

DS 593: Privacy in Practice

Decentralized Systems

News?



NEWS

Hertz says hackers stole customer credit card and driver's license data



Hertz says it's "not aware of any misuse of personal information" stemming from the breach. Image: Getty Images

/ The extent of the data breach is unclear, but customer notices have been released in multiple countries.

by [Jess Weatherbed](#)

Apr 15, 2025, 5:58 AM EDT



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<https://www.theverge.com/news/648741/hertz-customer-data-breach-hackers-cleo-vulnerability>

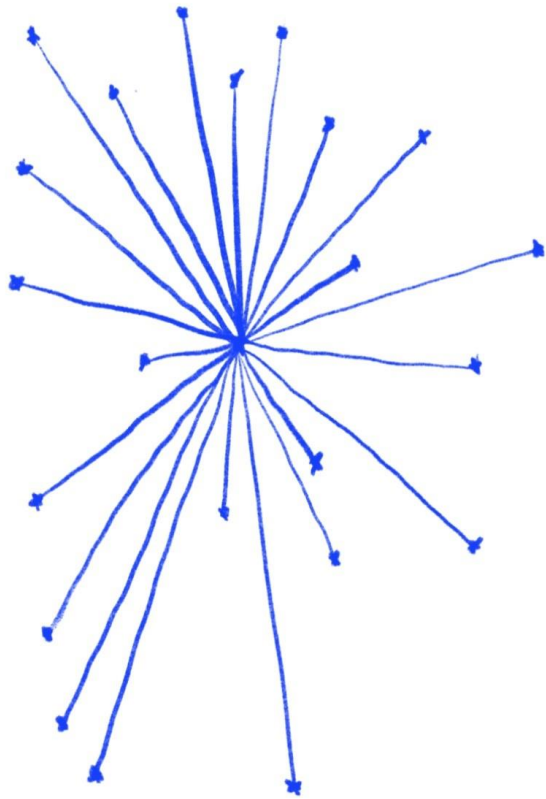
Last time

- Content Moderation and Privacy

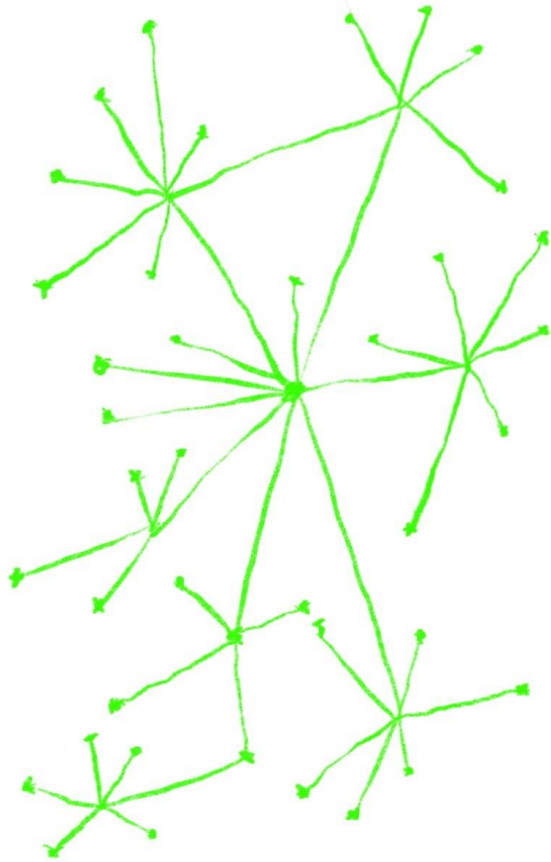
Today

- Decentralized Systems

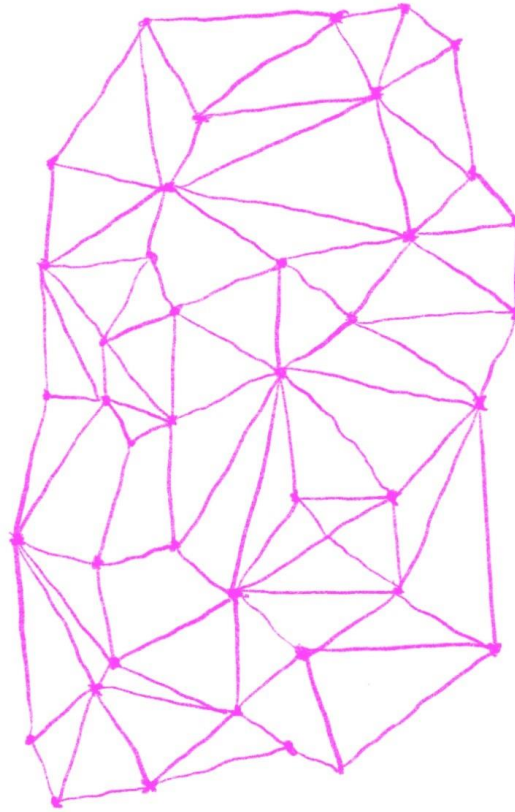
Centralization



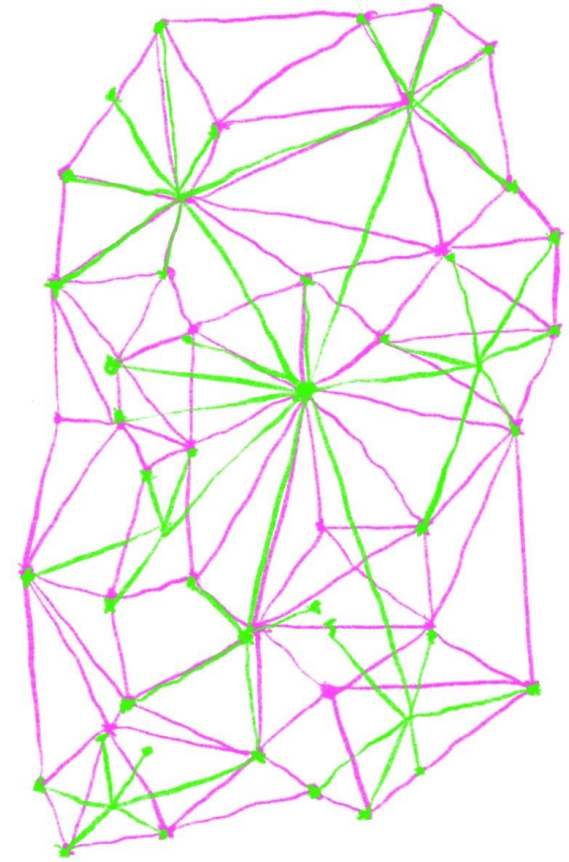
CENTRALIZATION



DECENTRALIZATION



DISTRIBUTION



DISTRIBUTED
DECENTRALIZATION

Which of the following is a Centralized system?

- Facebook
- The Internet
- Email
