# PROPOSAL AND EVALUATION OF A COOPERATIVE MECHANISM FOR HYBRID P2P FILE-SHARING NETWORKS

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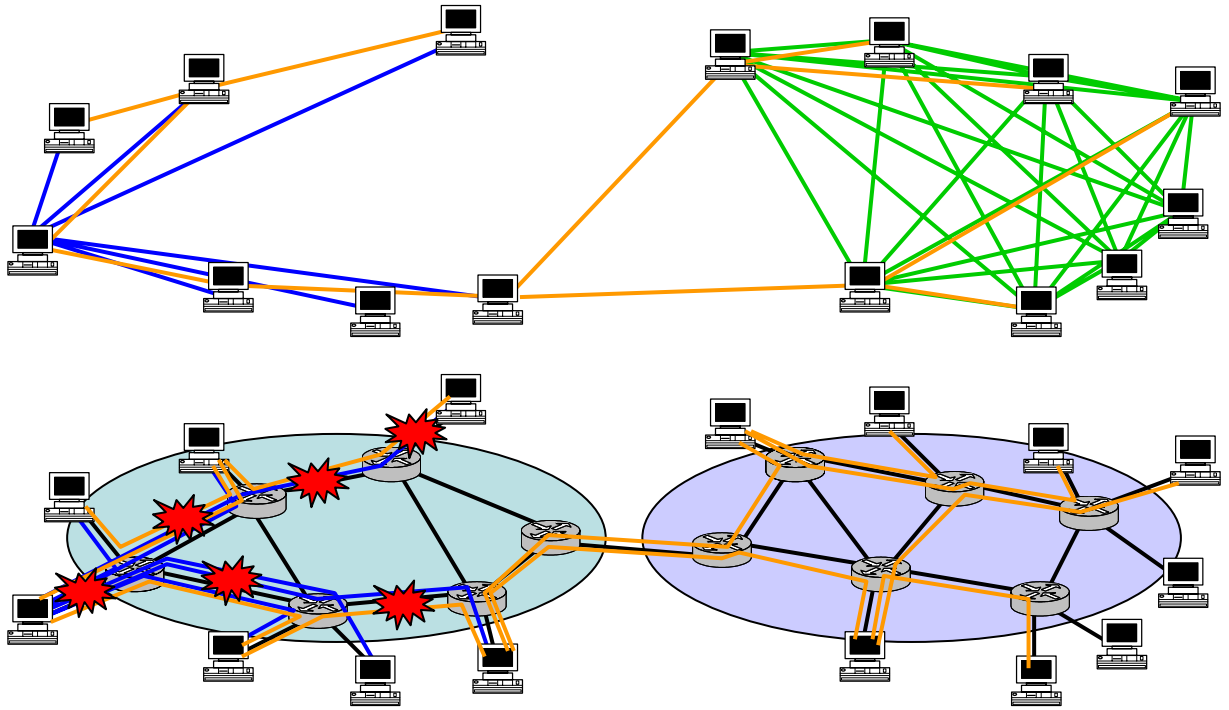
- Backgrounds
- Cooperation Mechanisms for a SPB Approach
- Simulation Results
- Conclusion and Future Works

# Competing Overlay Networks



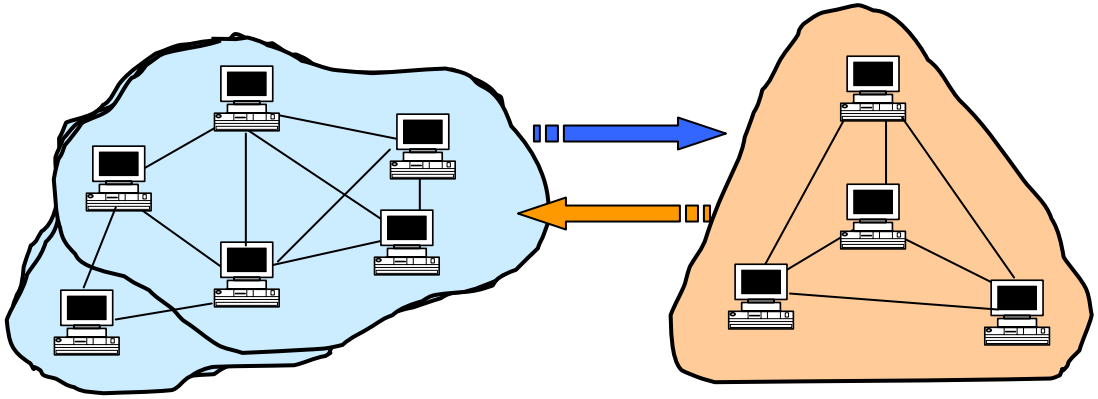
- Overlay networks are widely deployed over physical IP networks to obtain application-oriented QoS
- Selfish overlay networks compete for limited physical resources and disrupt each other

