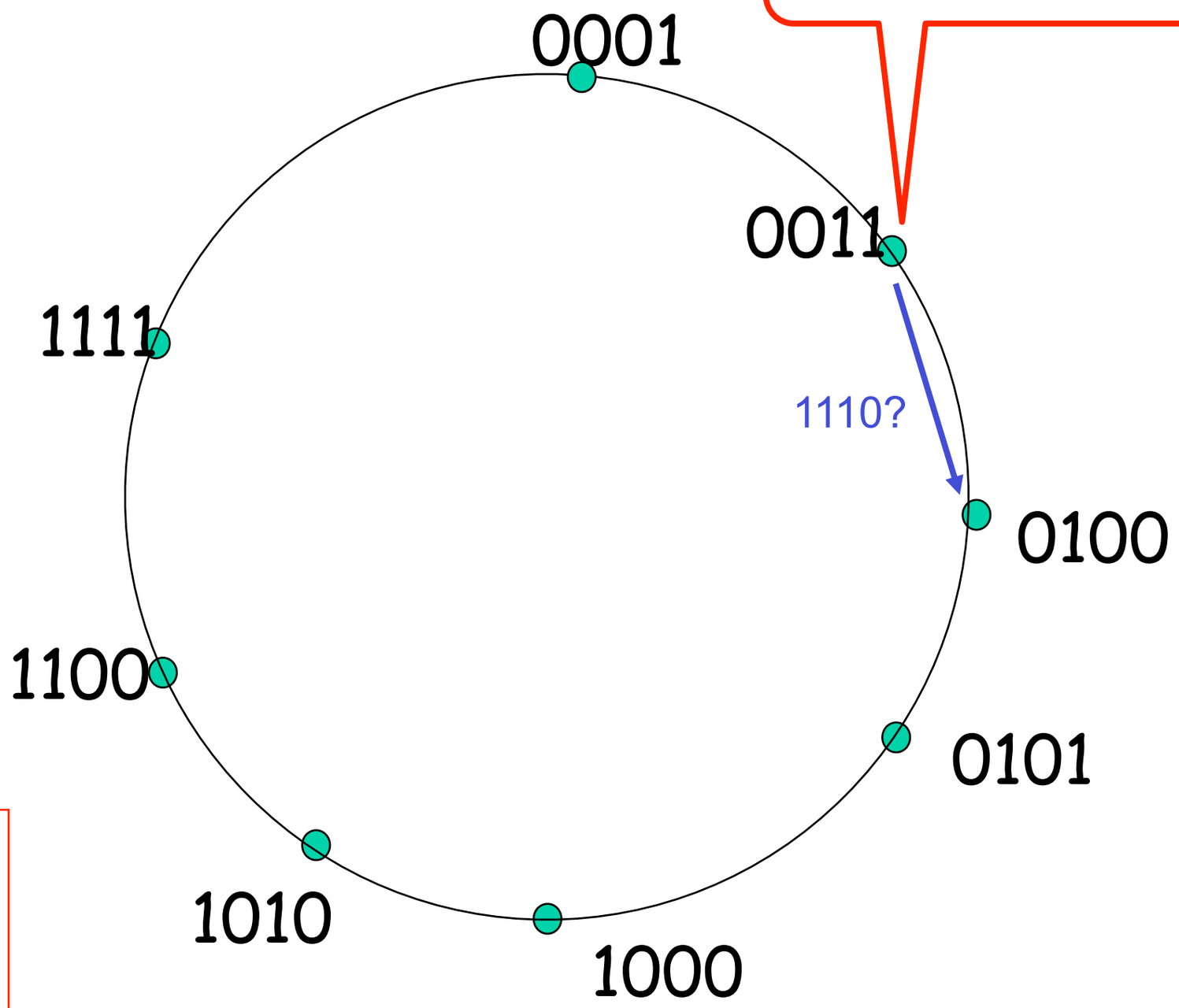

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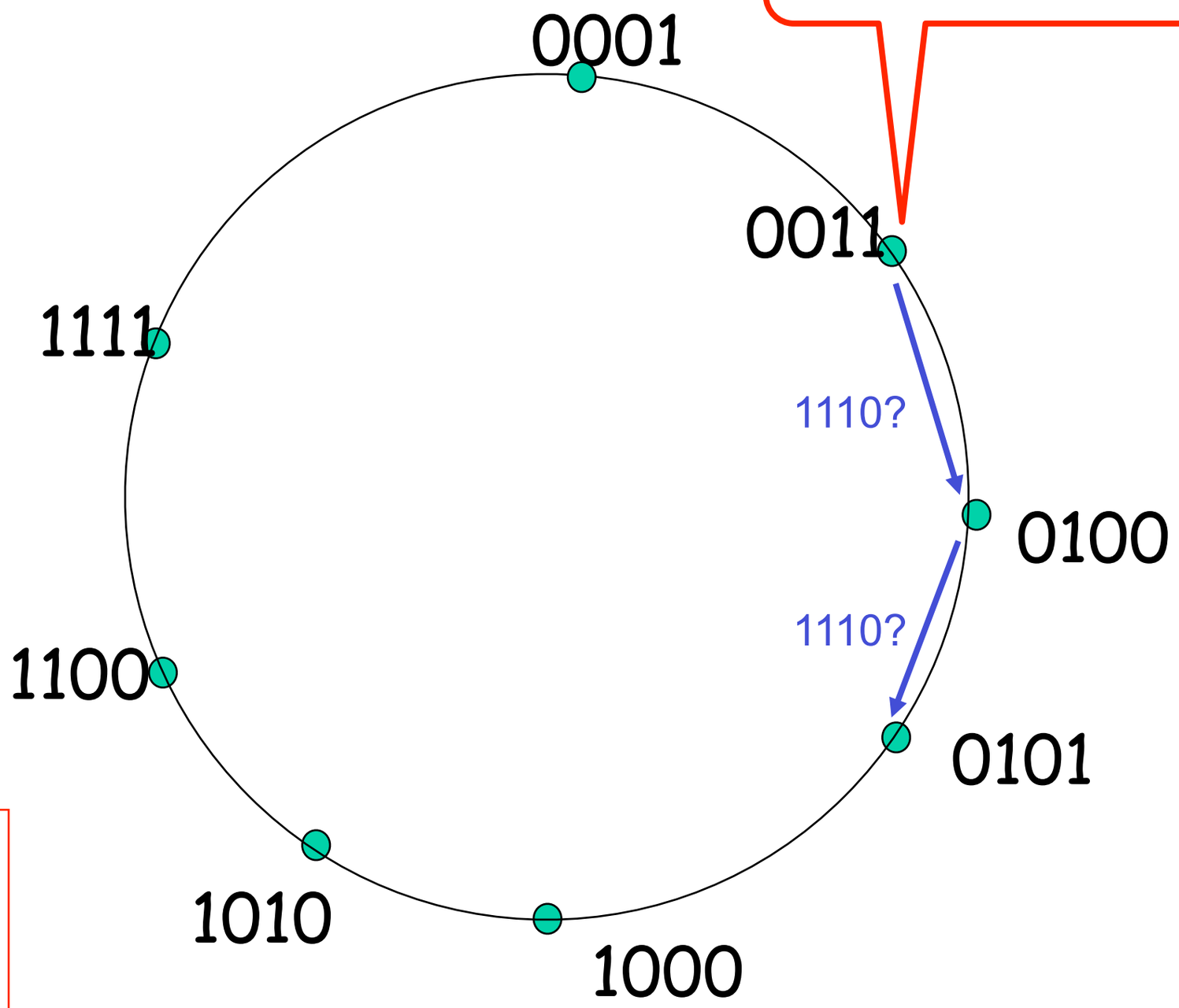

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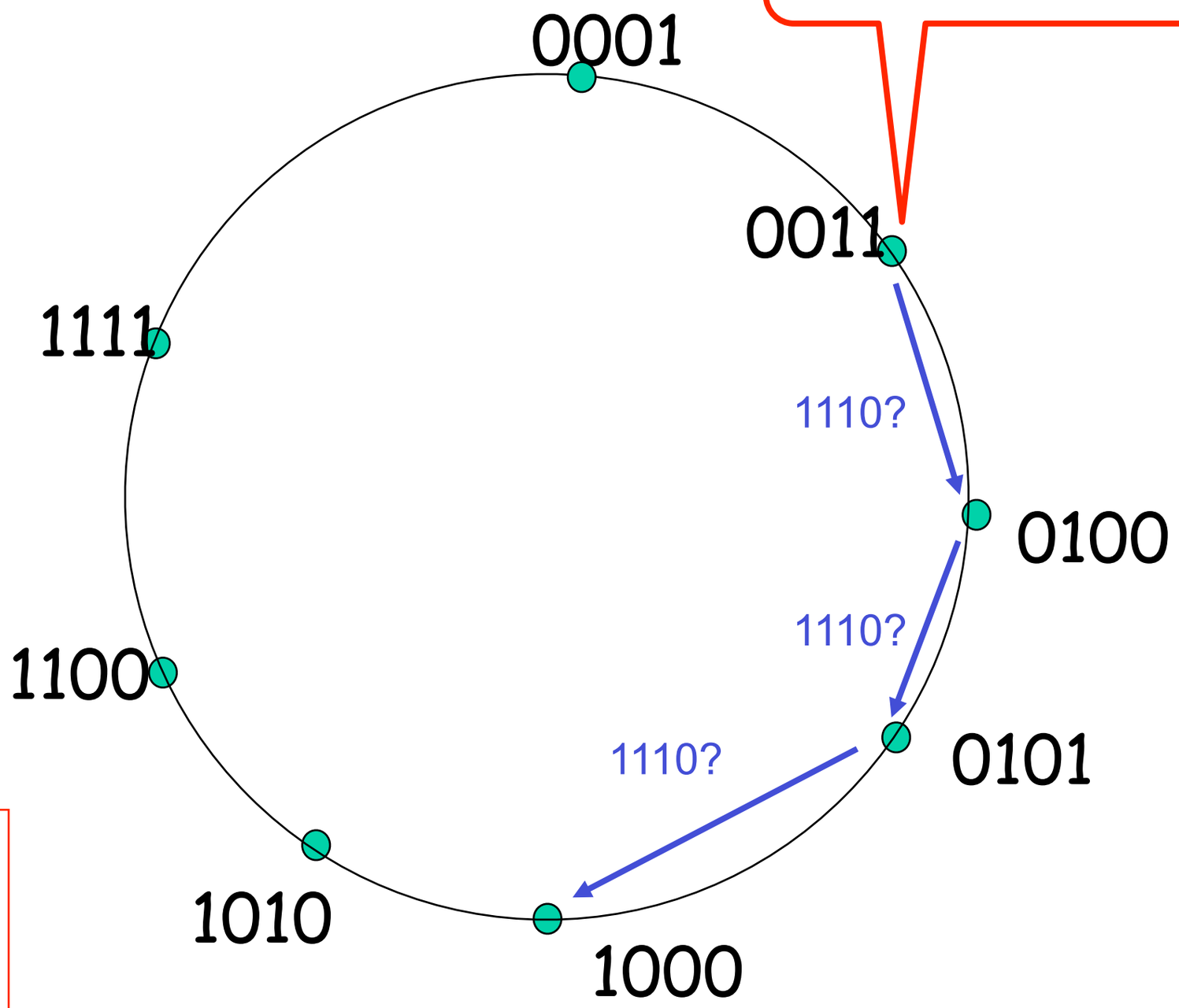