- DNS
- Wikipedia
- Firefox
- Venmo

What are the issues with Centralization?

Key Concepts

- A *Distributed System* is where multiple networked computers must collaborate to complete a task
- A *Decentralized System* is where key operations and control are pushed from a central hub to multiple devices with different owners
- A *Federated System* is a set of interoperable computing networks
- A *Peer-to-Peer (P2P) System* is a decentralized and distributed system composed of Peer devices
 - Peers have equal amounts of privilege and power

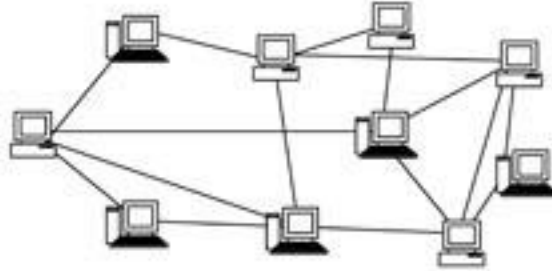
Decentralized System Considerations

- No single point of failure
- More complex coordination needed
- Usually needs some form of signaling protocol
 - How do you find your peers
- Identity?
 - Sybil Attacks
- Freeloading?
- Throttling?
 - Protocol Encryption

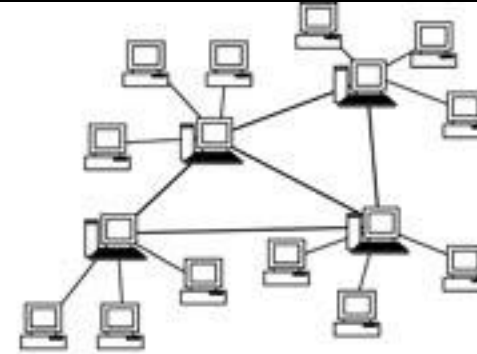
P2P Architecture



a
Centralized overlay.
Central peer facilitates
the interactions among
the leaf-peers.

