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A Novel Approach for Cooperative Overlay-Maintenance in Multi-Overlay Environments

A Novel Approach for Cooperative Overlay-Maintenance in Multi-Overlay Environments

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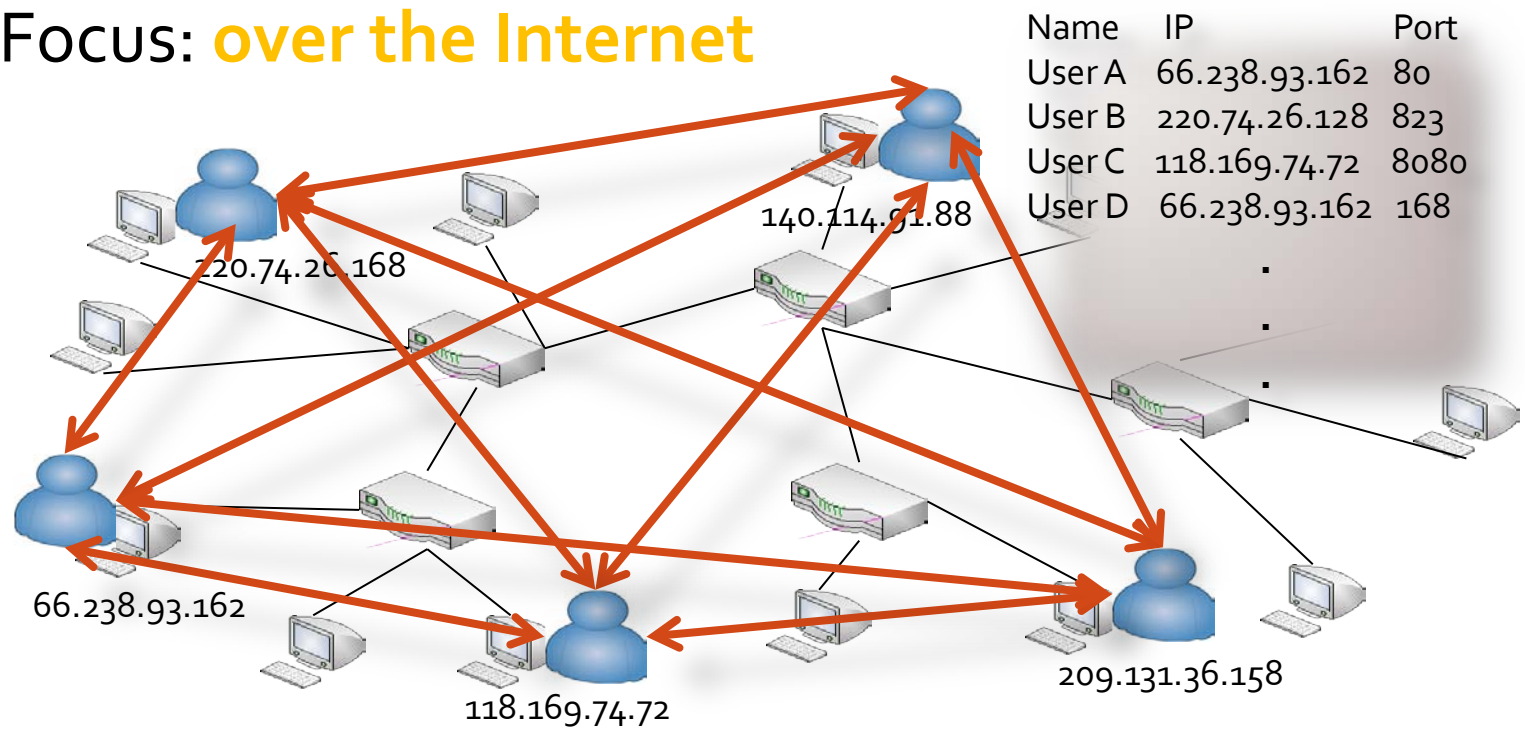
Outline

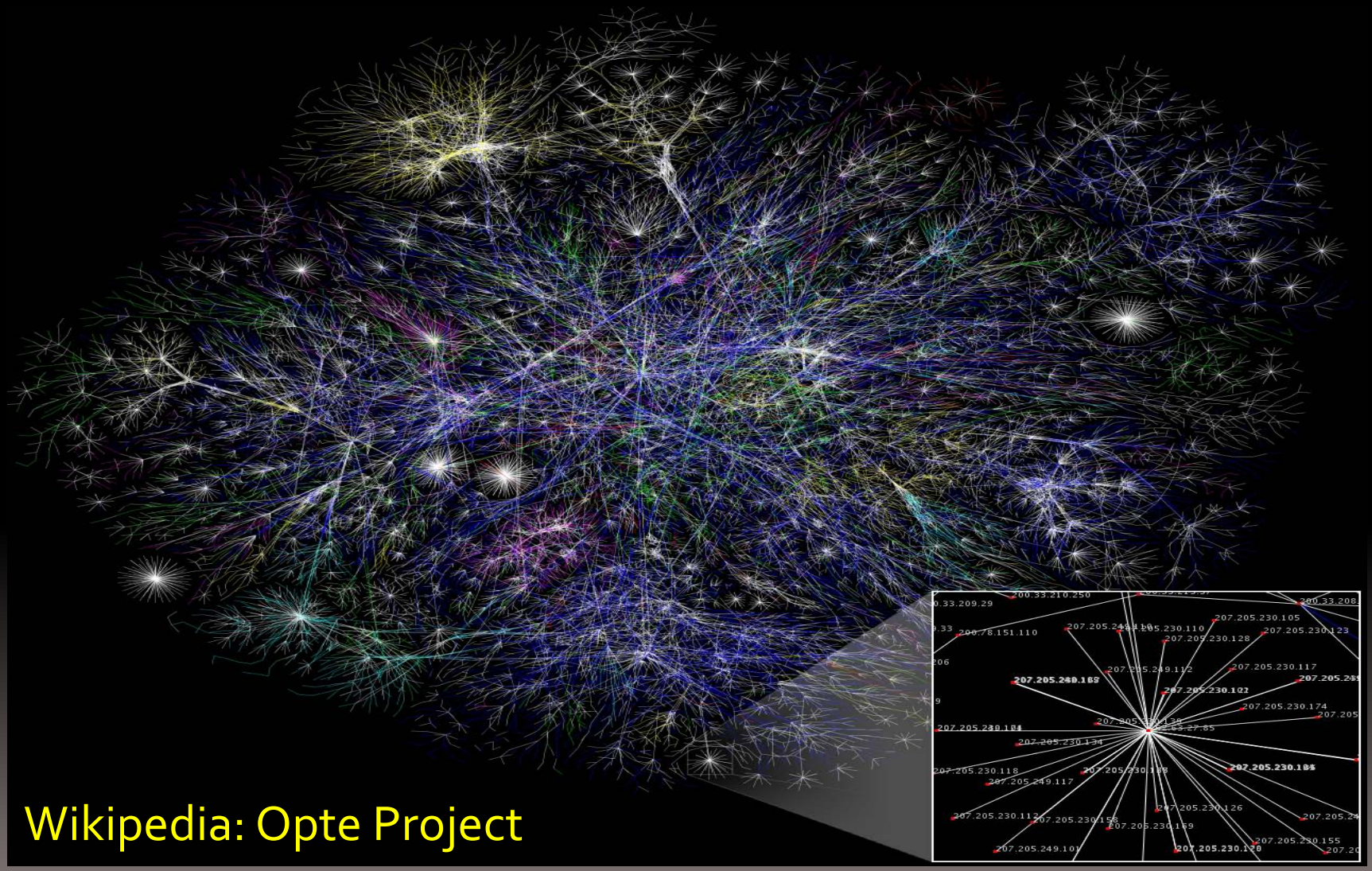
- Introduction
- Related Work
- Cooperative Strategy
  - CFD – failure detection
  - CNPE – network-proximity estimation
- Experimental Results
- Conclusions