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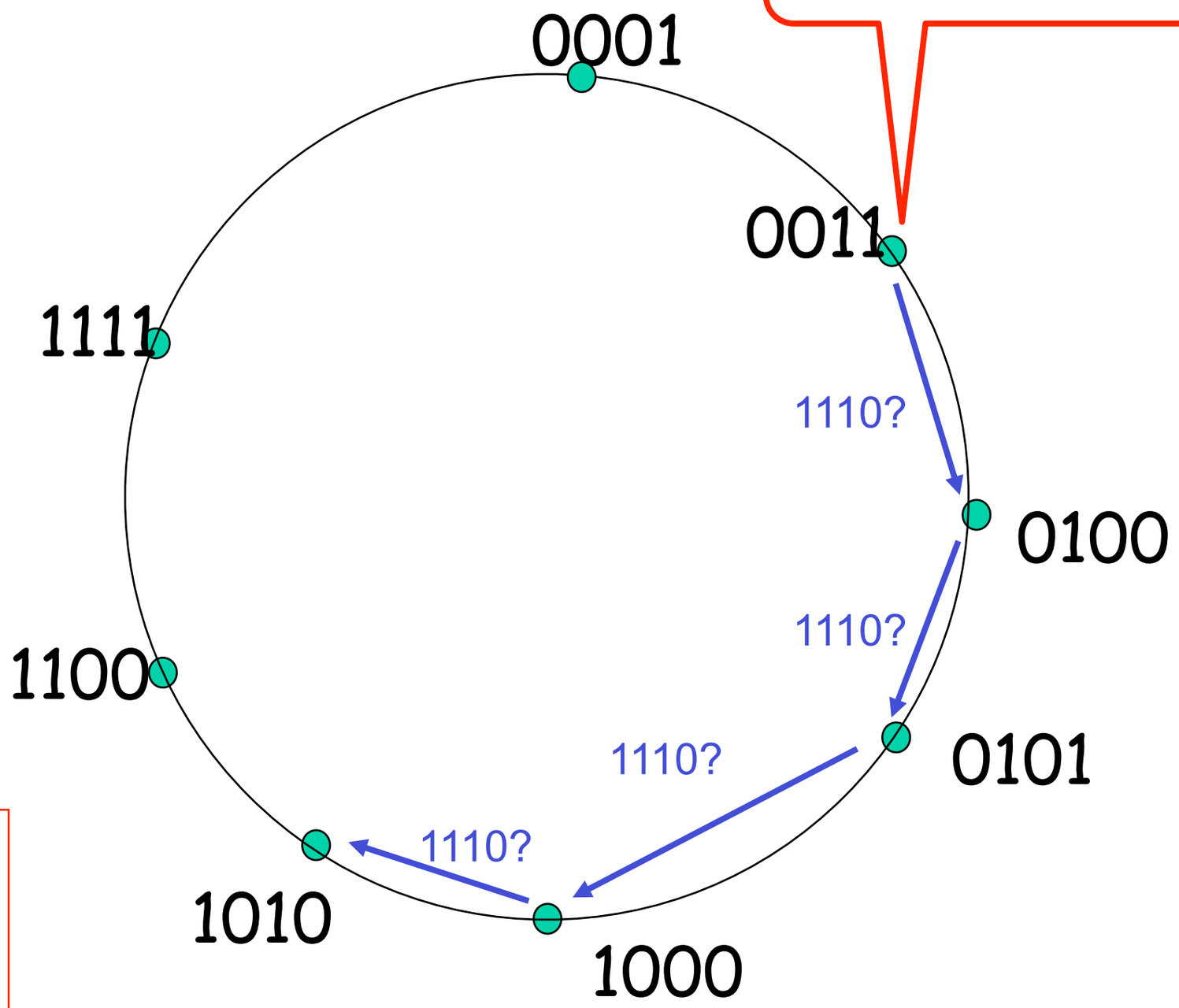

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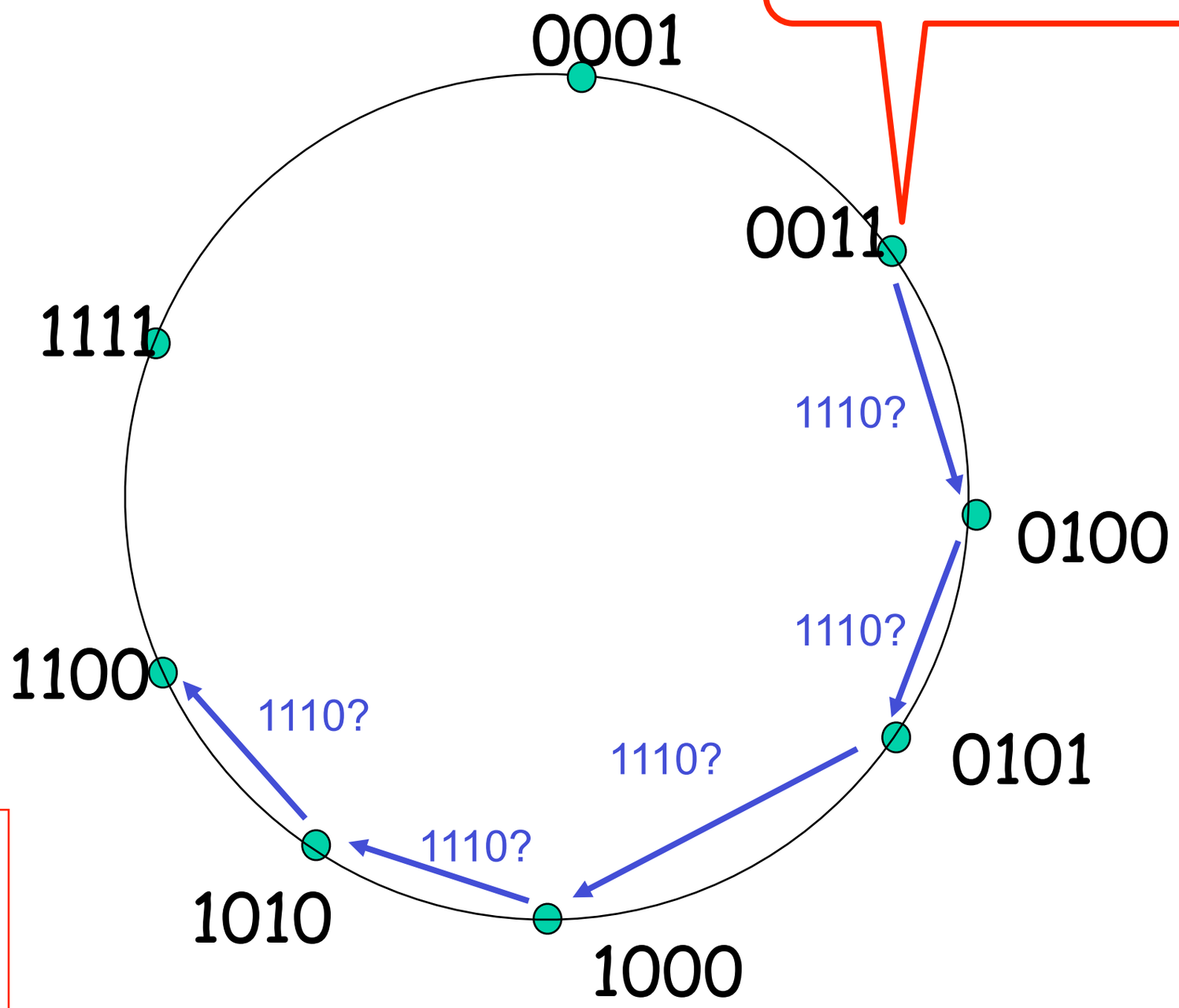

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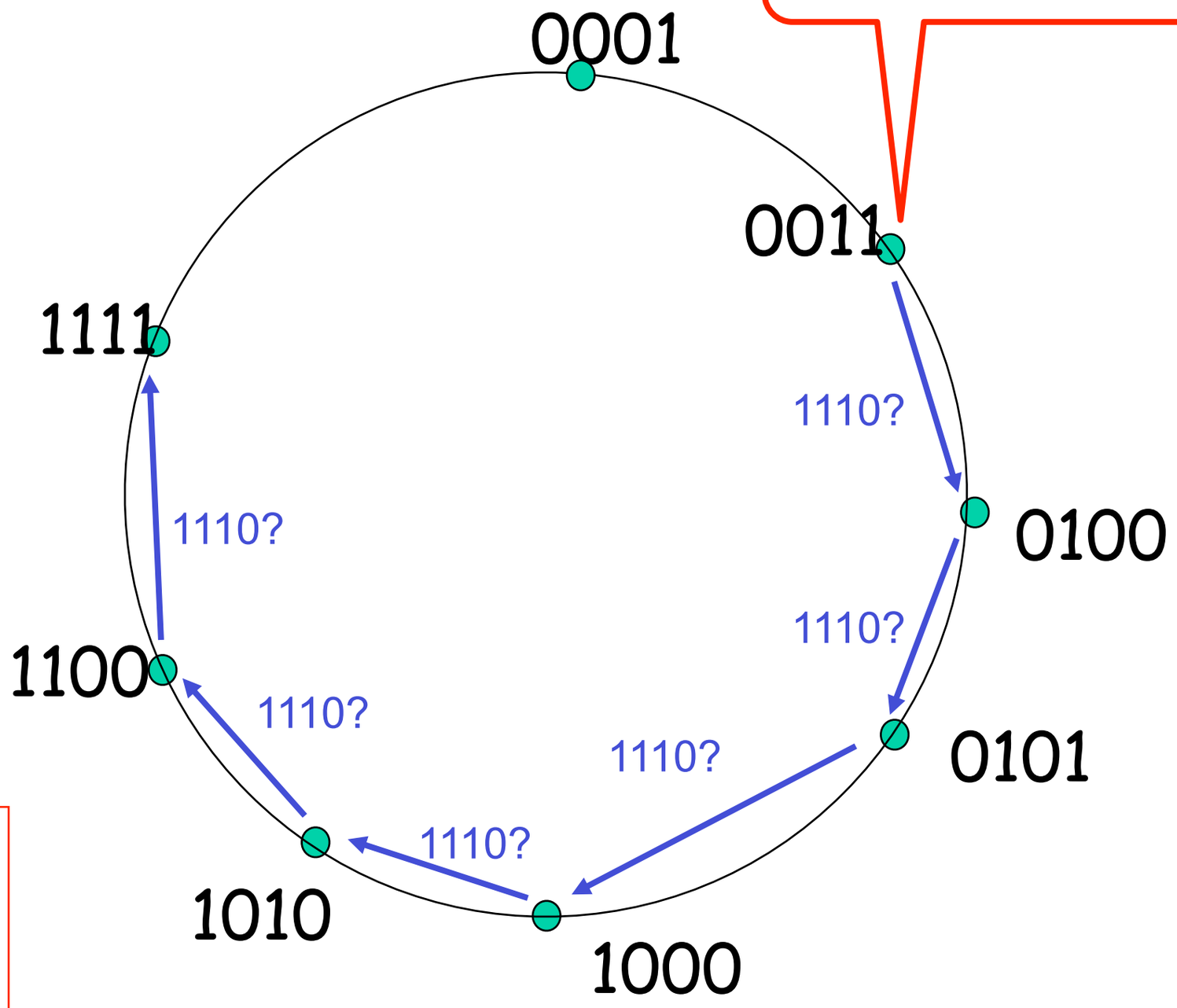