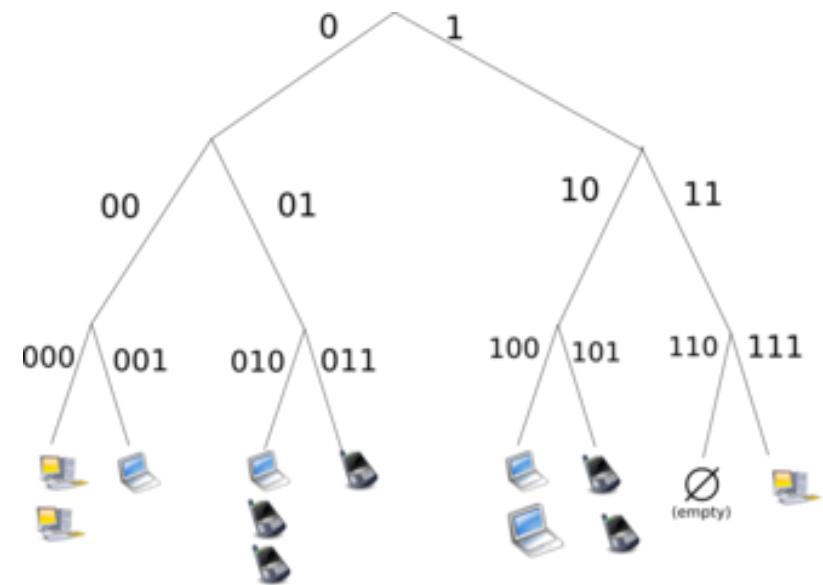
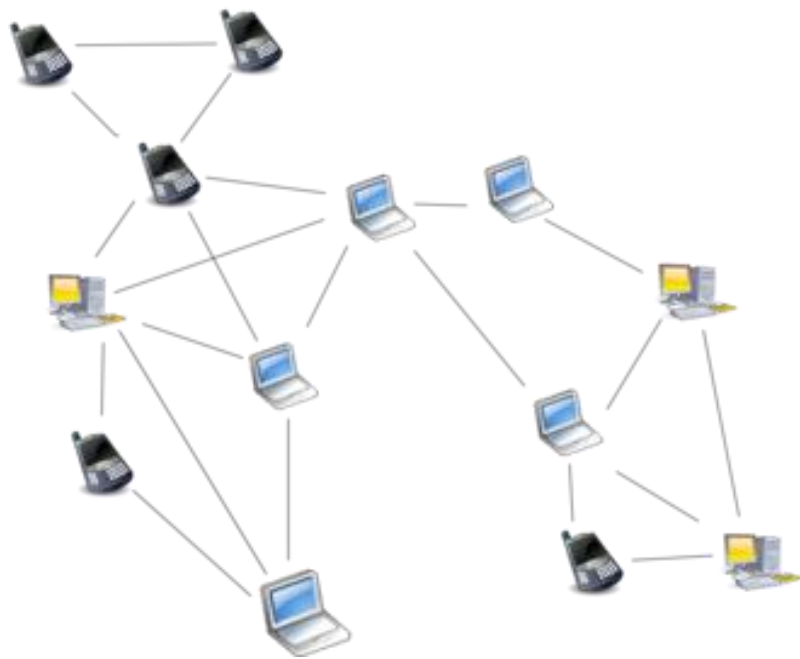


b
Decentralized overlay.
No central authority, all
peers treated equally.