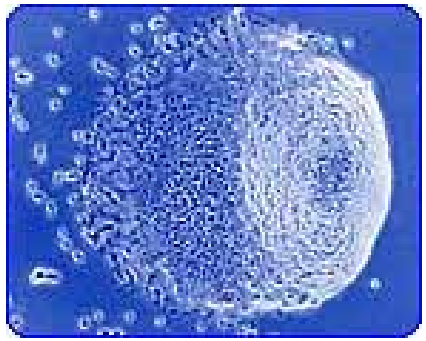


# Overlay Network Symbiosis



- Overlay networks improve and enhance their collective performance by cooperation
- Overlay networks = Organisms
  - Evolve as a new node joins
  - Shrink as a node leaves
  - Direct or indirect interactions
  - Change internal structures



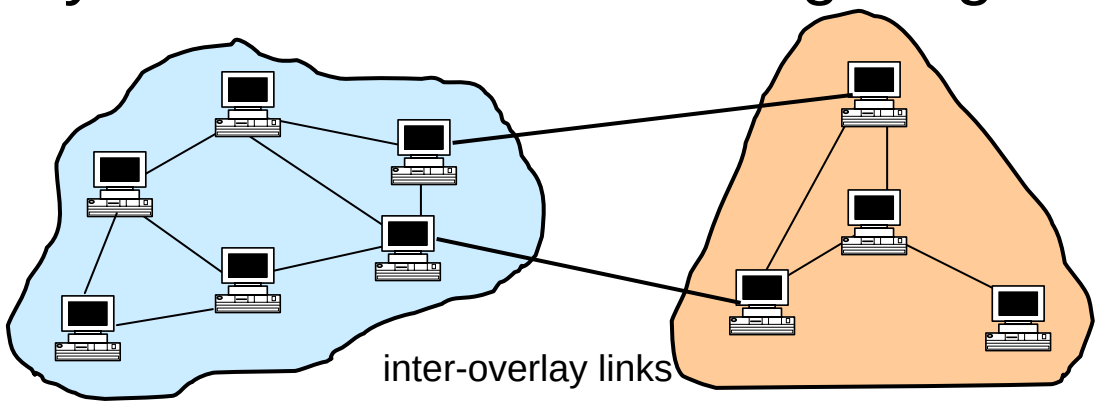


Symbiotic colony of E. coli and Dictyostelium

# Inter-Overlay Communications



- Each node in an overlay network autonomously establish or terminate logical links
  - within an overlay network
  - with another overlay network
- Message exchanges over a logical link
- A logical link is kept as far as the both sides benefit from the link (mutualism)
- Overlay networks come to merge together