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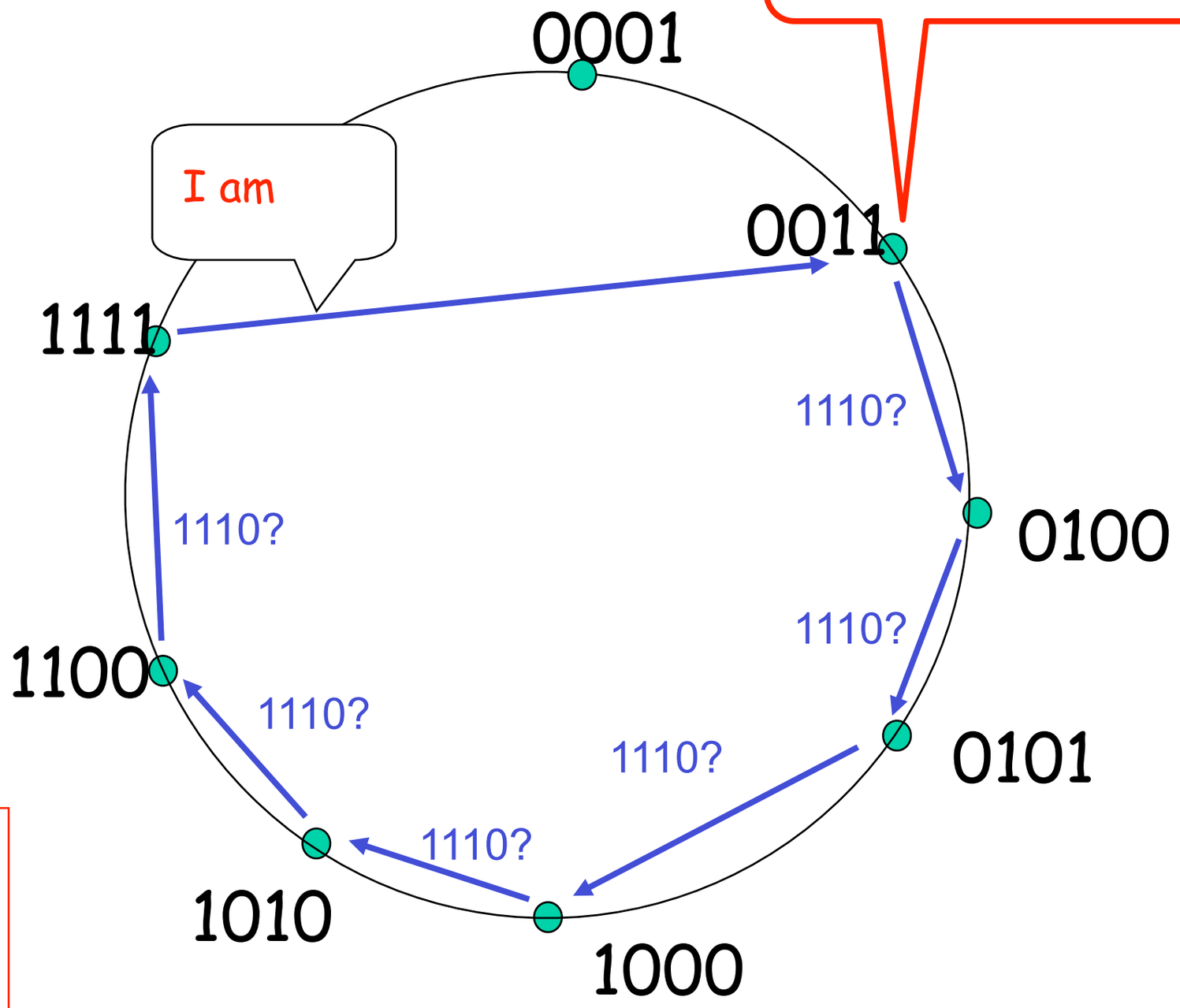

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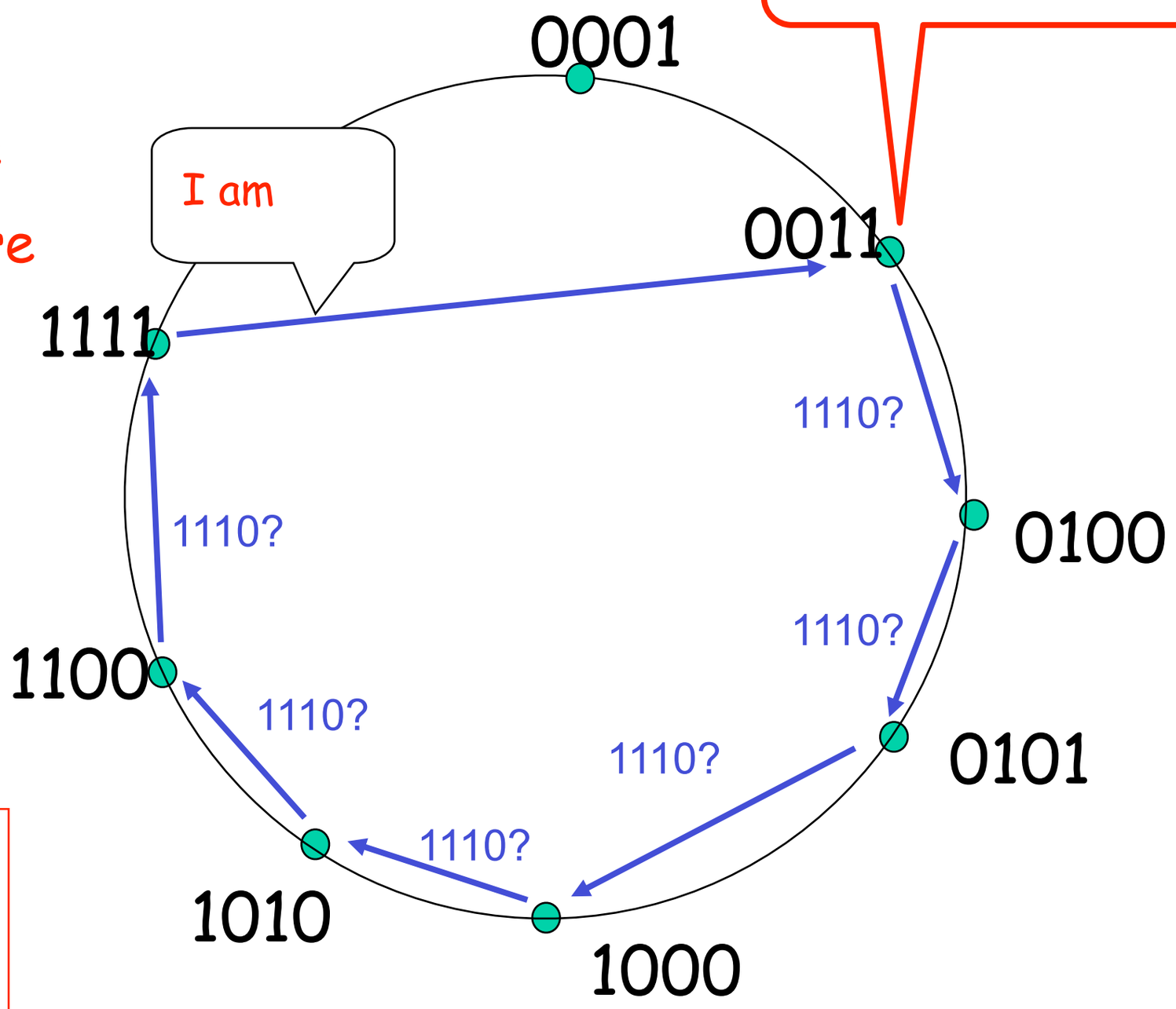
O(N) messages on avg to resolve query, when there are N peers