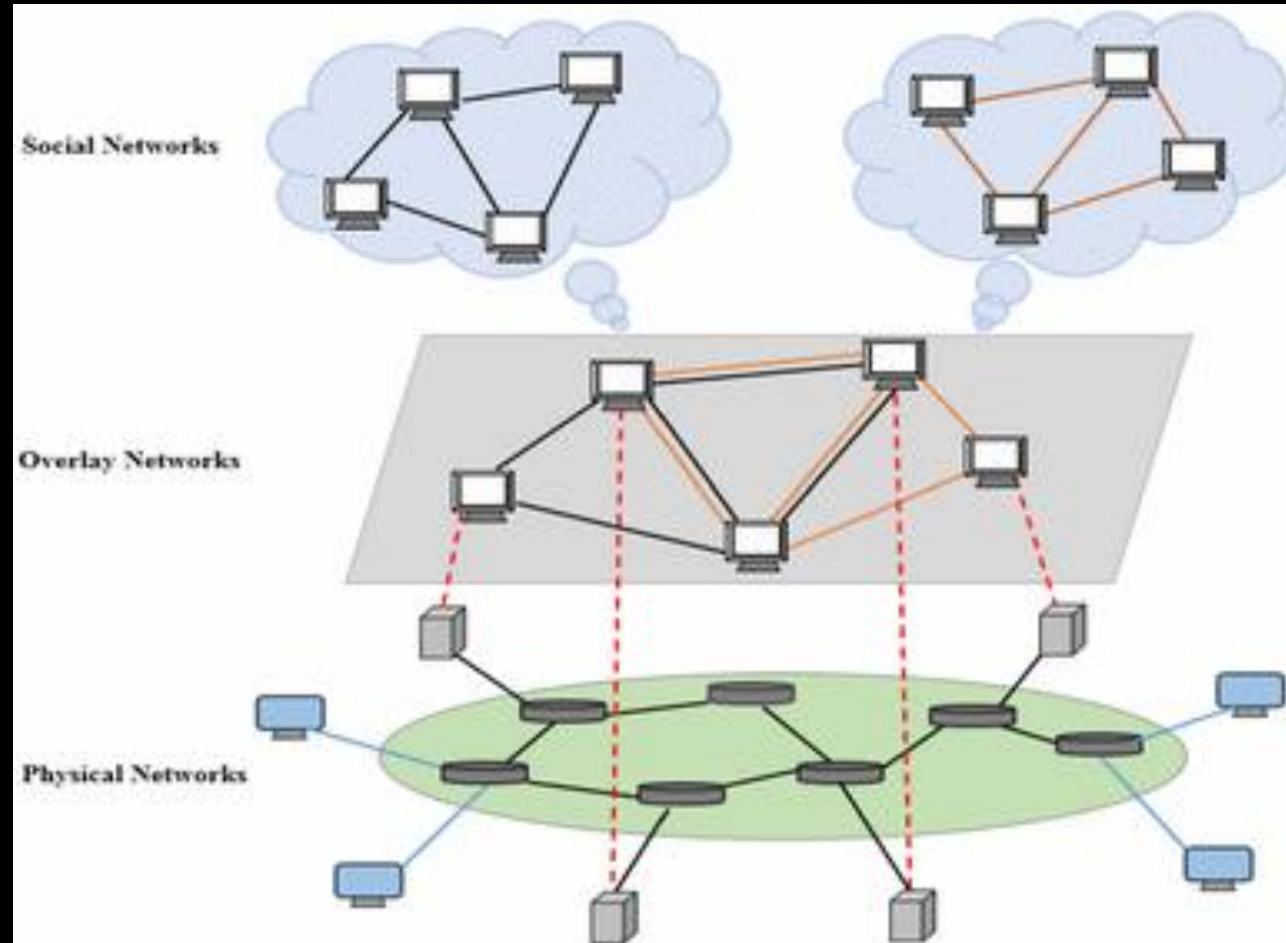


c
Hybrid overlay.
Hierarchical topology,
interconnected super-
peers locally serve the
subsets of leaf-peers.