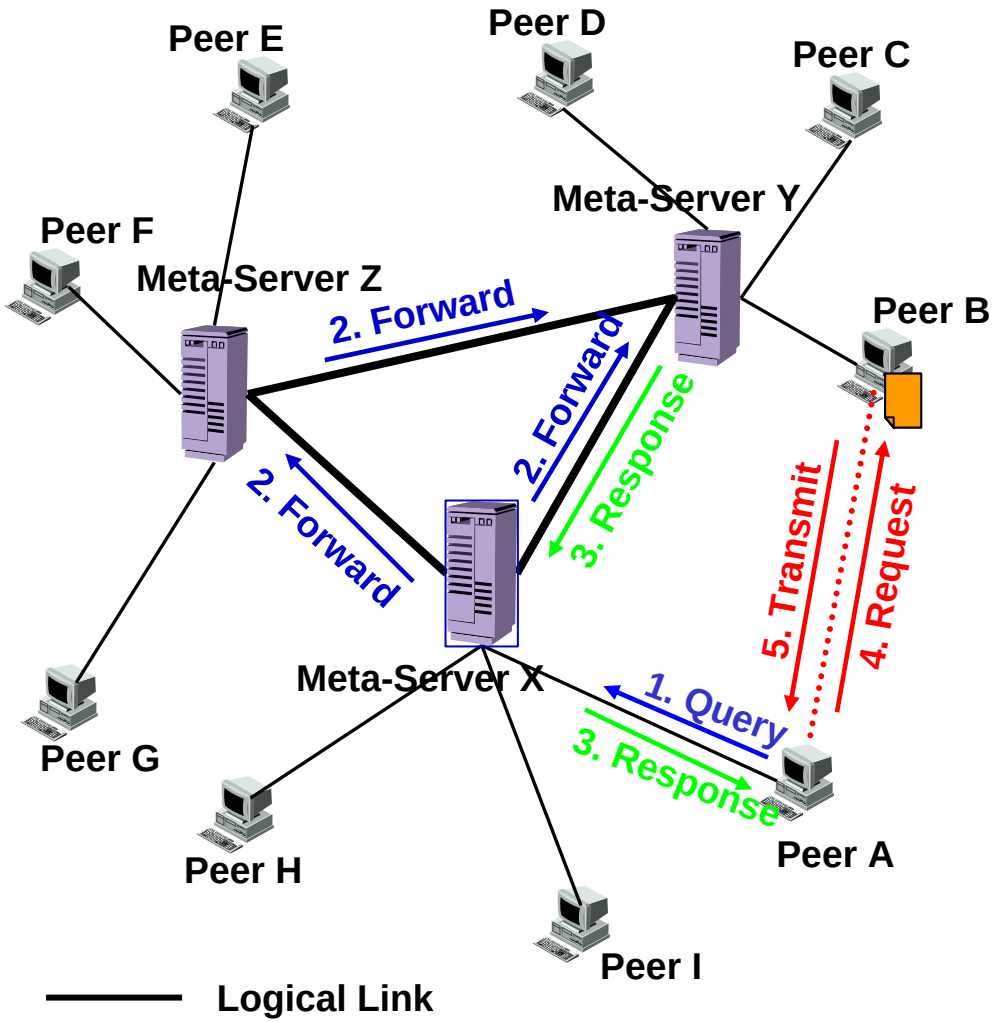
# A Cooperative Mechanism for P2P networks



- In this work, we focus on the cooperation among hybrid P2P file-sharing networks (Napster, winMX...)
- P2P networks exchange query and response messages with each other
- Benefits
  - A peer can find more files at more peers
  - A peer can choose the best, i.e., the fastest or the most reliable peer among many provider peers found in a search
  - The stability of the whole system will be improved

# Hybrid P2P File-sharing Networks






**The process of retrieving a file**
**～ The case that Peer A retrieves a file ～**

0. A peer connects with a meta-server and registers meta-information about files to share with the other peers
1. Peer A sends a query message
2. The meta-server forwards the query message to other neighboring meta-servers
3. The meta-server sends a response message to the querying peer when meta-information about the desired file exists in its directory
4. Peer A directly request a file from a provider peer (Peer B)
5. Peer B transmit a file to Peer A directly