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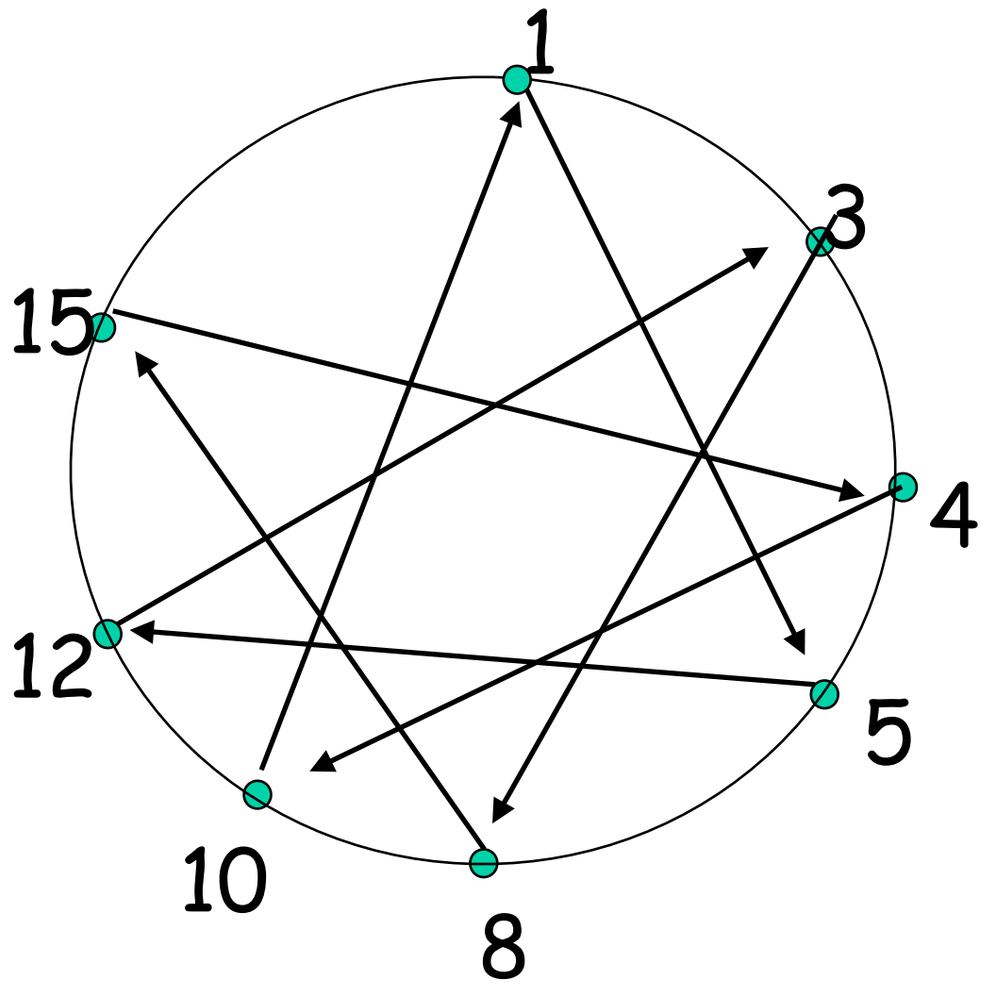

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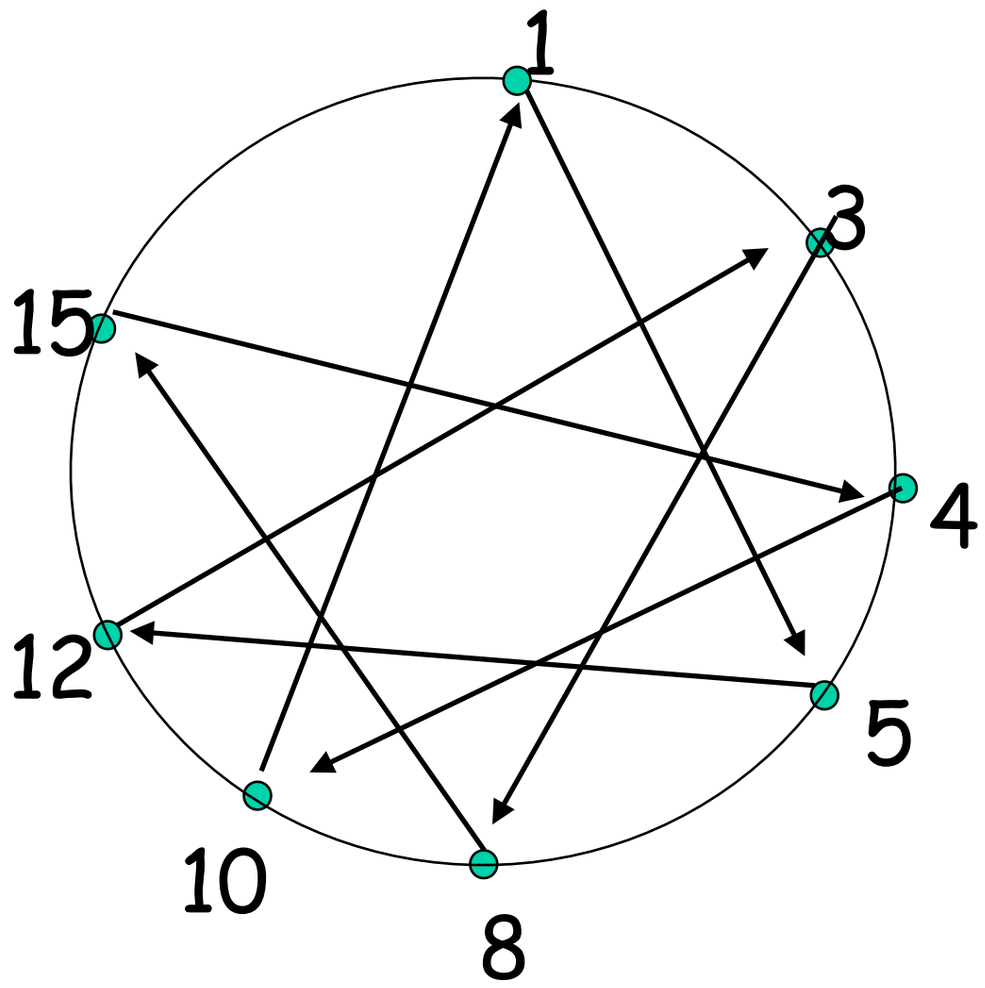

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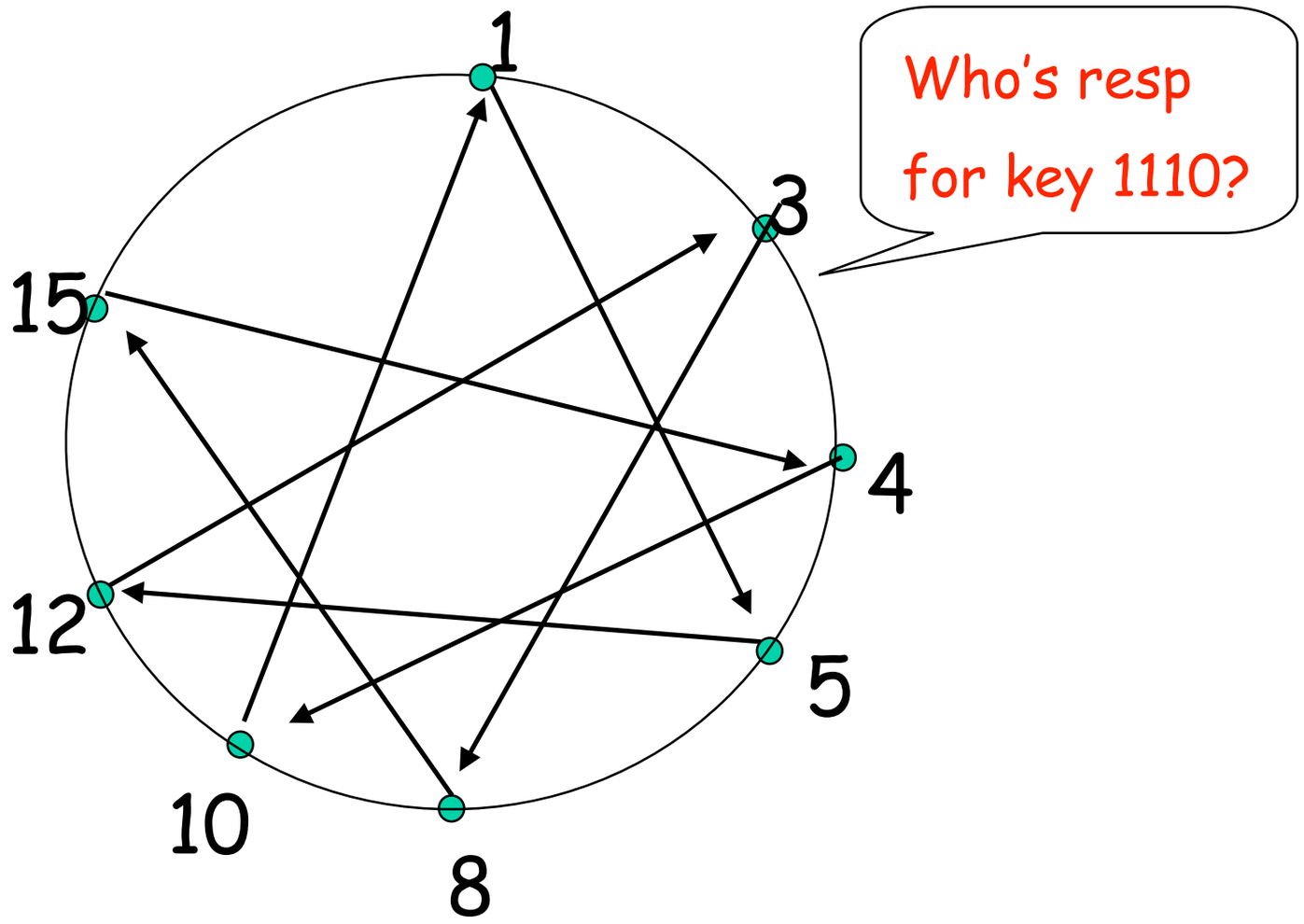