Introduction

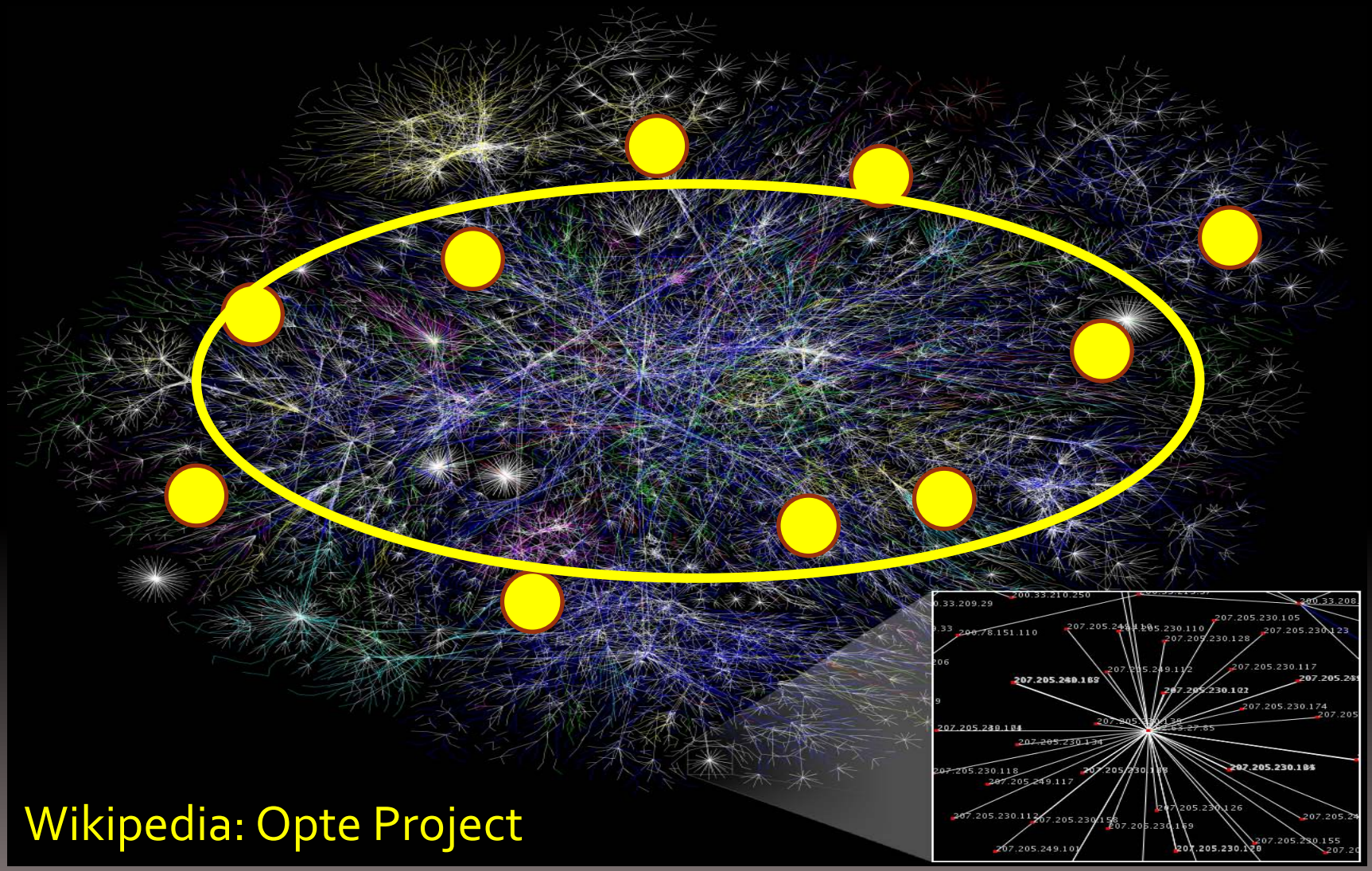
- Overlay Network
  A virtual network overlay another layer
  - Chord, Gnutella, Super-Peer model, etc.
- Focus: **over the Internet**



Internet Visualization



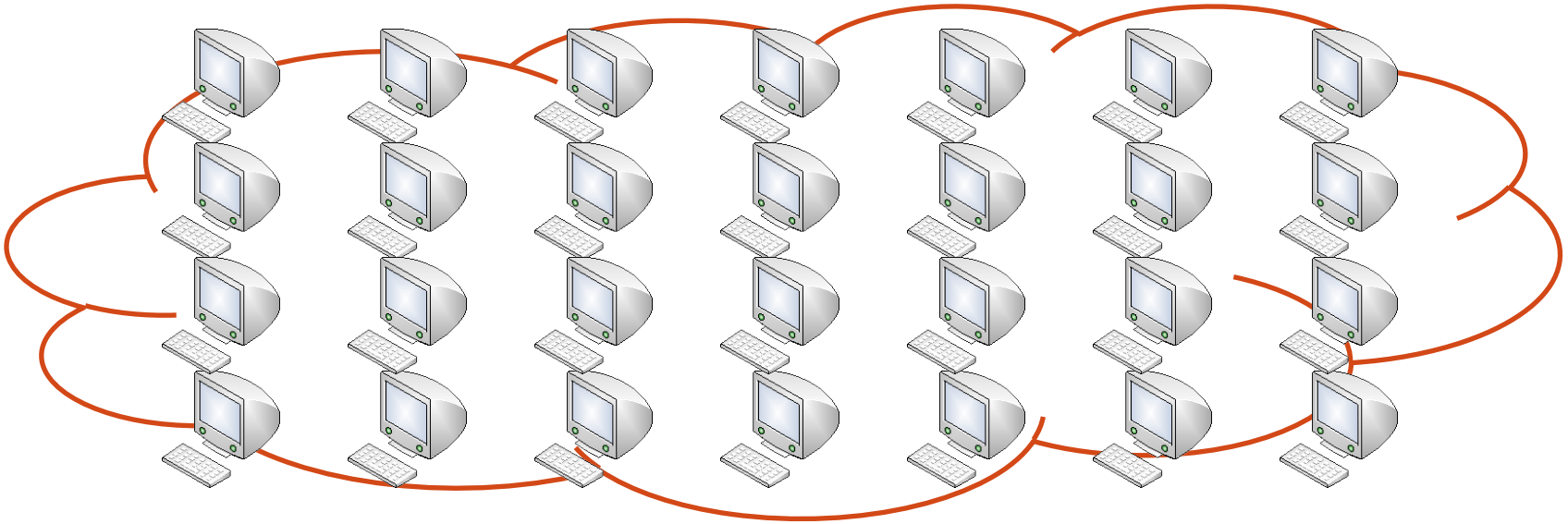
Example: Ring-based overlay



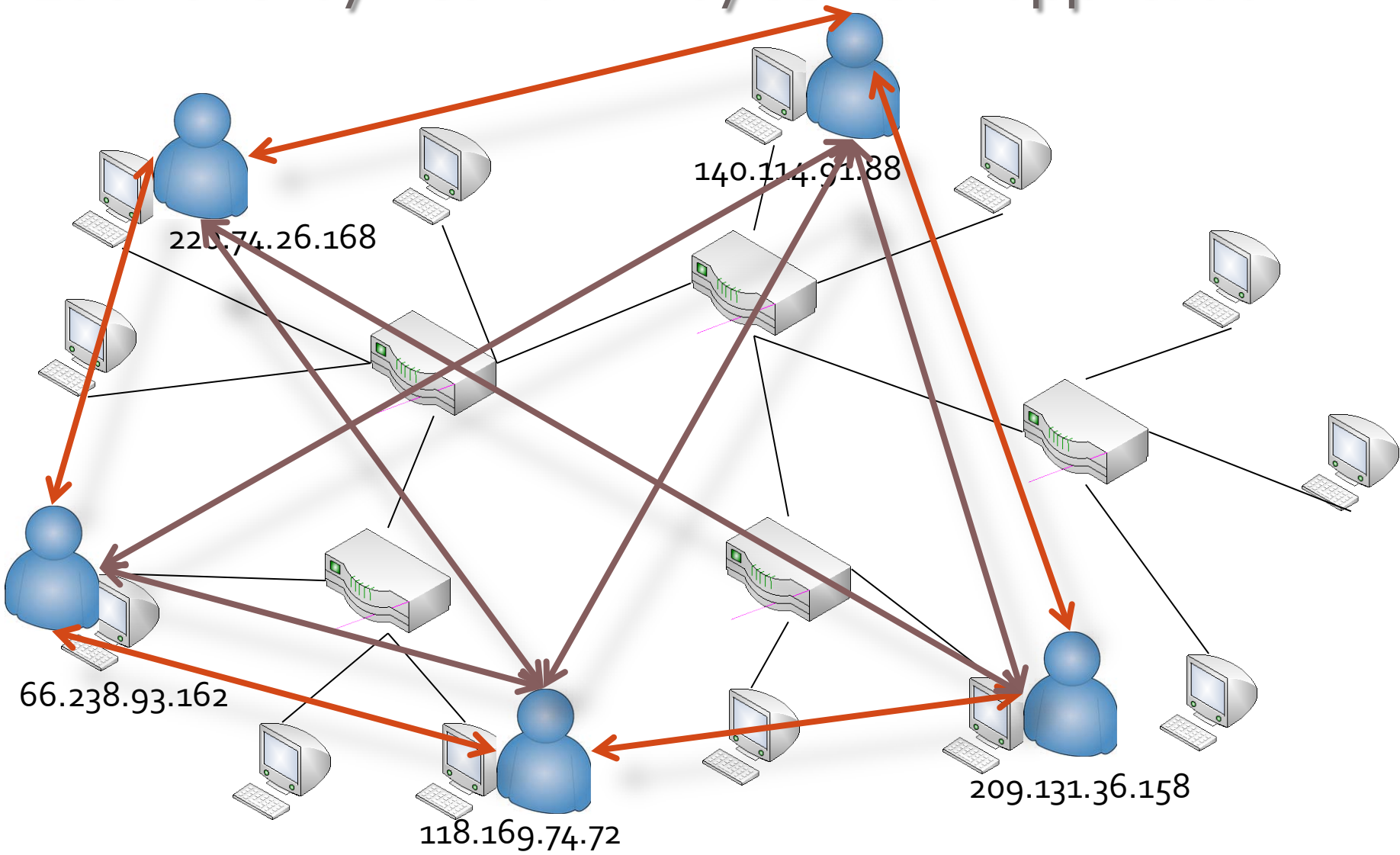
More and more applications

- Overlay-based applications are growing
  - P2P file sharing – gnutella, eDonkey, BitTorrent, etc.
  - P2P Steaming – PPStream, PPLive, Joost, etc.
  - Resource Discovery – Mercury, MAAN, etc.
  - Cloud computing – Cassandra, Hadoop, etc.
- Multiple overlays co-habit the Internet

A multi-overlay environment (MOE)



Each overlay network may serve an application



Motivation

- Overlay network introduces maintenance cost
  - failure detection
  - latency/bandwidth measurement
  - routing table adjustment
  - adaptive approach
  - … etc.