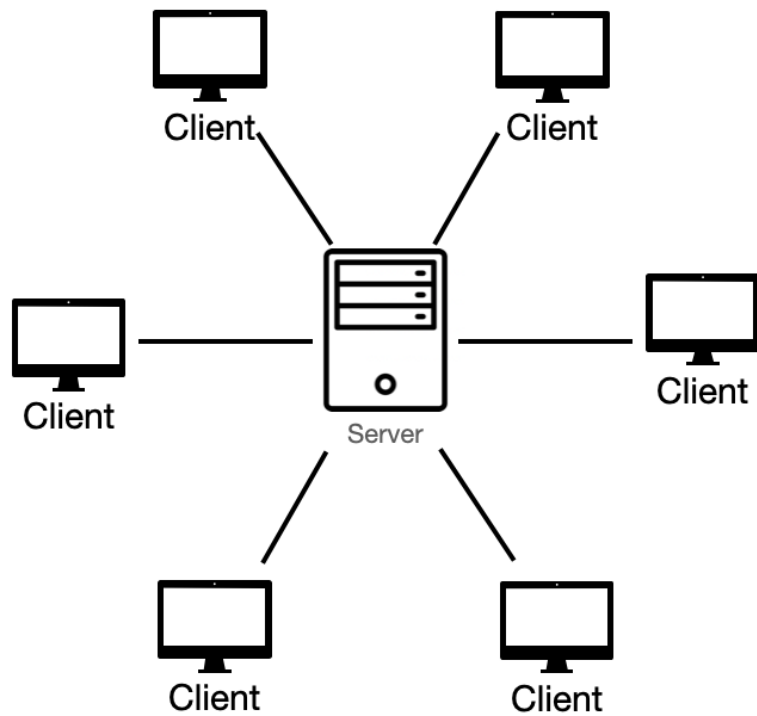
P2P Architecture



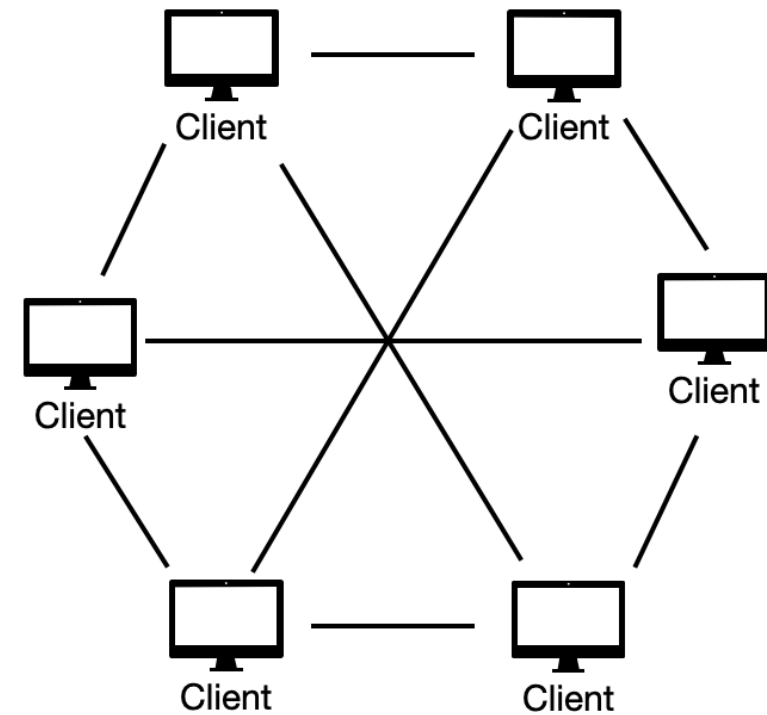