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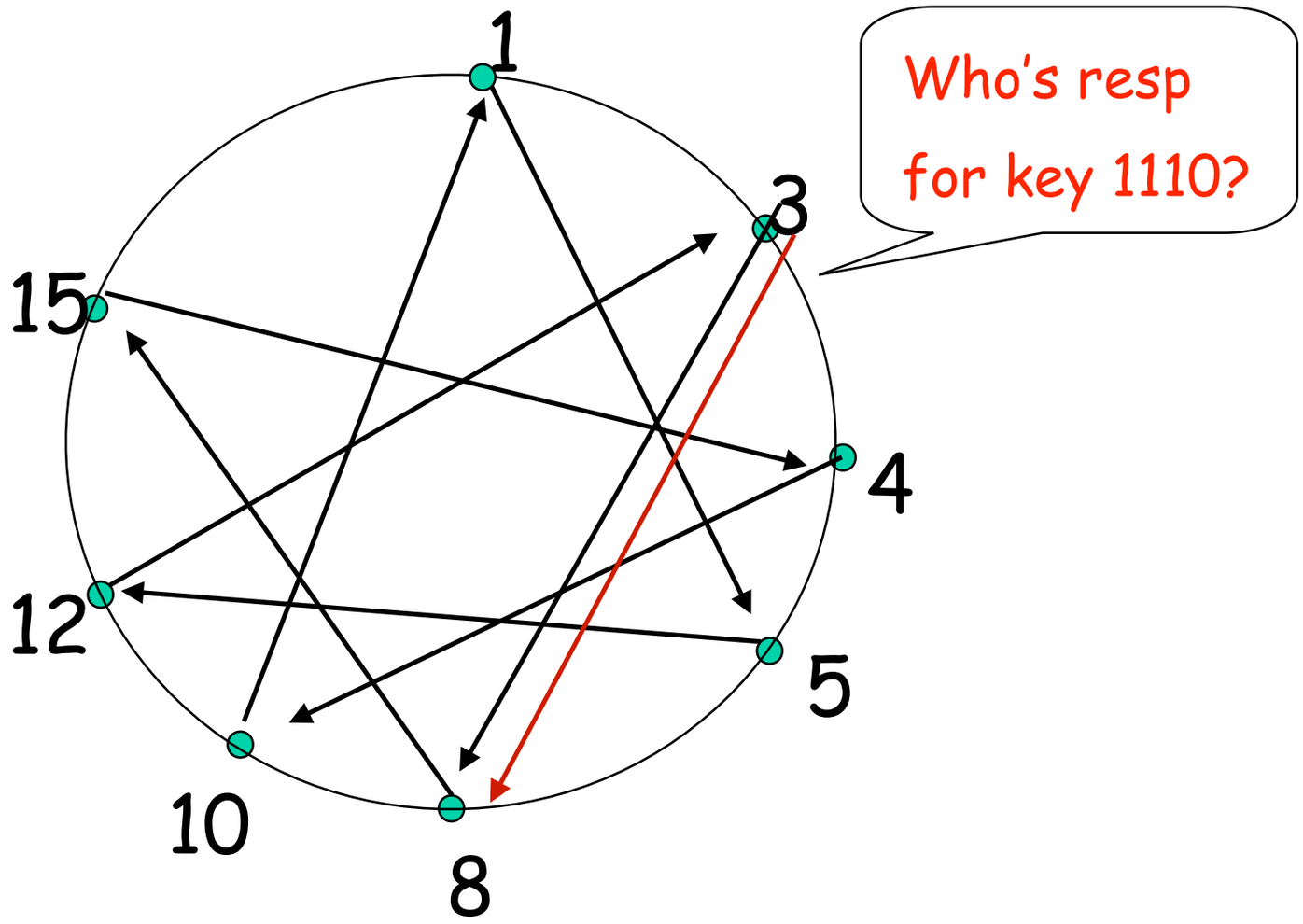

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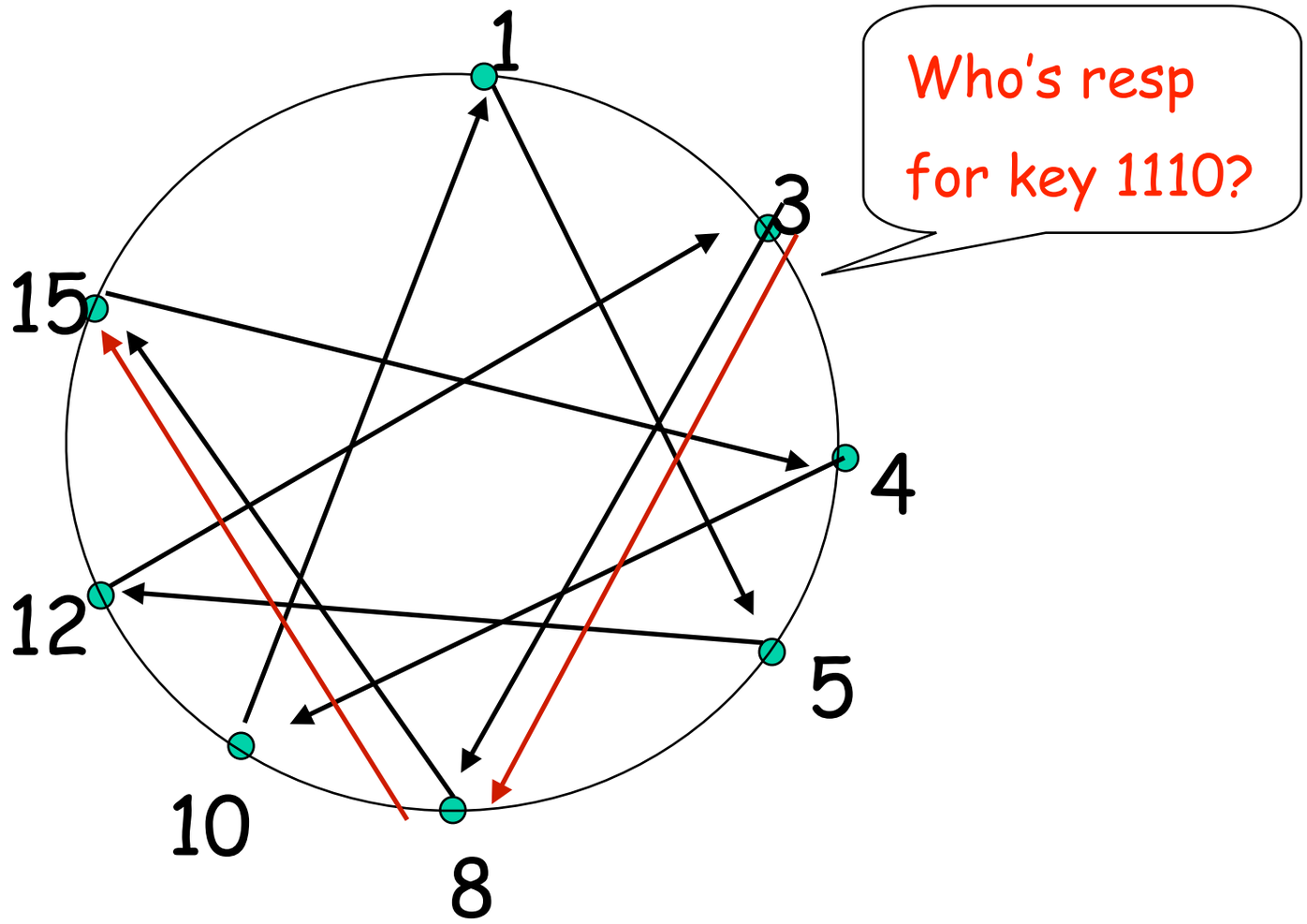

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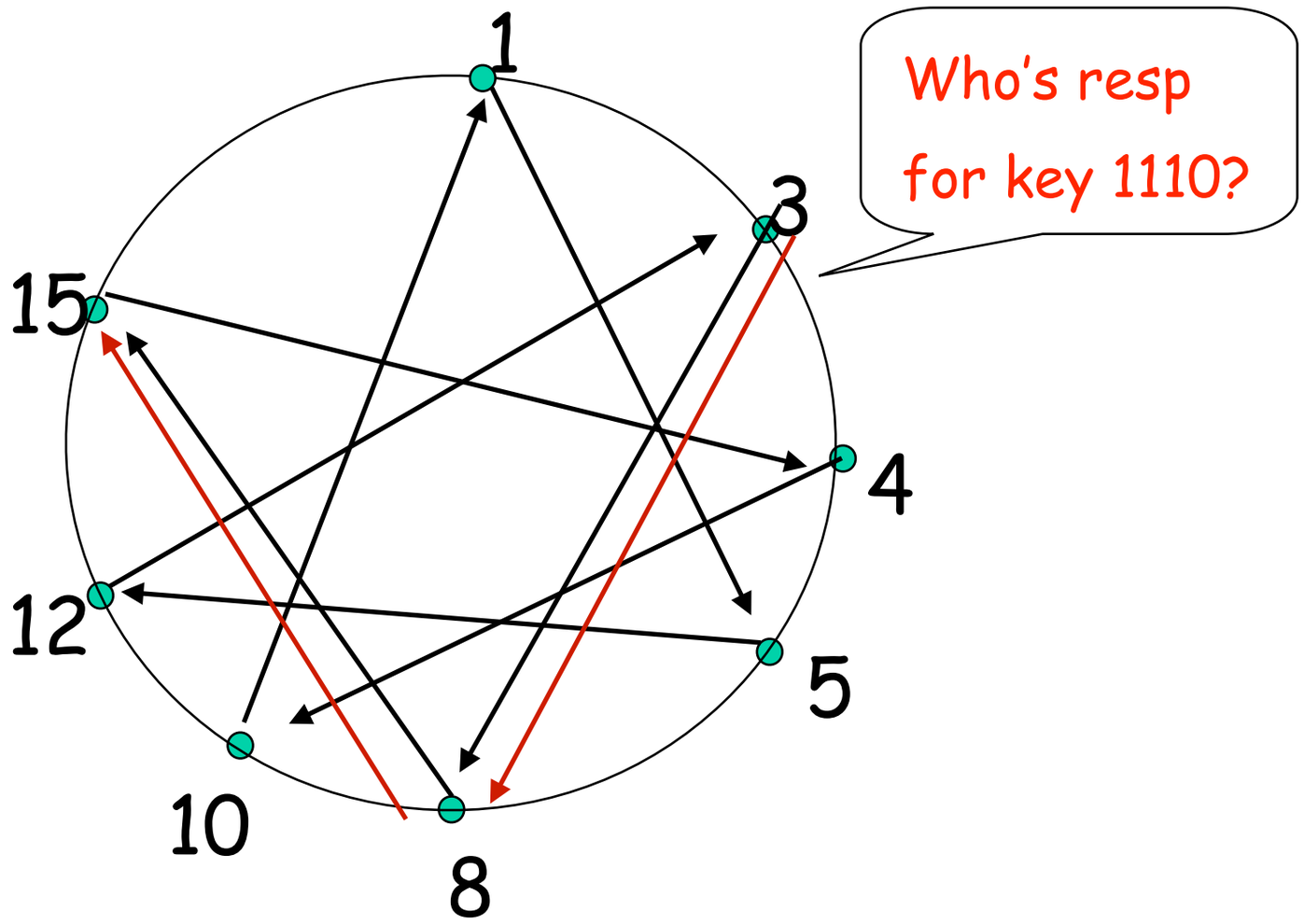