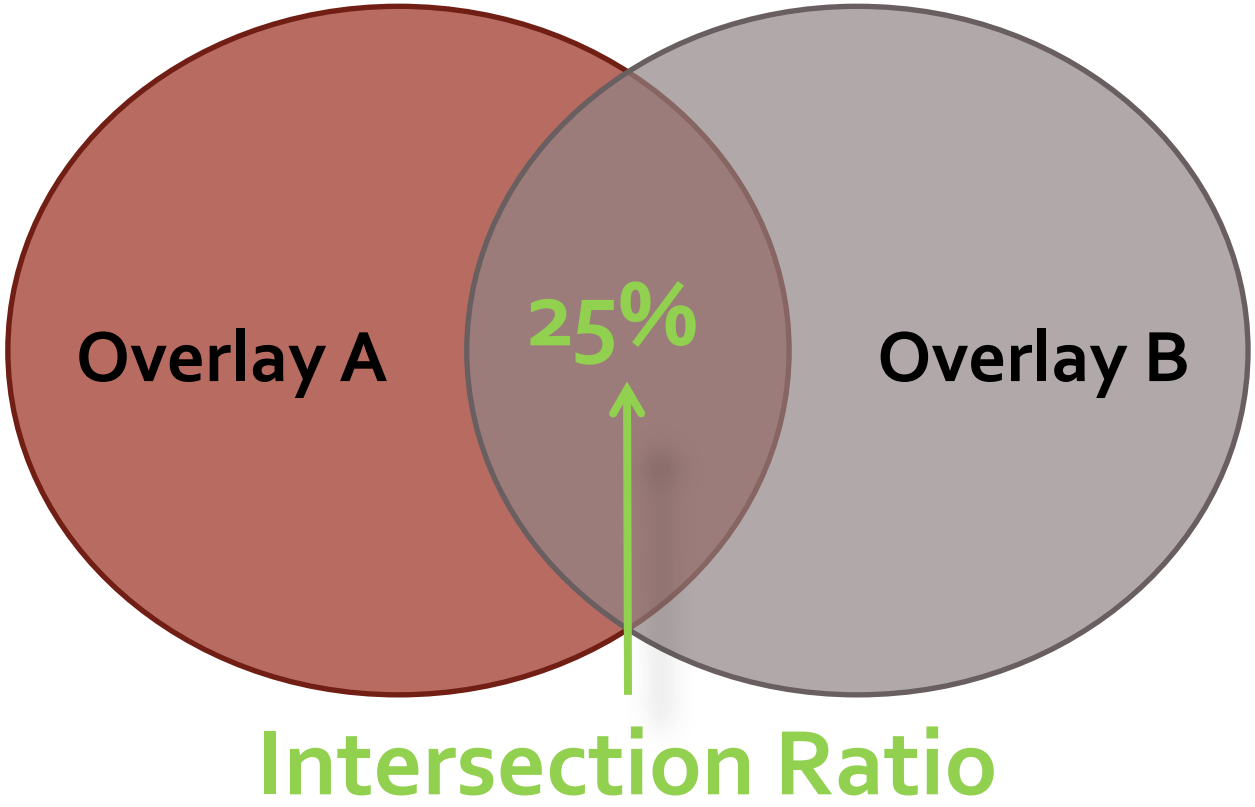
- *n* * Cost = large → how to reduce?
  - Some of these overlay-maintenance costs are redundant

Related Work

- [2007][ICDCS] Build One, Get One Free: Leveraging the Coexistence of Multiple P2P Overlay Networks
  - Sharing information to reduce maintenance cost
  - Focus on two specific overlays
- [2009][DAIS] Exploiting Synergies between Coexisting Overlays
  - A comprehensive consideration on the reduction of maintenance costs
  - Lack of the consideration of intersection ratio

Intersection Ratio

- the percentage of nodes which locates in both overlays

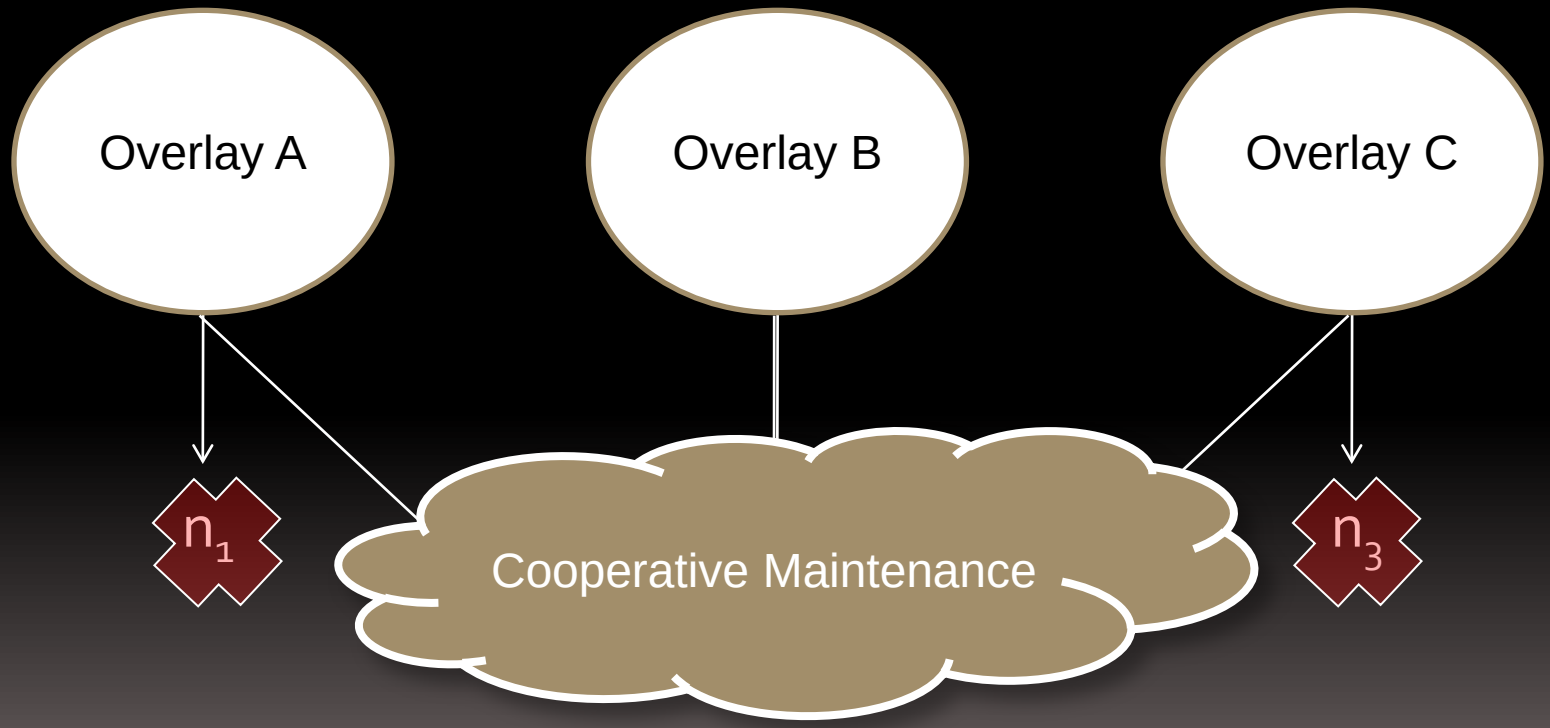


Objective

- Multi-overlay environments
- Reduce the total maintenance cost
- Propose a general approach
- Consider a realistic MOE environment

Cooperative Strategy

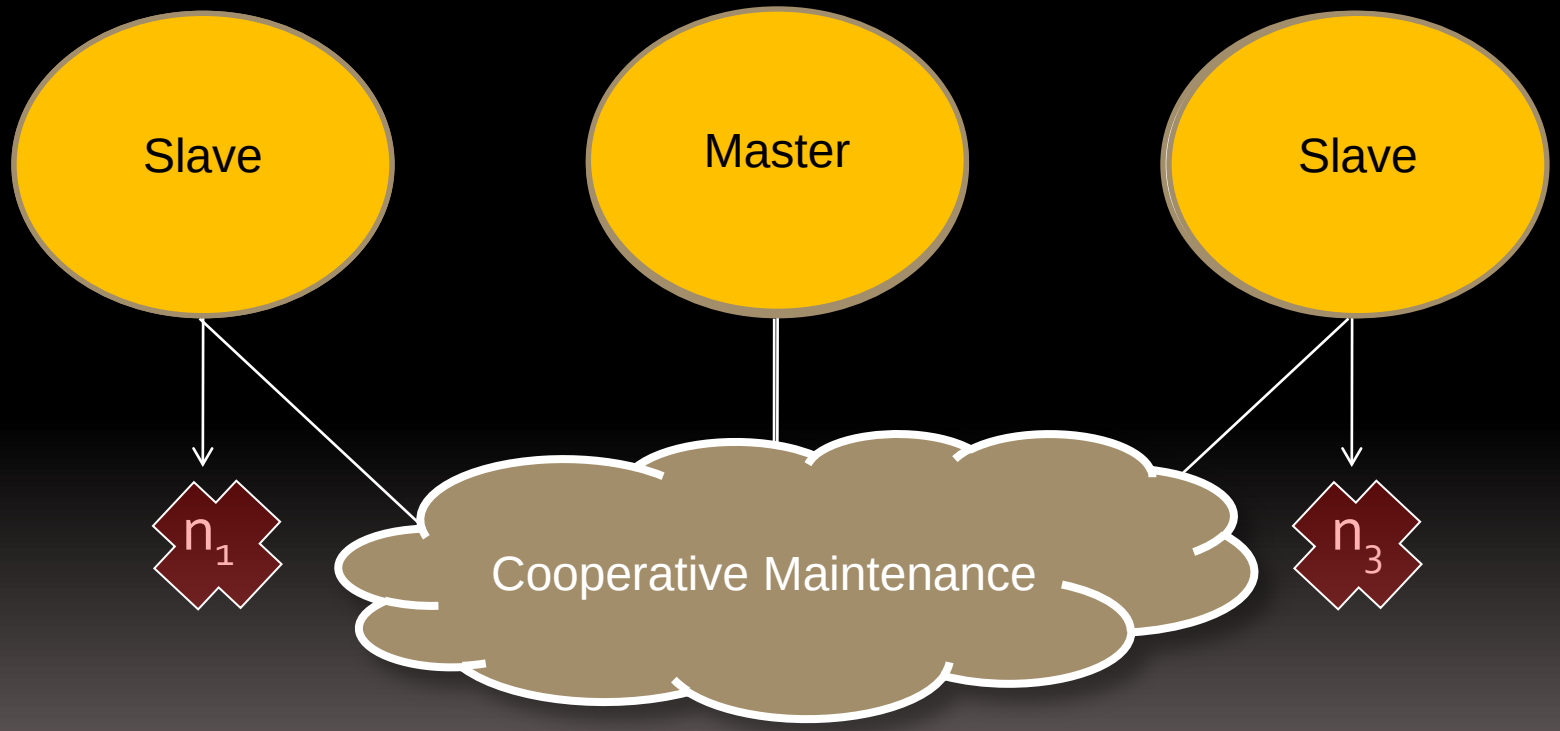
- To reduce the maintenance costs
- The total cost could be smaller