# Basic Mechanisms

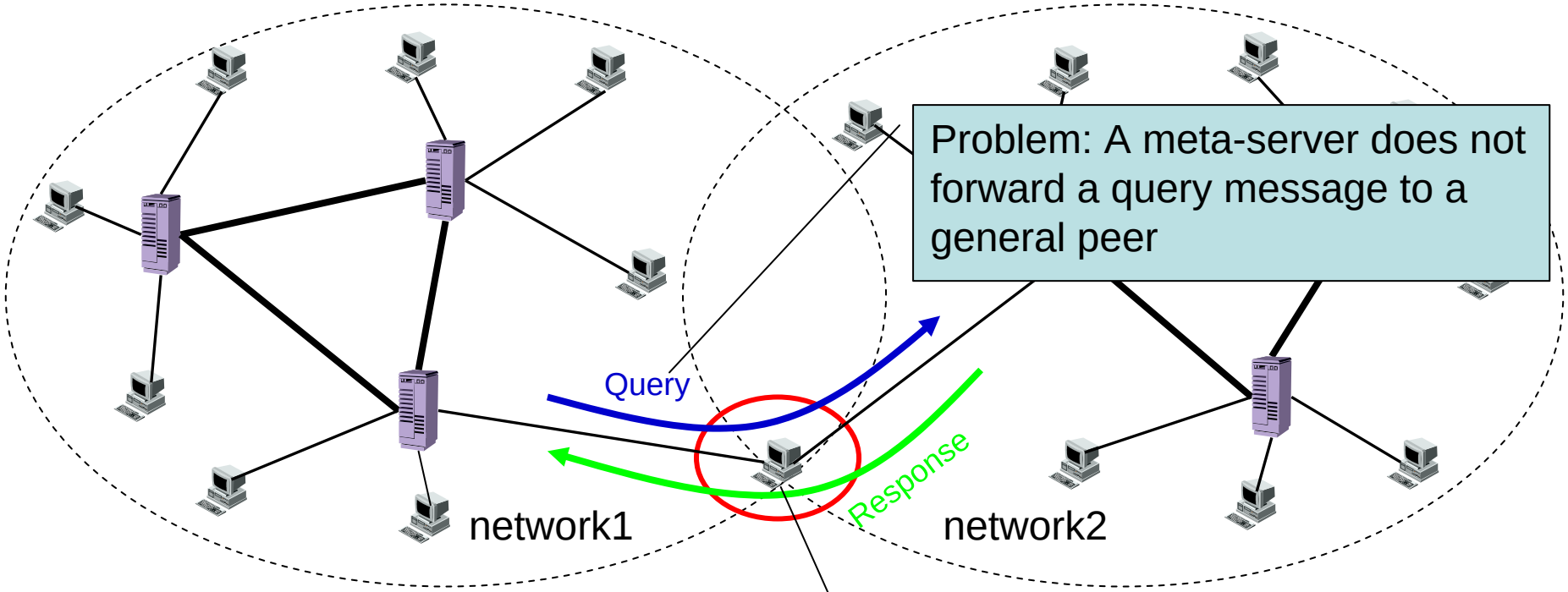


- A node introduces a cooperative program to enhance its own application-level QoS
- A cooperative program:
  - discovers other P2P networks
  - decides whether P2P networks cooperate with each other
  - cooperate by exchanging messages
- Two types of mechanisms
  - Shared-Peer-Based (SPB) approach
  - Server-Chain-Based (SCB) approach

# Cooperation Mechanisms for a SPB Approach



Our Goal：The cooperation is achieved in a transparent way where other meta-servers and peers are unaware of the cooperation