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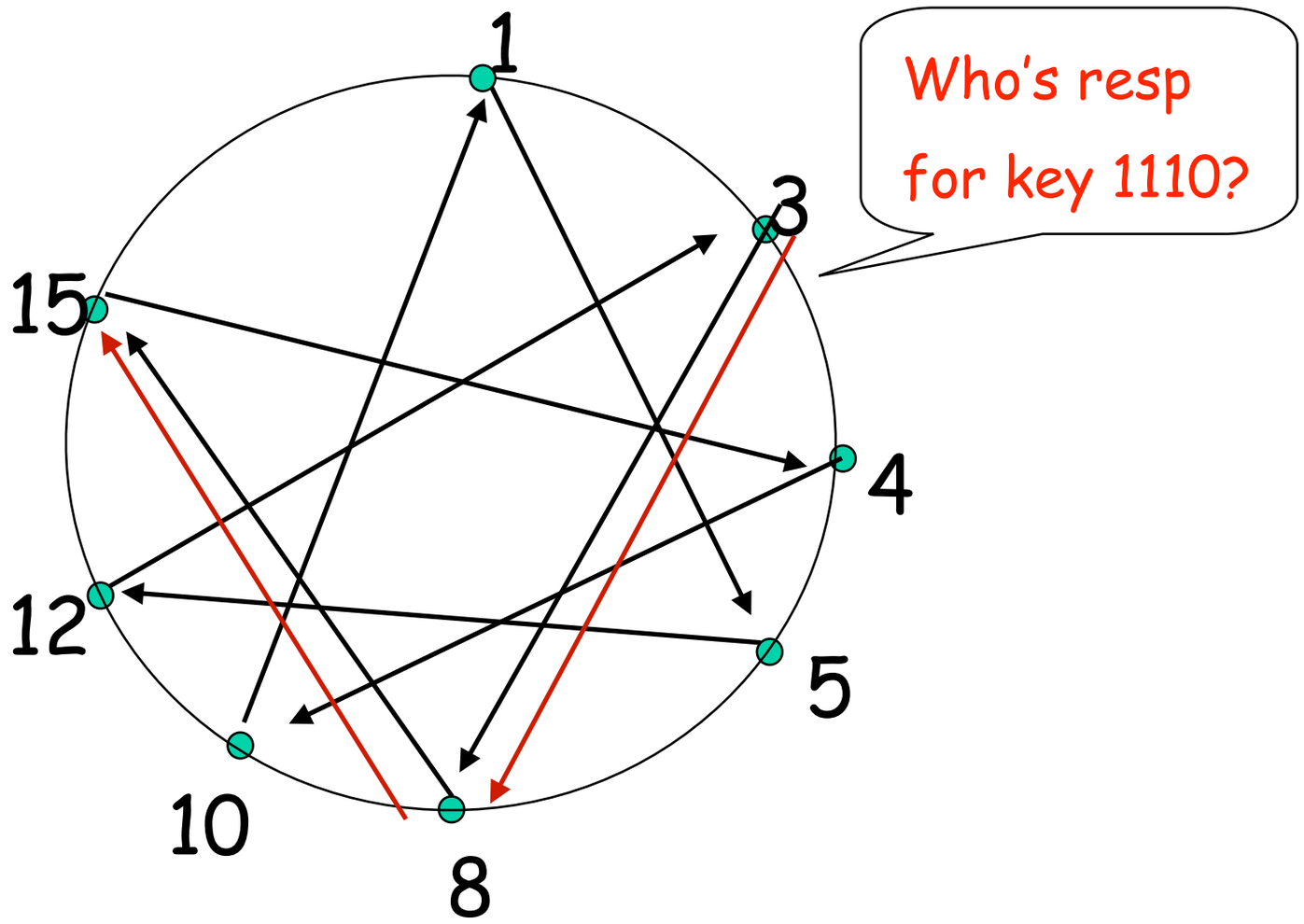

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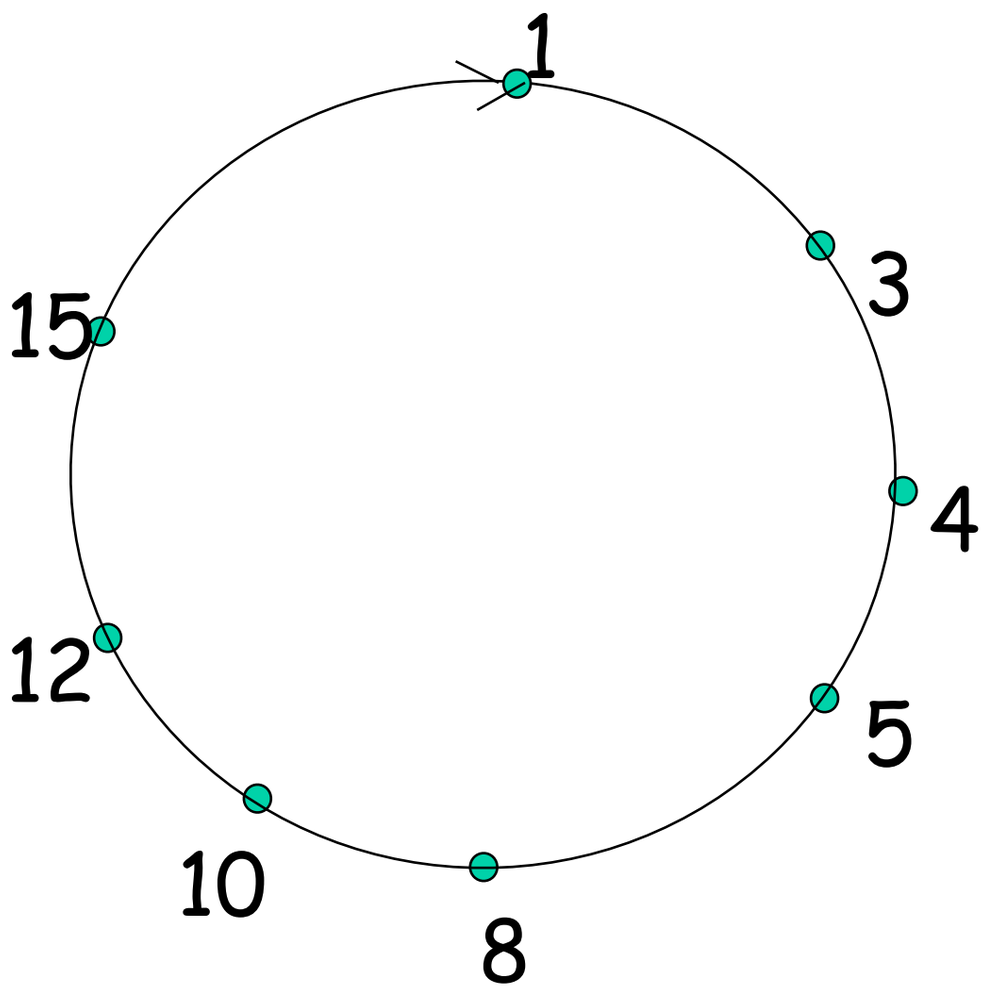
- reduced from 6 to 2 messages.
- possible to design shortcuts so O(log N) neighbors, O(log N) messages in query

Peer Churn



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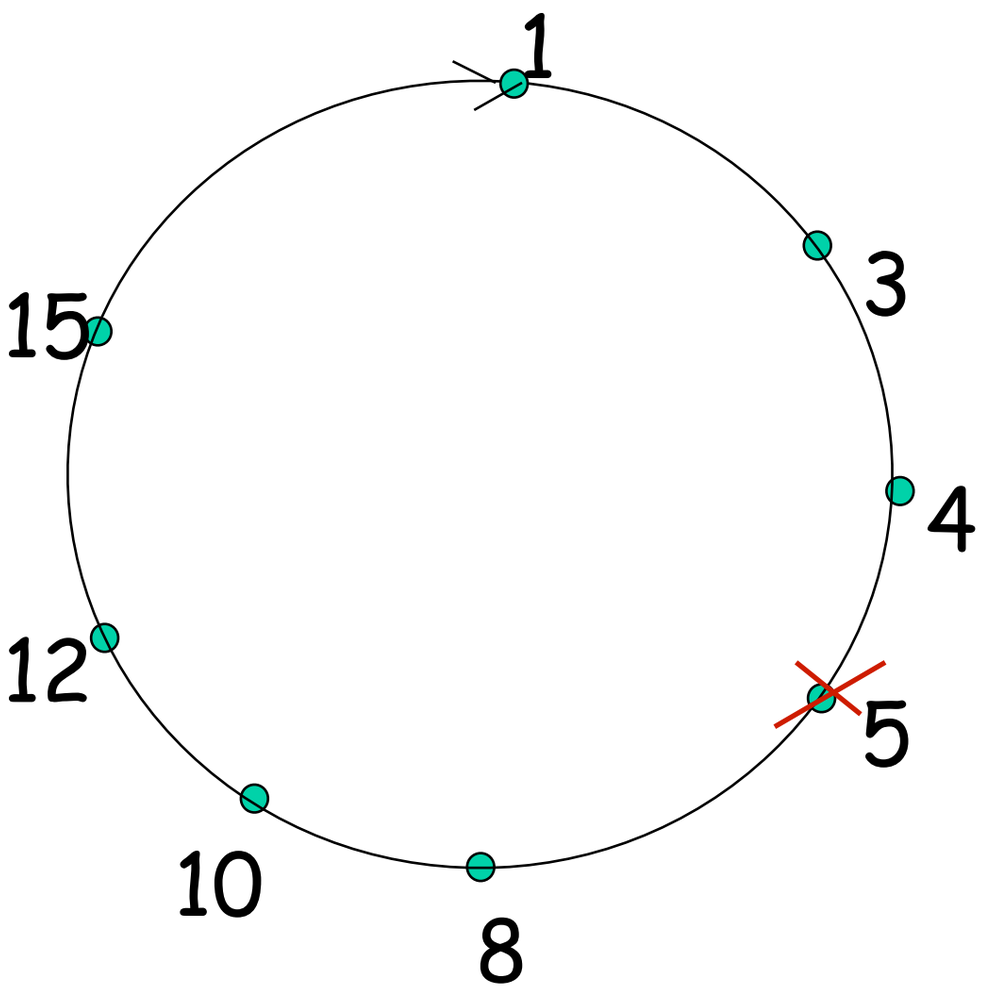