$$n < n_1+n_2+n_3$$

Master-Slave Model

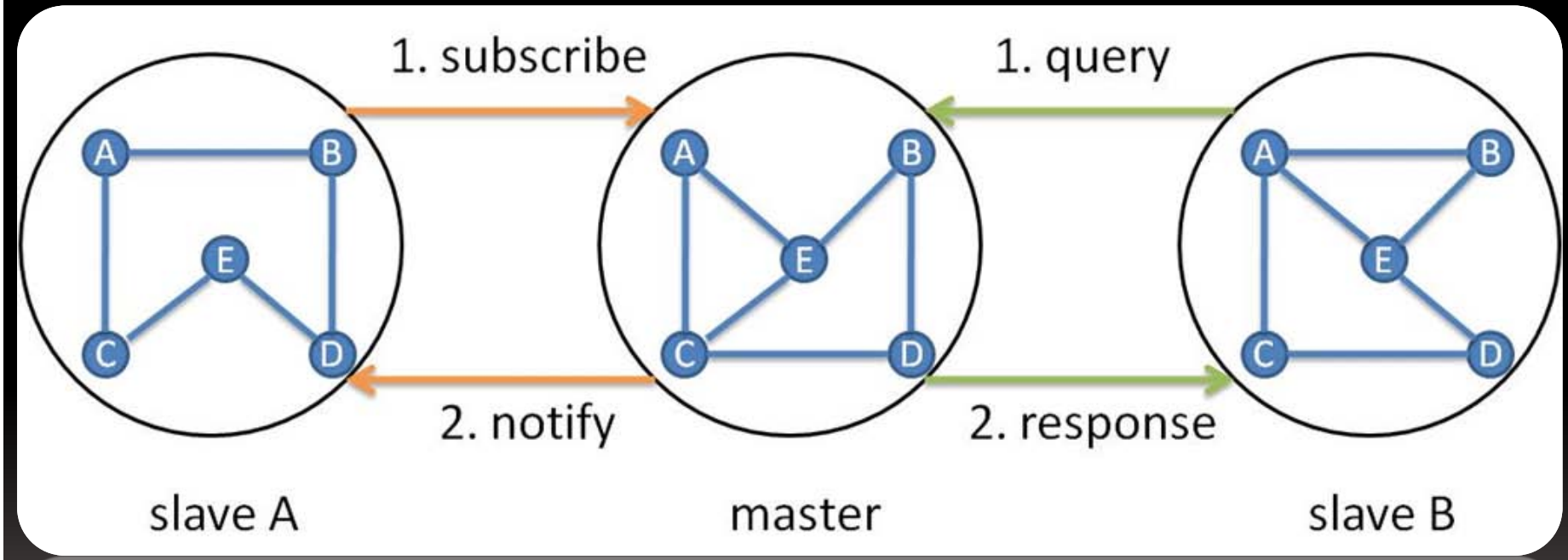
- One overlay is selected to be the master
- The master overlay could help reduce the common maintenance operations



$$n < n_1+n_2+n_3$$

Master-Slave Model

- Two kinds of inter-overlay protocols to support two types of overlay maintenance



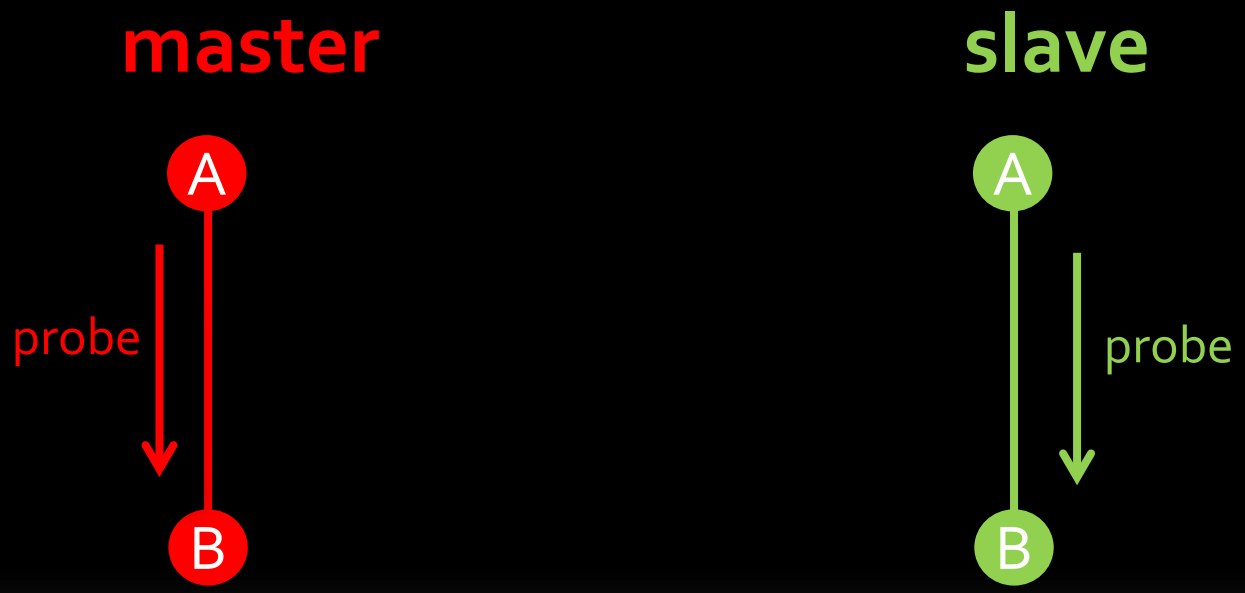
Periodical Maintenance

State Sharing

Inter-Overlay Protocols

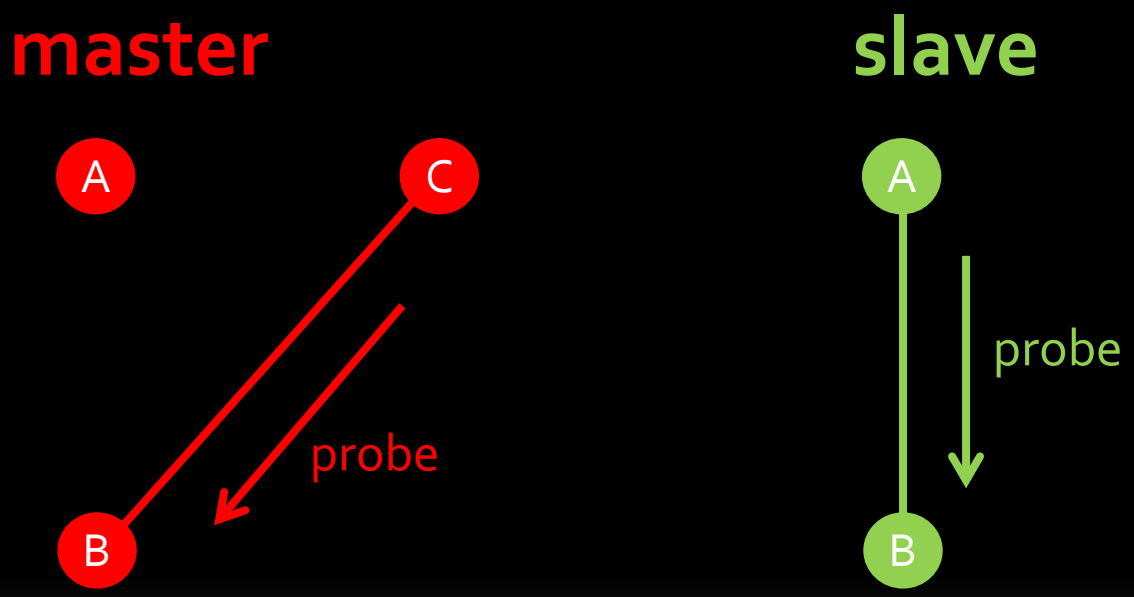
- Subscribe/Notify protocol
  - → periodical maintenance
  - E.g. failure detection
    - periodically checks the status of neighbor nodes to ensure the routing mechanism
- Query/Response protocol
  - → state sharing
  - E.g. network-proximity estimation
    - share the information of network state to make the decision of routing path