P2P Architecture



P2P Robustness

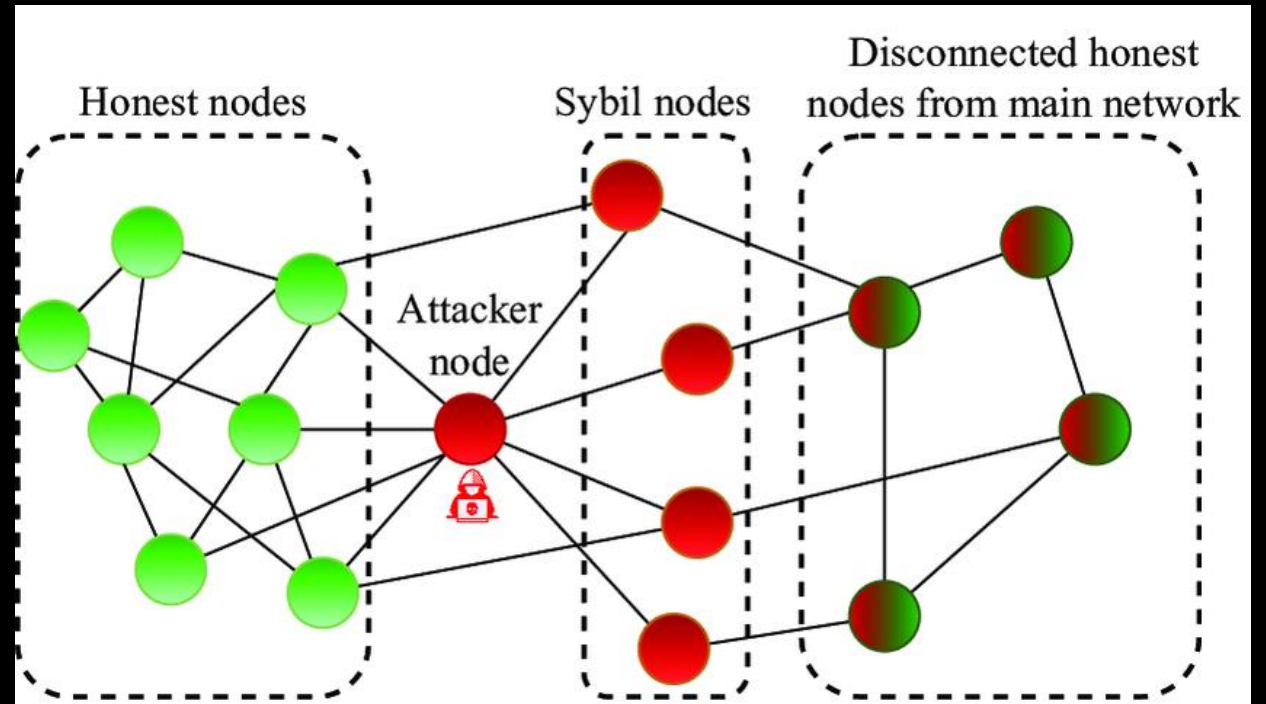
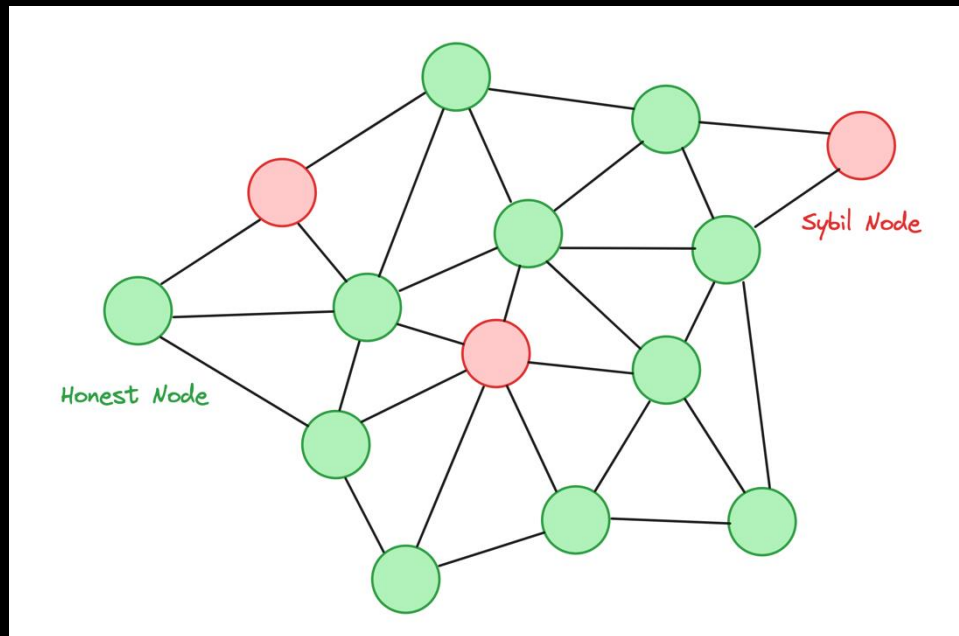