A cooperative program includes meta-server modules

A Meta-server module can

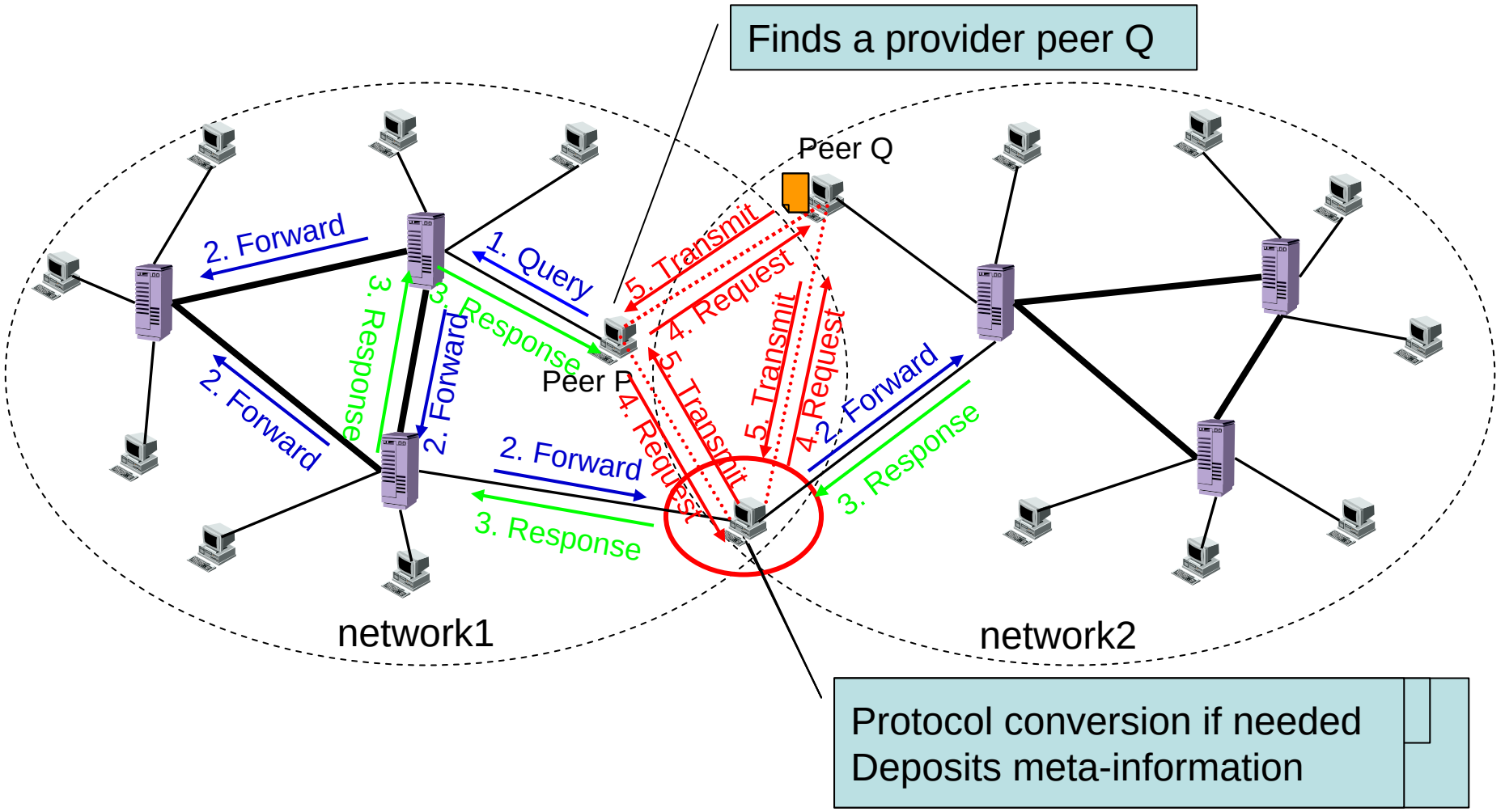
- relay query and response messages
- generate response messages
- deposit meta-information into its local cache

By introducing a cooperative program, a shared peer becomes a cooperative peer

A cooperative peer behaves not only as a peer, but also as a meta-server

# File Retrieval

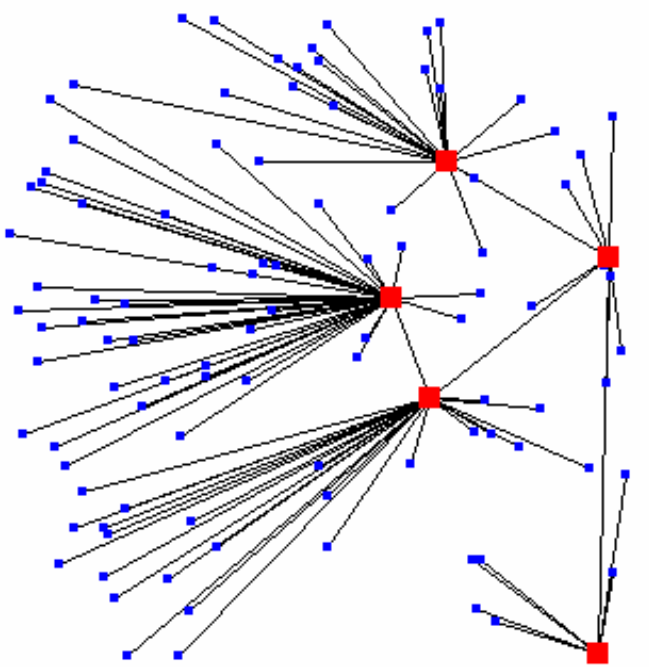




# Simulation Experiments



- No caching meta-information
- *F* kinds of files are available
  - The popularity of files follows a Zipf distribution with $\alpha = 1.0$
  - Files are assigned to peers
- Peers generate query messages following the poisson process
  - File to find are determined by its popularity