Cooperative Failure Detection (CFD)



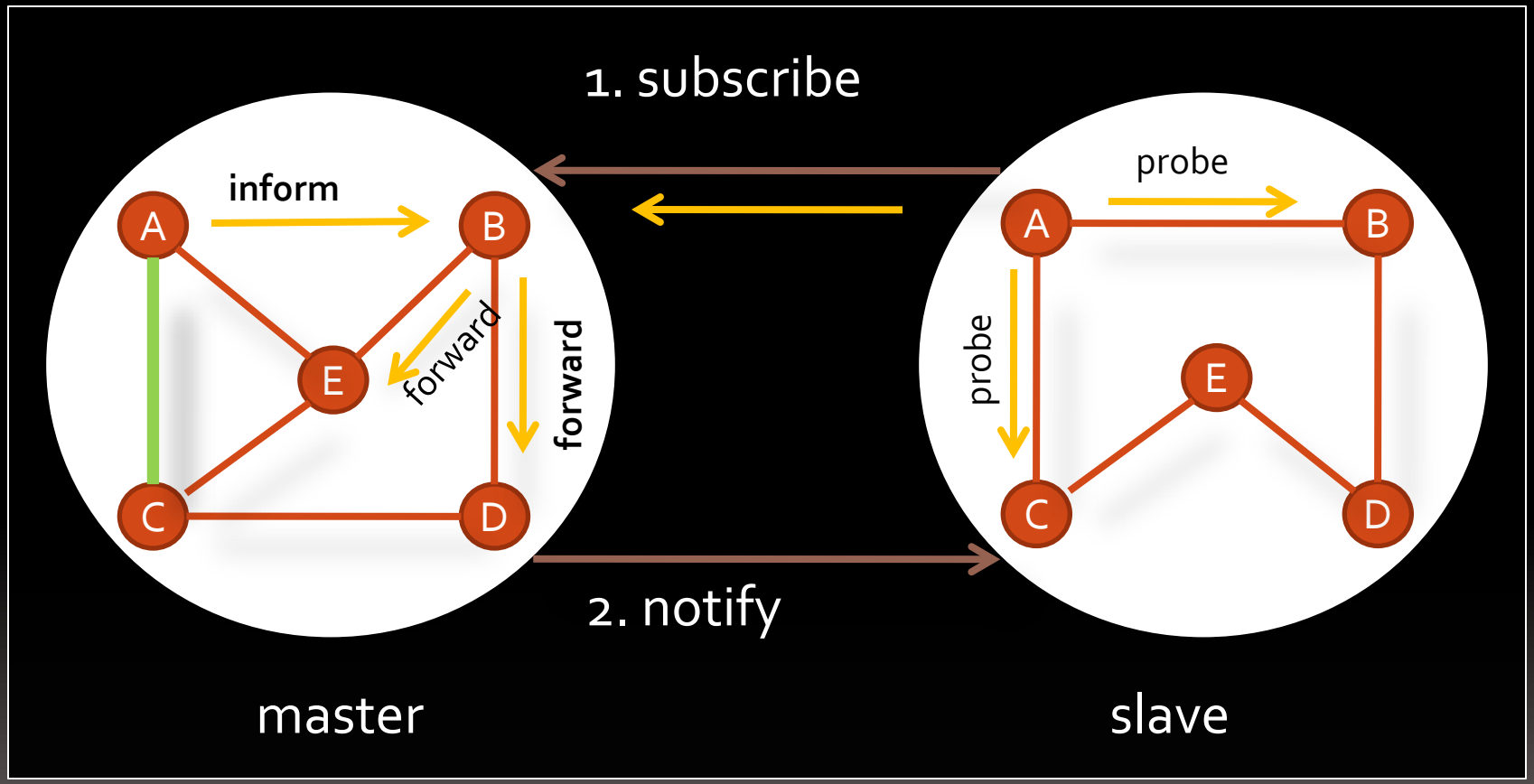
Elimination

Cooperative Failure Detection (CFD)