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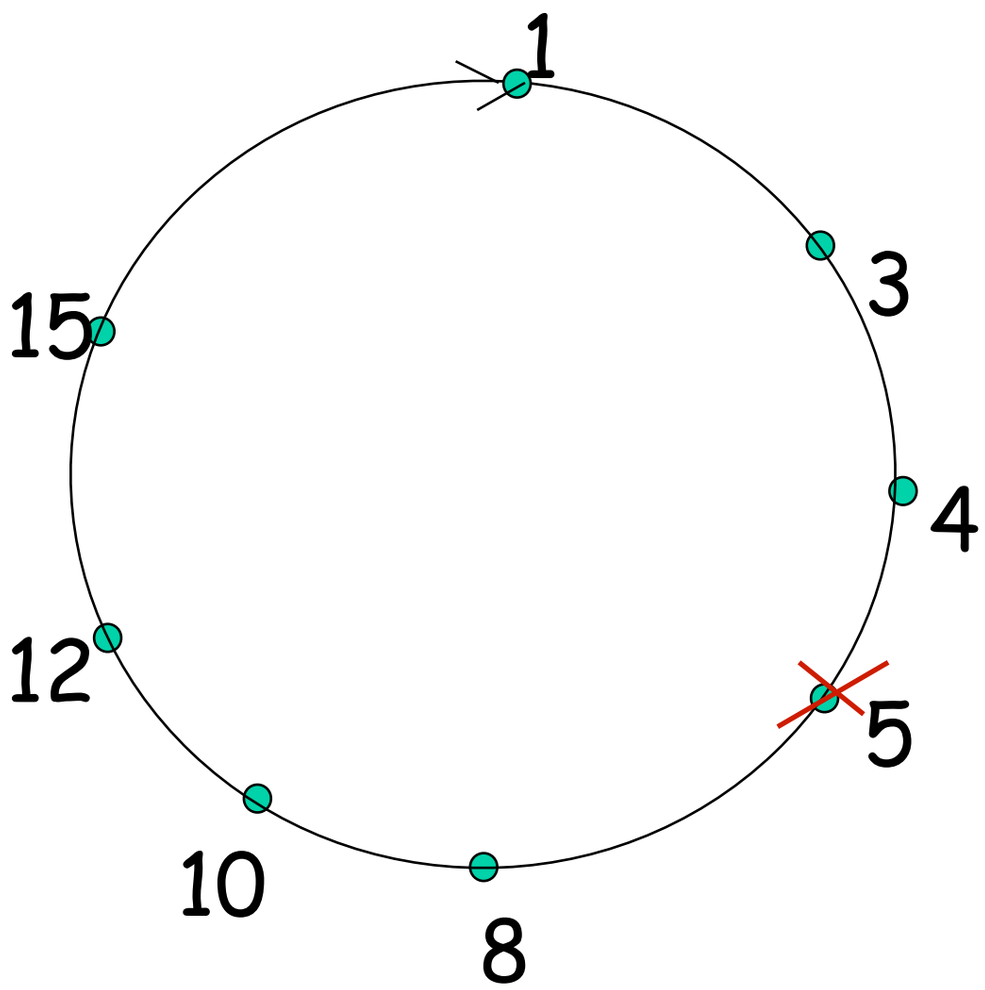

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- Peer 4 detects; makes 8 its immediate successor; asks 8 who its immediate successor is; makes 8's immediate successor its second successor.

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- What is another distributed data structure?
  - blockchain
  - essentially a cryptographically secure ledger that can be broadly shared with integrity guarantees

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- inherently P2P: pairs of users communicate.
- proprietary application-layer protocol (inferred via reverse engineering)
- hierarchical overlay with SuperNodes (SNs)
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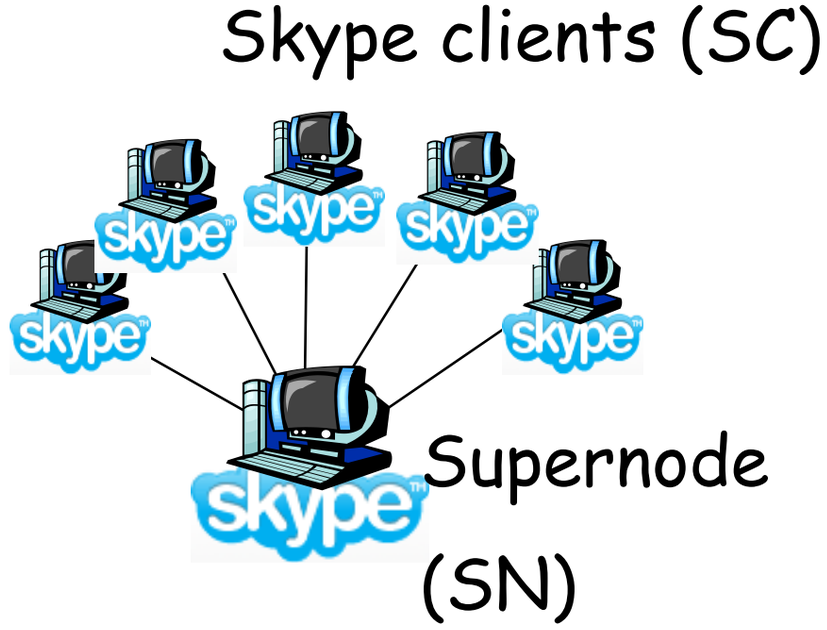

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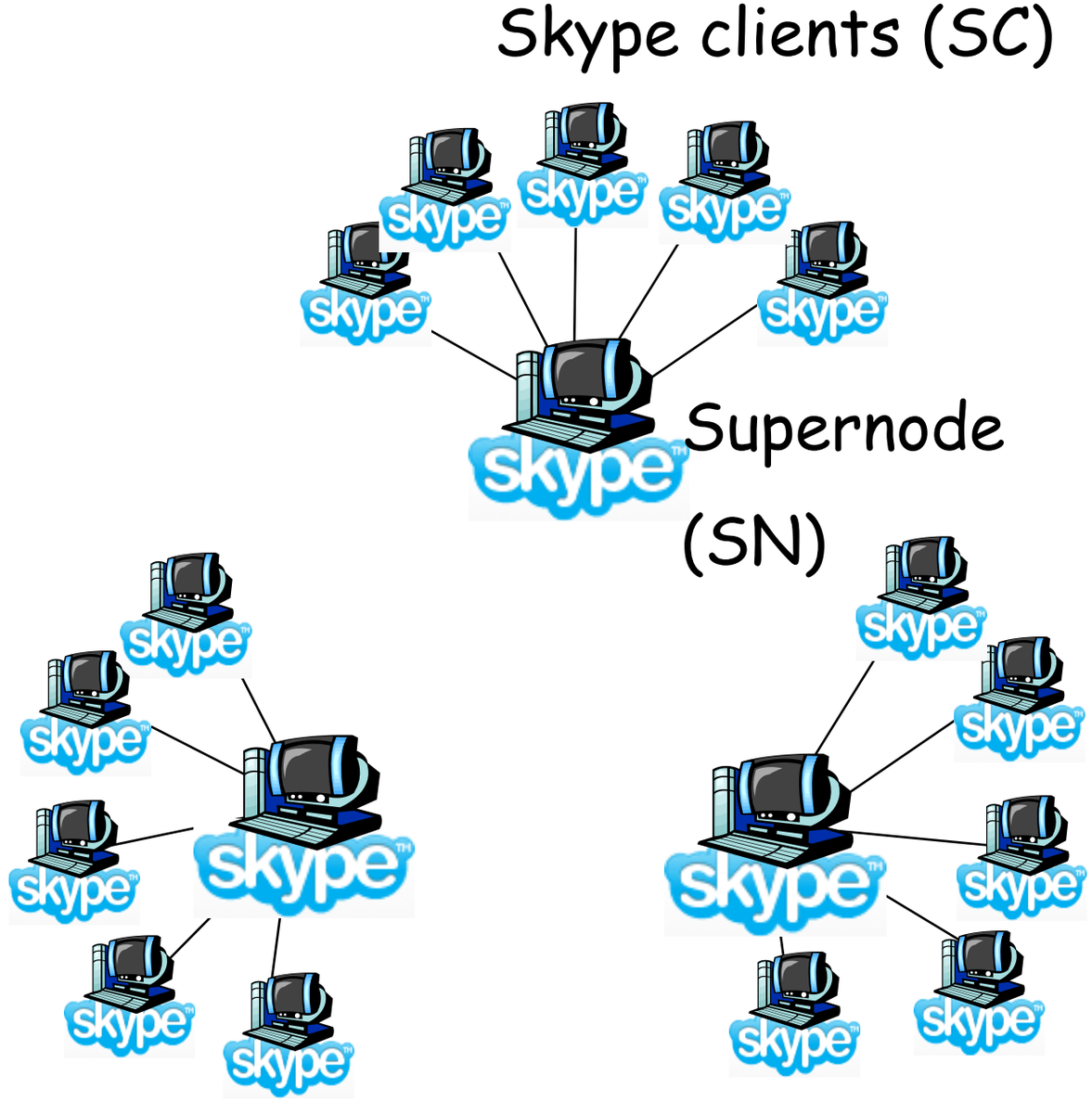