An Example for Hybrid P2P File-Sharing Network Topology (m=5, n=100)

# Measures



- Application-level measures
  - Ratio of Available Files

$$\frac{\text{Number of kinds of available files in a network}}{\text{Number of kinds of available files in two network } (F)}$$

  - Hit Rate

$$\frac{\text{Number of successful query messages}}{\text{Total number of query messages generated}}$$

- System-level measures
  - Load on Cooperative Peers
  - Load on Meta-Servers

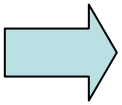
# Simulation Results
## - Ratio of Available Files and Hit Rate -



- No-Cooperation
  - Peers can only find files in their own network
    - Ratio of Available Files: 69 ~ 70%
    - Hit Rate: 89 ~ 95%

| | | Ratio of Available Files | Hit Rate |
|---|---|---|---|
| 100:100 | network1 | 0.69 | 0.90 |
| | network2 | 0.69 | 0.89 |
| 1000:1000 | network1 | 0.69 | 0.93 |
| | network2 | 0.69 | 0.93 |
| 10000:10000 | network1 | 0.69 | 0.95 |
| | network2 | 0.70 | 0.95 |

- Cooperation
  - Peers can find files not only in their own network but also in the other
    - Ratio of Available Files: 100%
    - Hit Rate: 100%