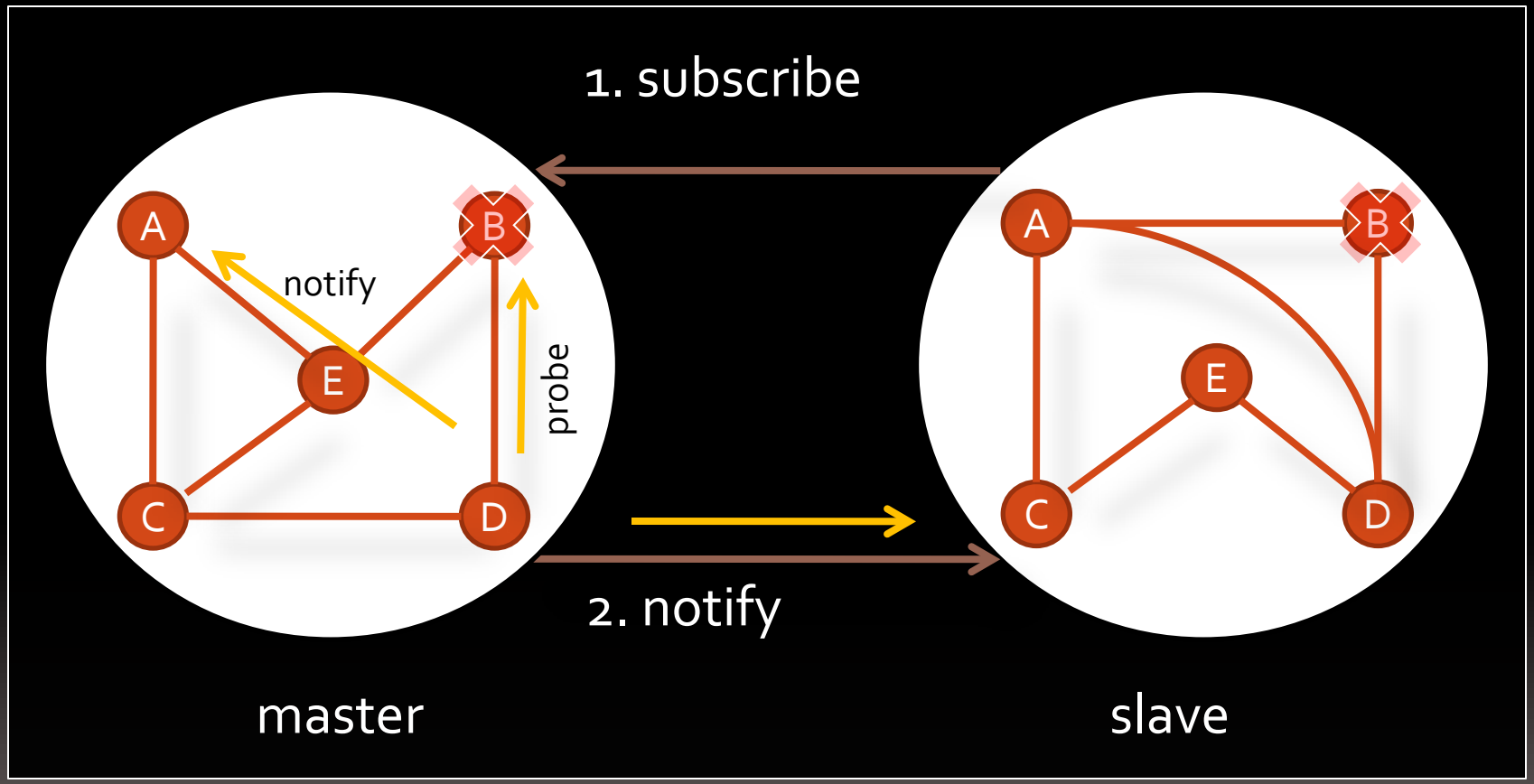


Cooperation

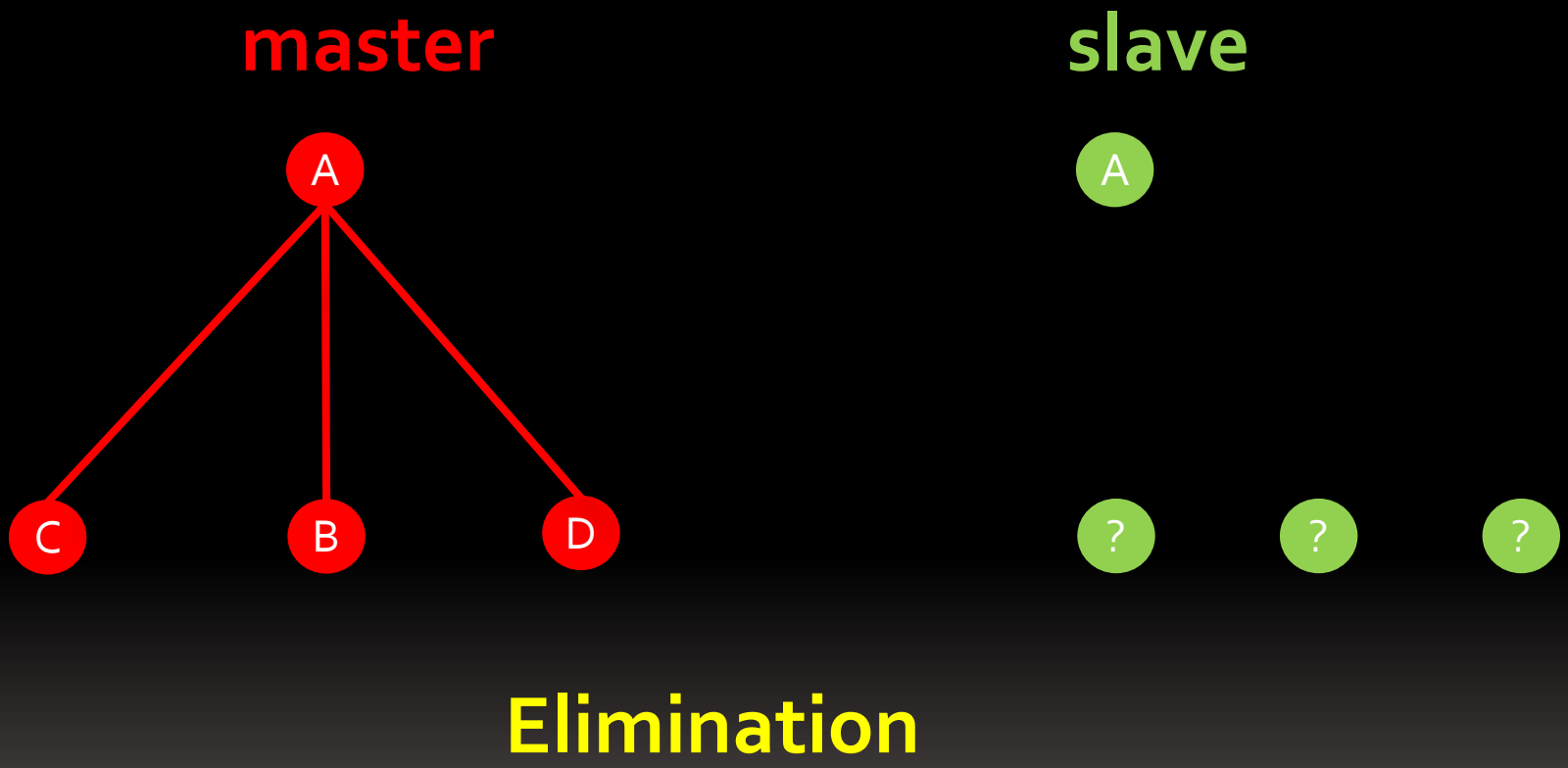
CFD – Subscription Process



CFD – Notification Process



Cooperative Network-Proximity Estimation (CNPE)



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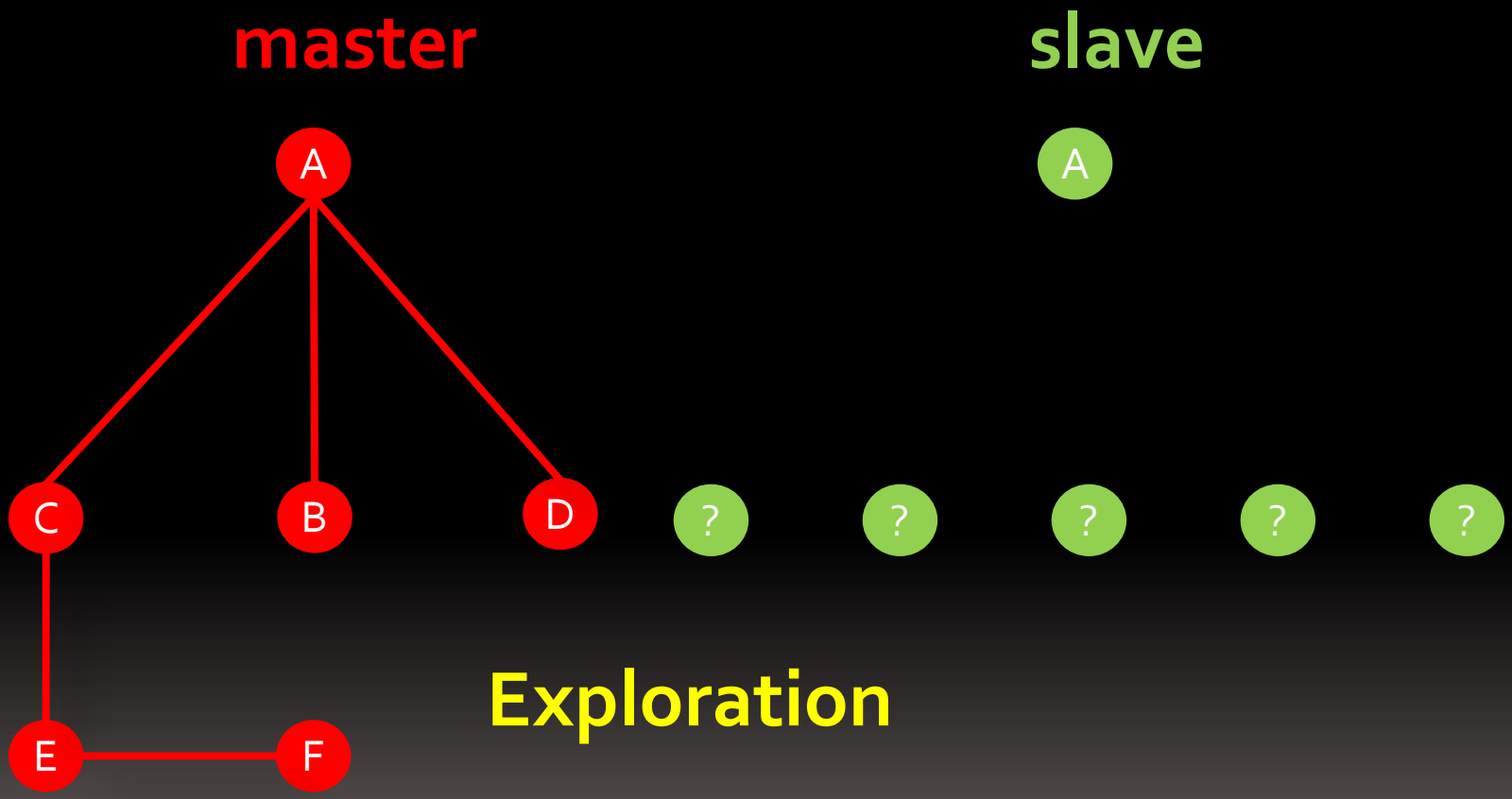
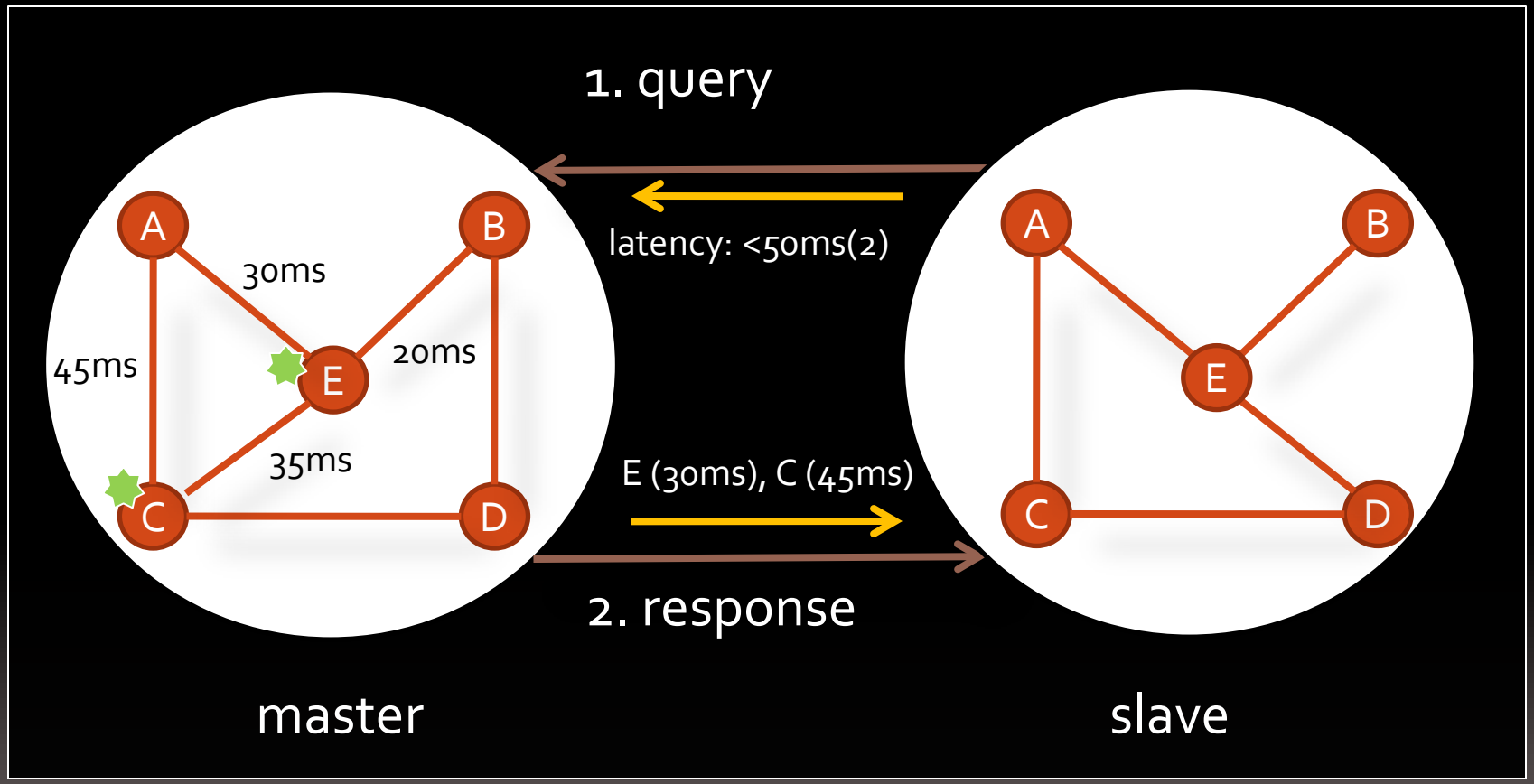
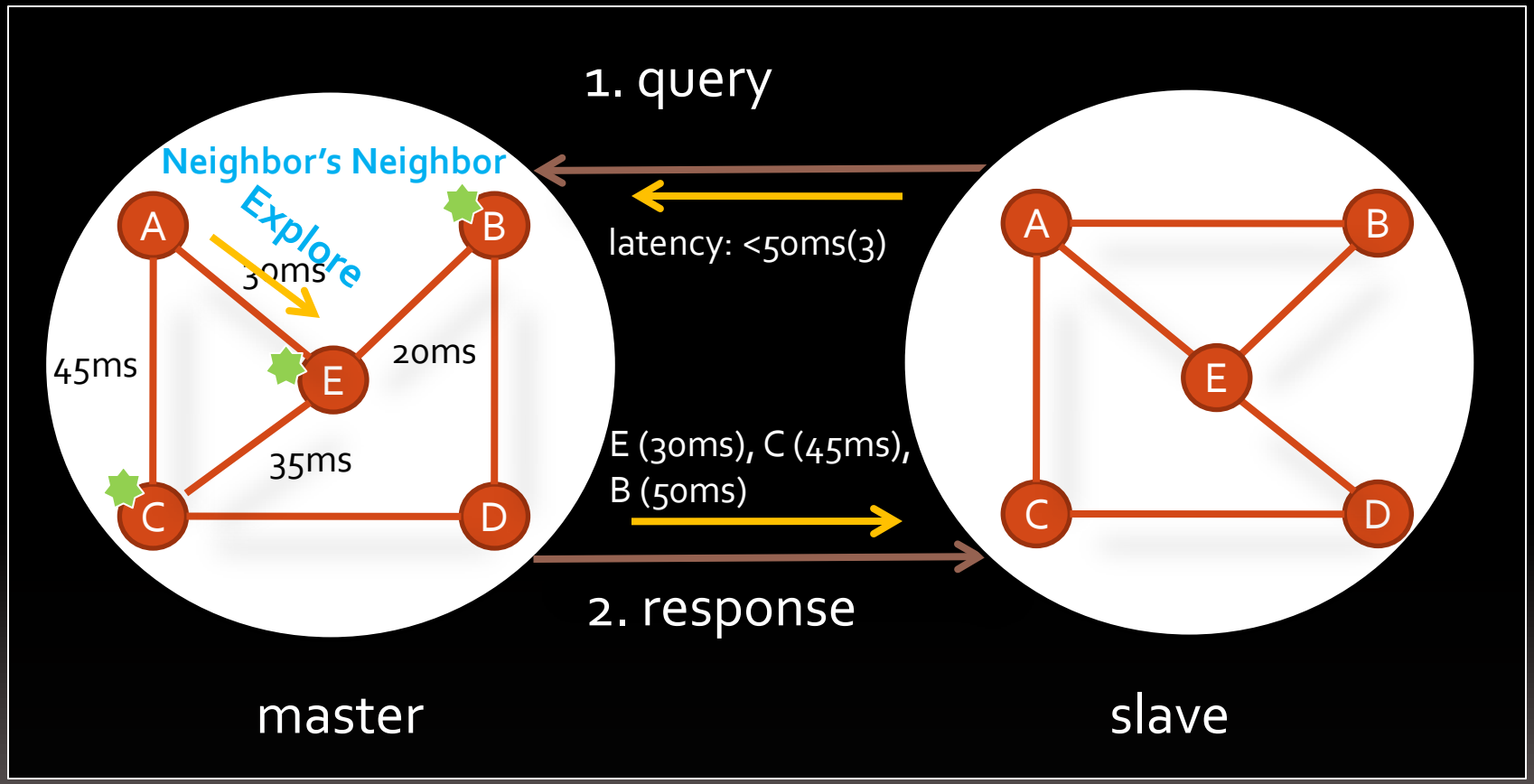