P2P Case study: Skype

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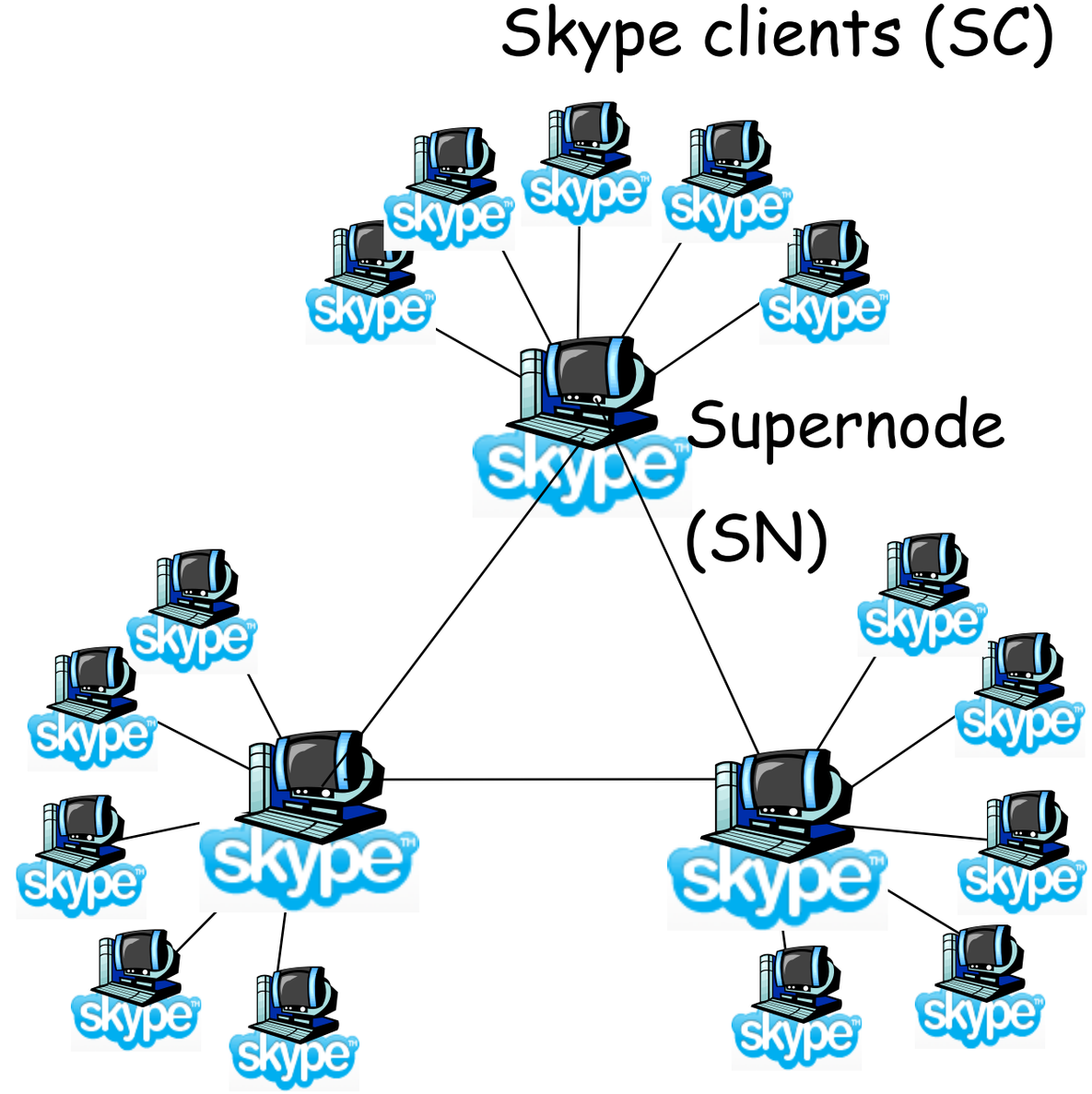

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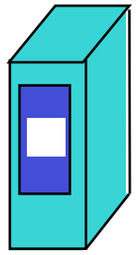

Skype login server

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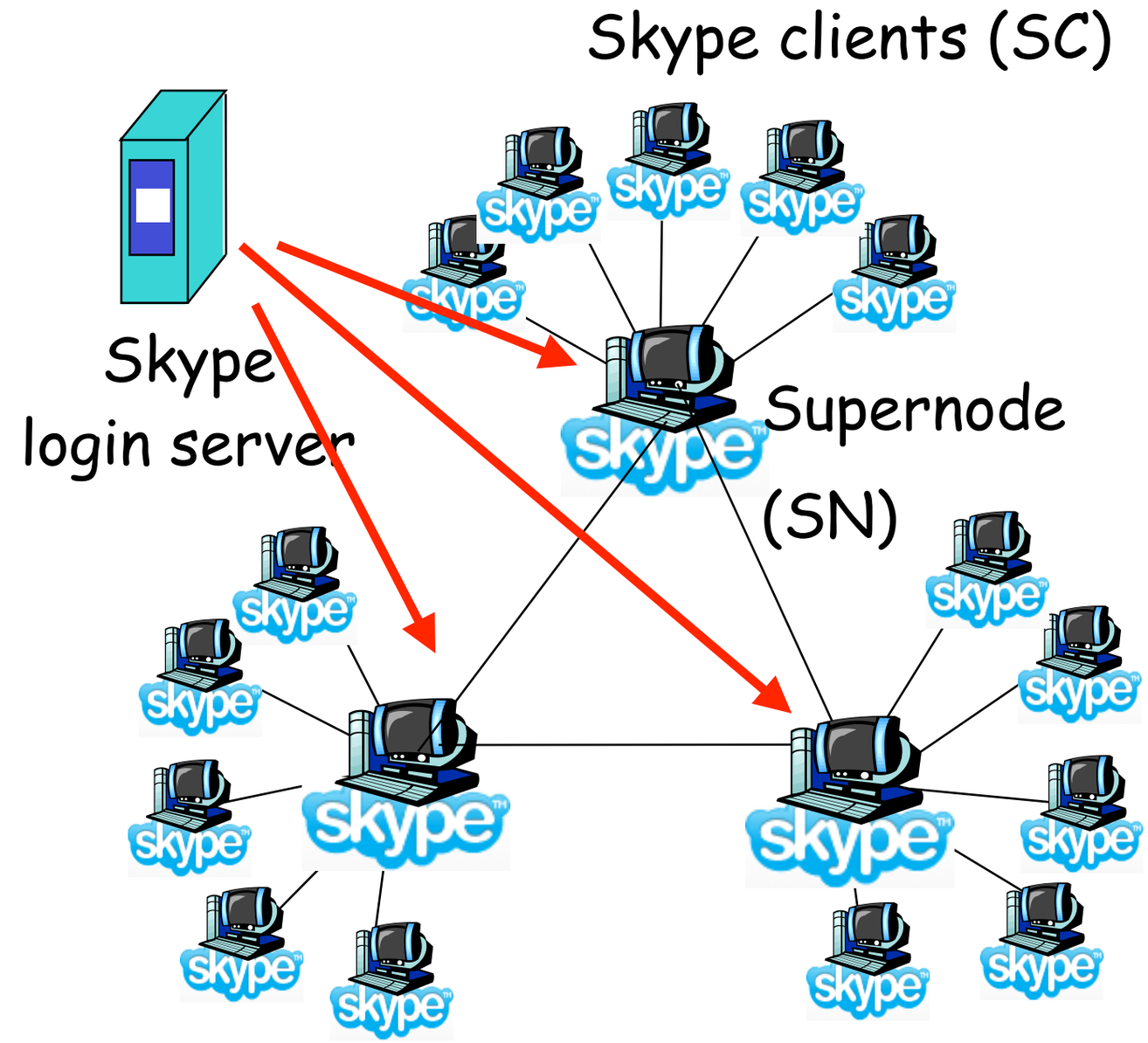

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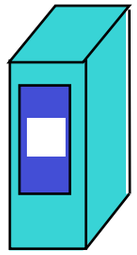

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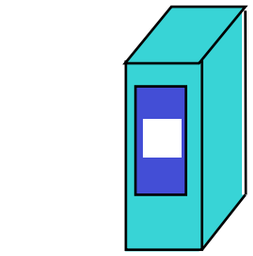
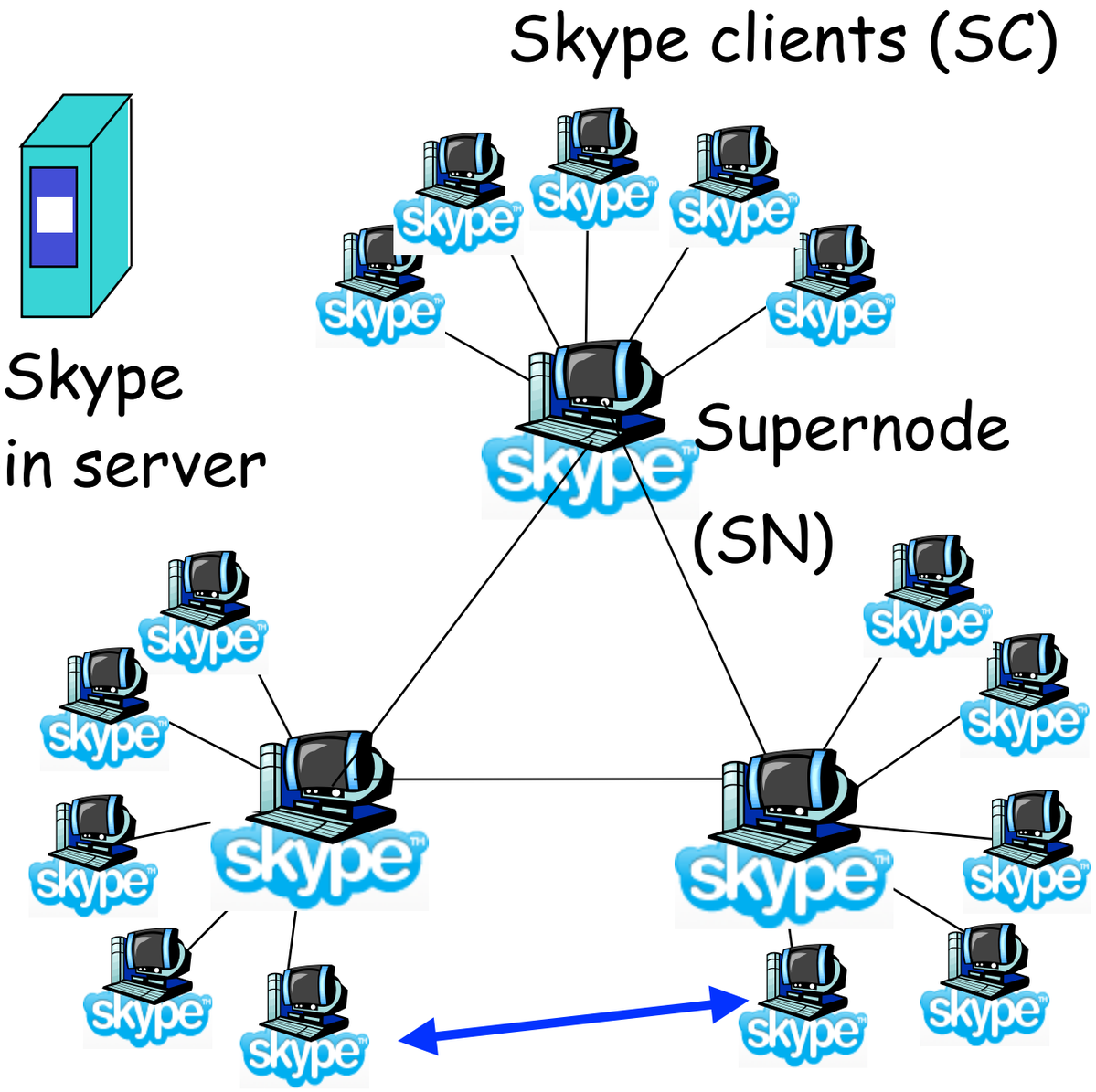


Skype login server



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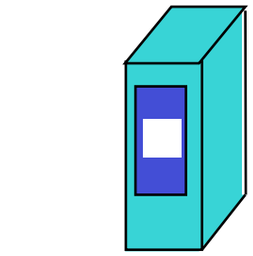

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