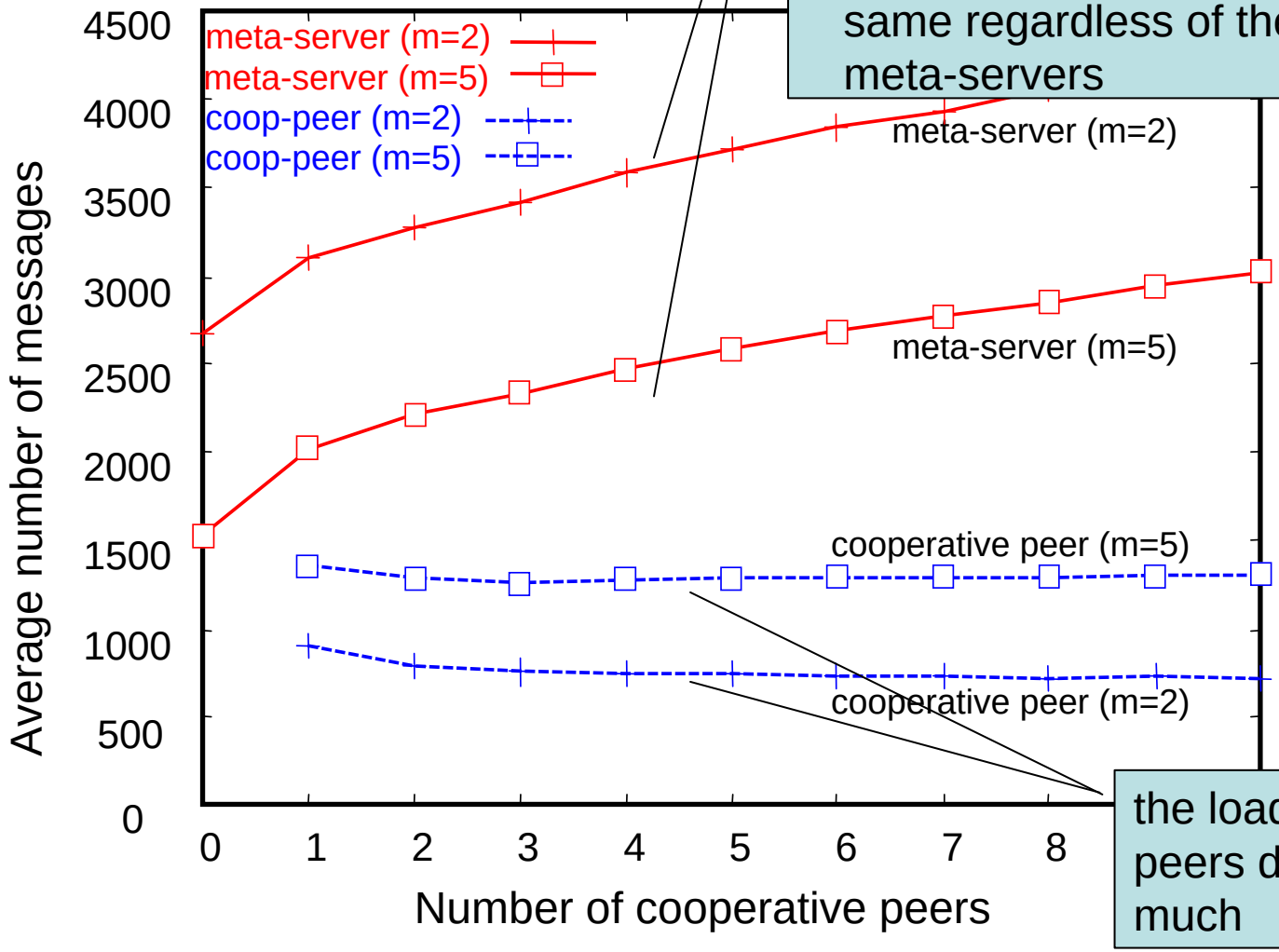


- Ratio of Available Files increases by about 30%
- Hit Rate also increases regardless of the network size and the degree of increase is higher with smaller networks

# Simulation Results

- Influence of Number of CP on Load (1

- the load on meta-servers almost linearly increases with the increase of the number of cooperative peers
- the increase in the load on meta-servers by cooperation is almost the same regardless of the number of meta-servers