CNPE – Query/Response Process I



CNPE – Query/Response Process II



Experimental Environment

- PeerSim simulator
- Cycle-based simulation engine
- Unstructured, Ring, Tree Overlays
- Parameter K: neighbor numbers
- Comparison metric: reduction rate

Comparison Metric – Reduction Ratio

- The higher the reduction ratio is, the more efficient our approach will be

CFD

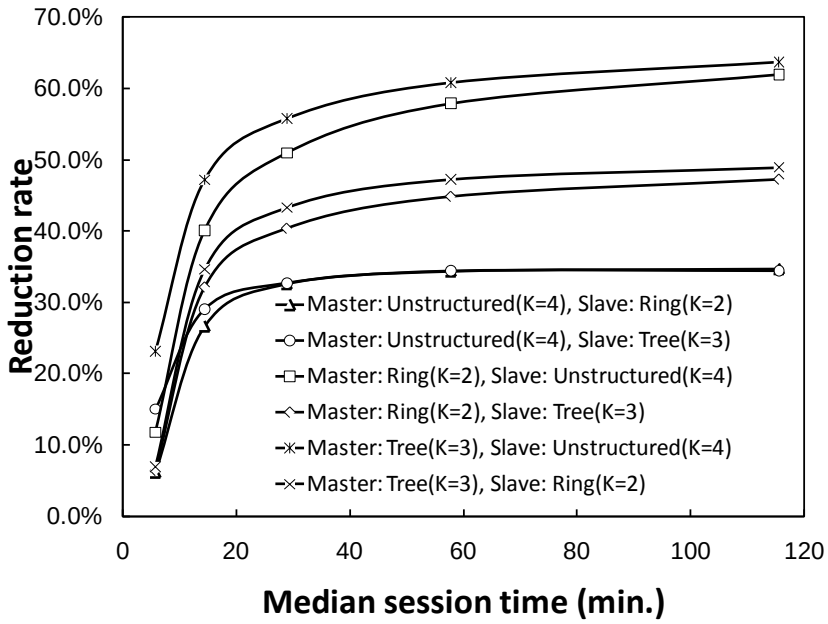
$$RR = \frac{M - M_{CFD}}{M} \times 100\% = \left(1 - \frac{M_{CFD}}{M}\right) \times 100\%.$$

CNPE

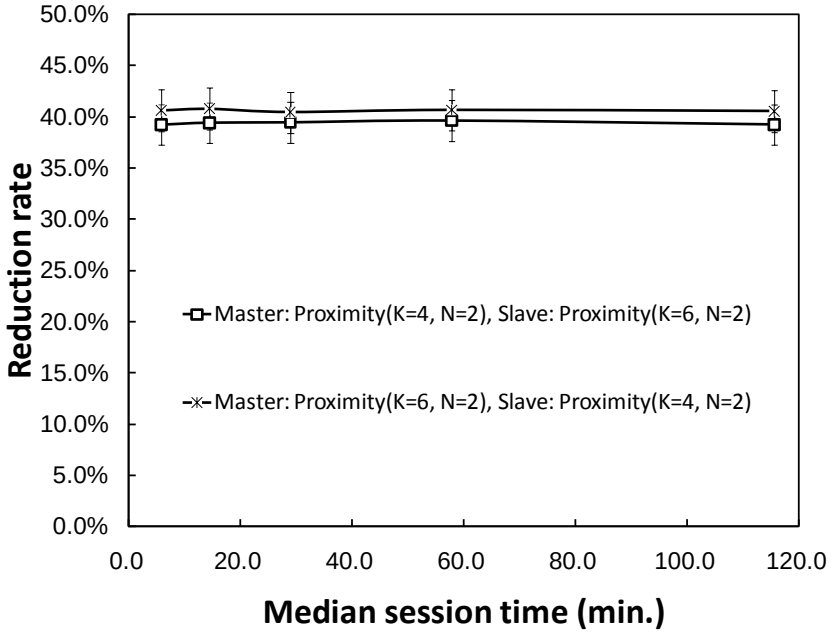
$$RR = \left(1 - \frac{M_{CNPE}}{M}\right) \times 100\%$$