Client Server Architecture

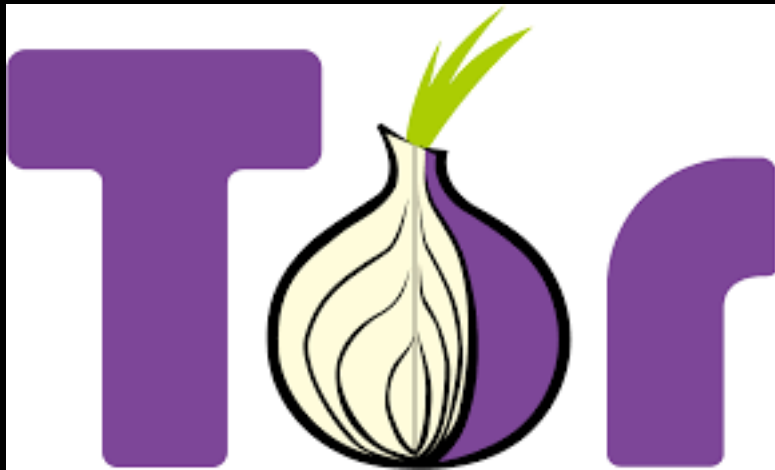


P2P Architecture

P2P Security



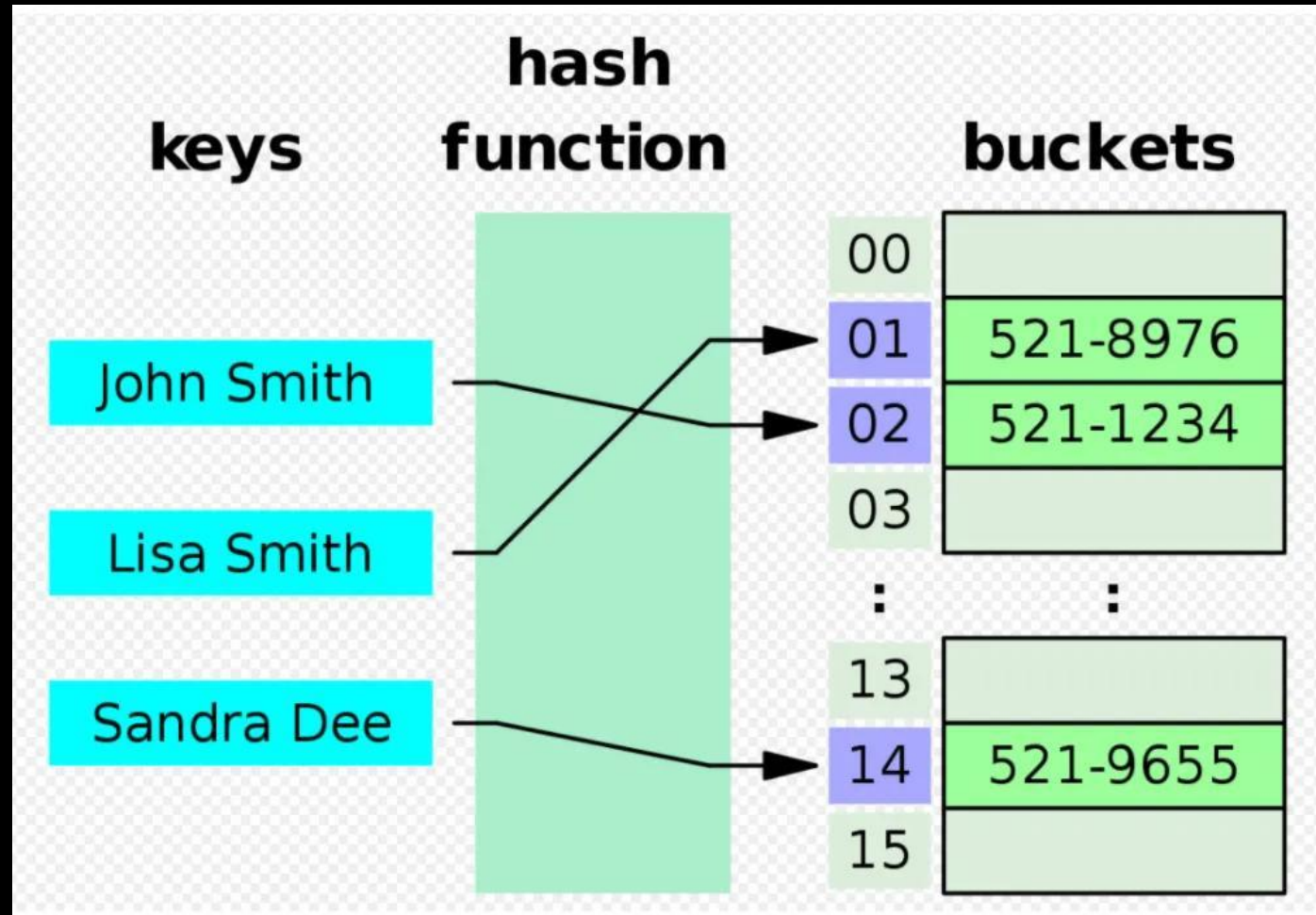
Examples of Decentralized Applications



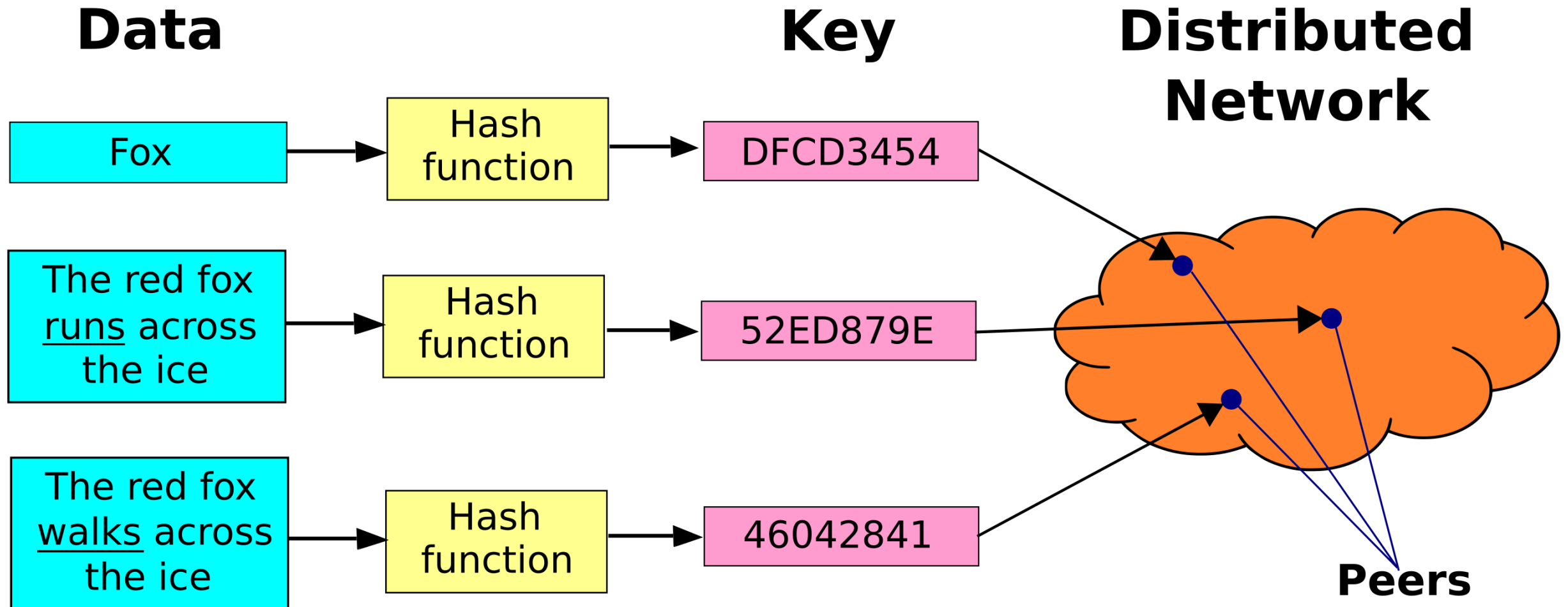
Examples of P2P Applications



Hash Tables



Distributed Hash Tables



Storing data in a DHT

- Compute $\text{Hash}(\text{filename}) = k$
- Send k , data to the P2P network
- Nodes forward the message until it reaches the node responsible for key k , who then stores the data
- Retrieval works similarly

BitTorrent

- P2P file sharing protocol
- Designed by Bram Cohen in 2001
- Optimized for transferring large files
 - Examples?
- In 2019, was responsible for 2.46% of downstream and 27.58% of upstream internet traffic

Torrents

- A *seed* is a system with a complete copy of a file
- Peers that download the file become *seeds*
- *Trackers* are special servers that keep track of which peers have which files
- A *torrent file* helps clients connect to trackers
 - Does not contain the content, only information about the content and verification info
- DHTs can remove the need of a torrent file

Torrenting

- The content being distributed is broken into chunks
 - When a peer receives a chunk it can become a seed for that piece
- The torrent client uses the torrent file to connect to a tracker which then facilitates retrieving chunks of the content from seeds
- Client simultaneously fetches these pieces from multiple seeds
- The client then reassembles these pieces

Seeding

- BitTorrent relies on there being many peers to retrieve pieces from
- Expectation that each client also performs seeding

Next Time

Decentralization Continued