Experimental Results – Session Time

CFD

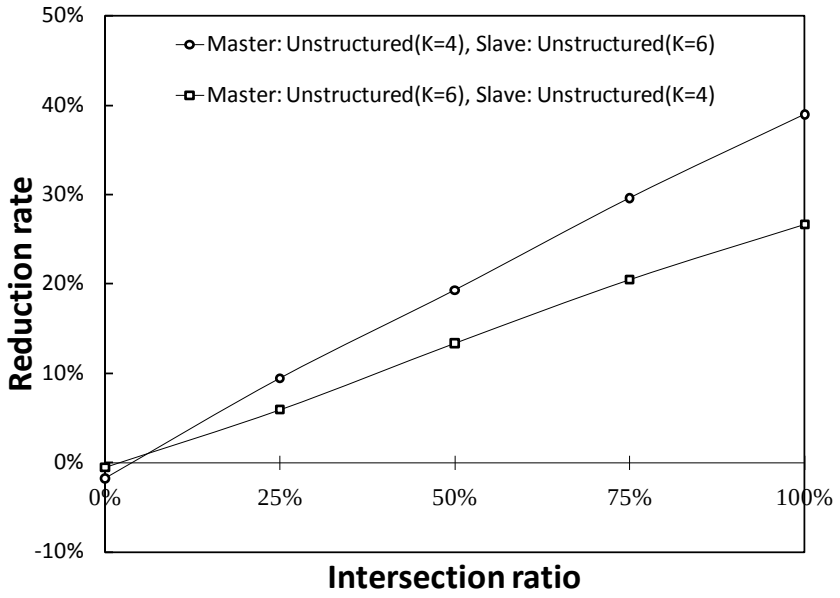


CNPE

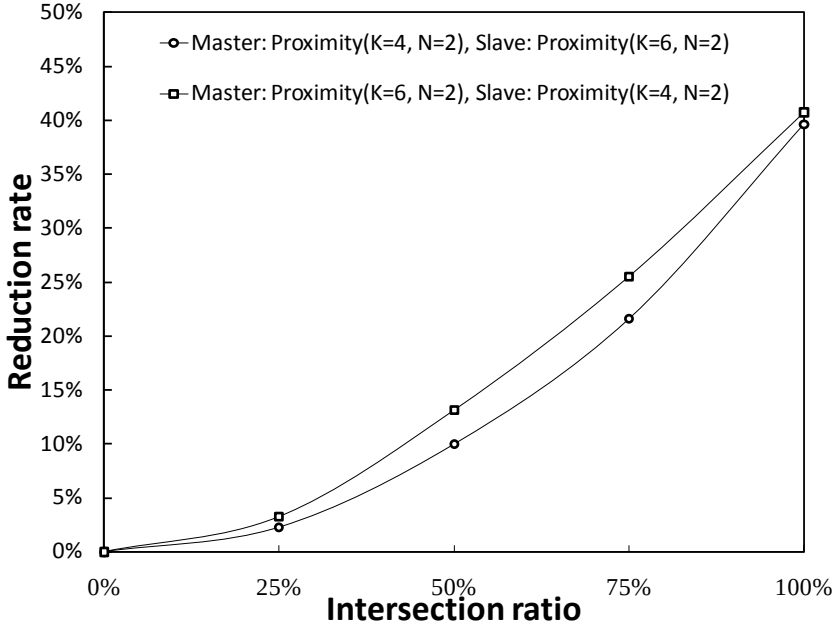


Experimental Results – Intersection Ratio

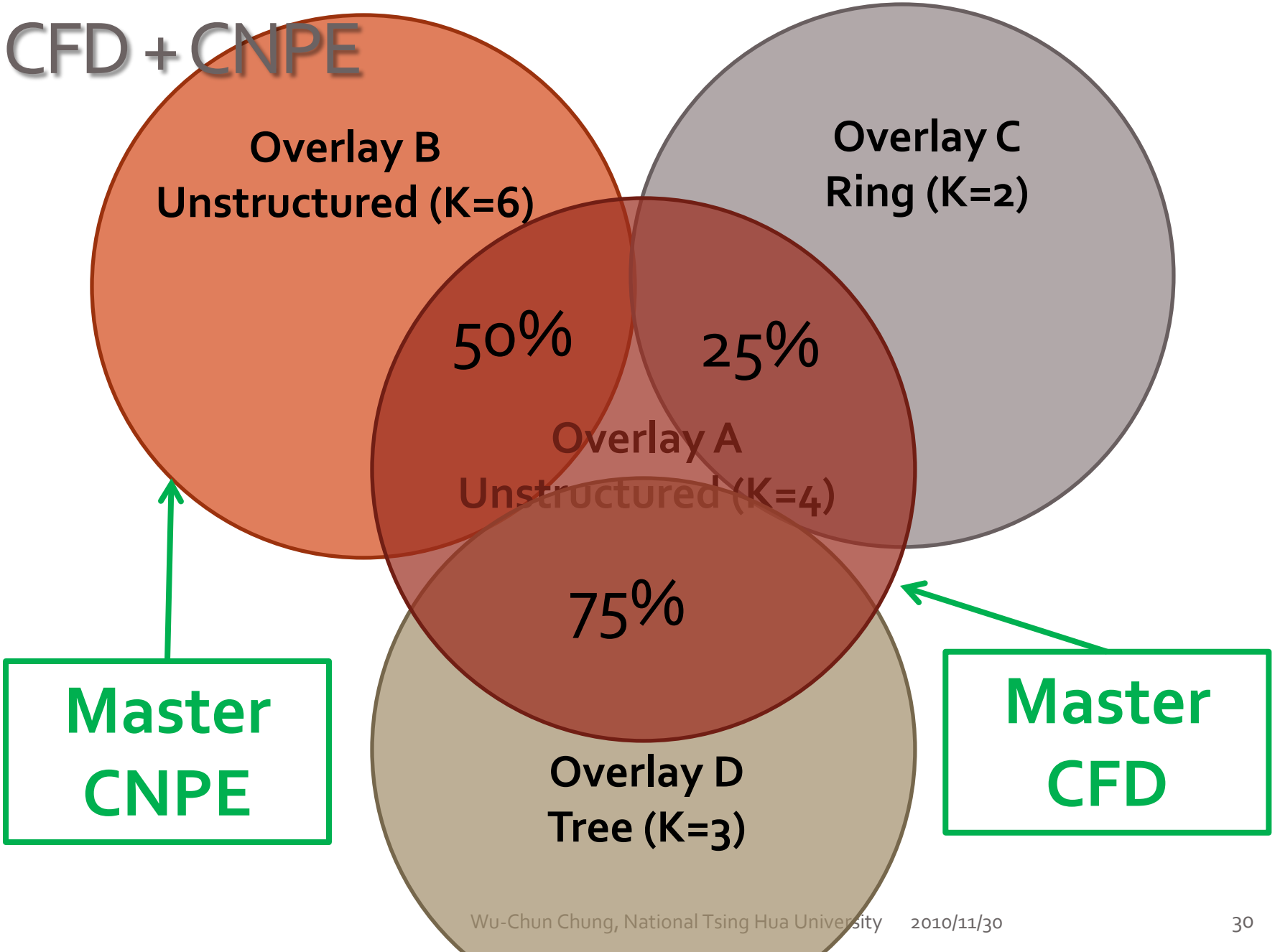
CFD



CNPE

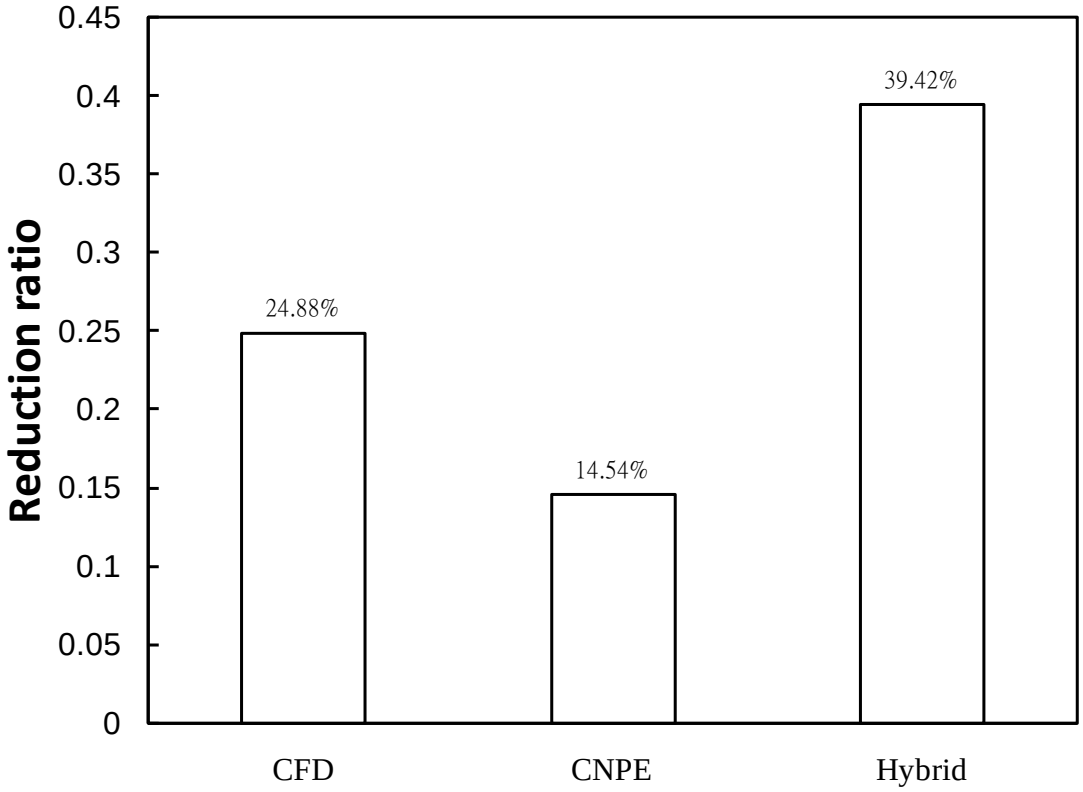


CFD + CNPE


Overlay B
Unstructured (K=6)
Overlay C
Ring (K=2)
50%
25%
Overlay A
Unstructured (K=4)
75%
Overlay D
Tree (K=3)
Master
CNPE
Master
CFD

CFD + CNPE

- The total reduction rate approximates 40%



Conclusions

- Multi-overlay environments have emerged
- Total maintenance cost is high
- Some operations are redundant
- Cooperative maintenance approach
- A general Master-Slave model
  1) CFD – Subscribe/Notify protocol
  2) CNPE – Query/Response protocol
- Reduce more than 60%

Conclusions

Maintain one, Get many free

Future Work

- Other operations of overlay maintenance
- Master overlay selection criteria
- Automatic selection mechanism

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