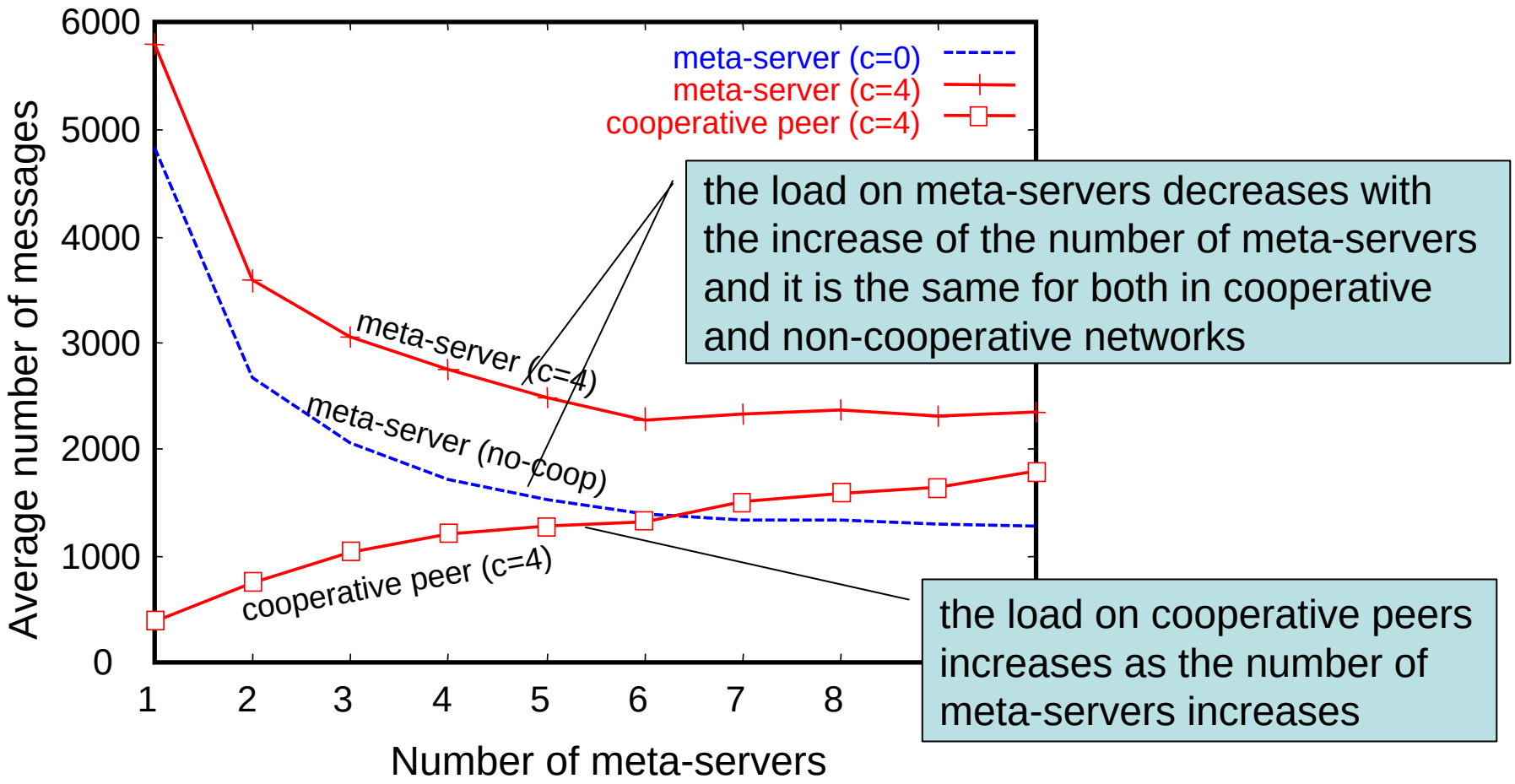



the load on cooperative peers does not change much

# Simulation Results

## - Influence of Number of MS on Load（1000:1000）-






the load on meta-servers decreases with the increase of the number of meta-servers and it is the same for both in cooperative and non-cooperative networks

the load on cooperative peers increases as the number of meta-servers increases

From a view point of the load on cooperative peers, which is usually less powerful than meta-servers, the cooperation among P2P networks with a small number of meta-servers is desirable

# Conclusion and Future Works



- Conclusion
  - Two cooperative approaches are proposed for hybrid P2P file-sharing networks to efficiently cooperate with each other to improve their collective application-level QoS
  - Through simulation experiments
    - our cooperative mechanisms (SPB approach) can improve the application-level QoS at the sacrifice of the increased load
    - the influence of network configurations (the number of peers and meta-servers) is investigated
- Future work
  - An efficient cache algorithm for cooperative peers
  - A decision algorithm of cooperation
  - Cooperative mechanisms which take into account characteristics of physical networks

# Thank you

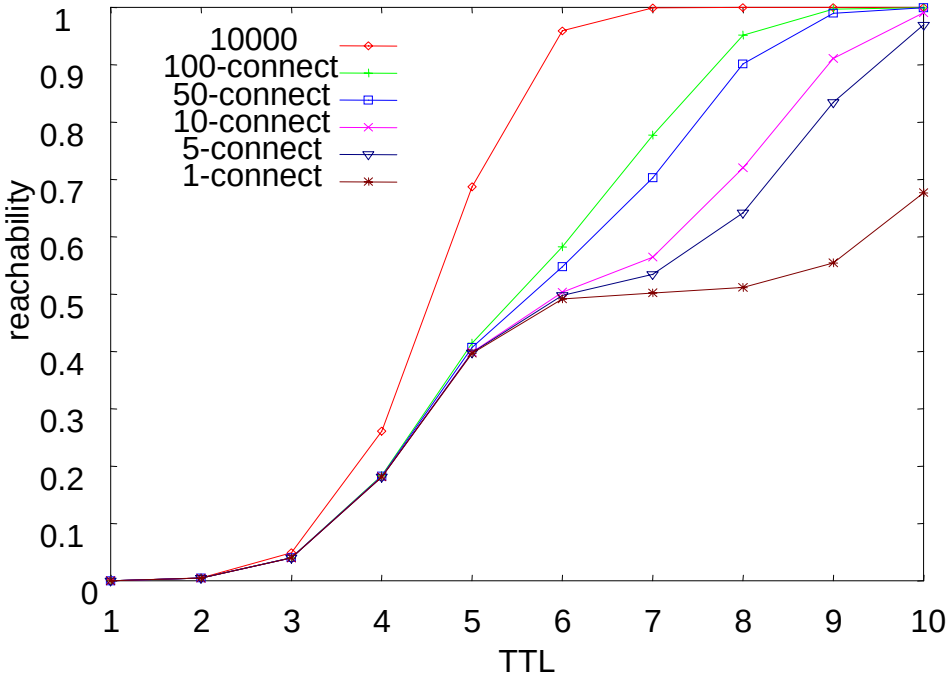


- Questions?

# Reachability

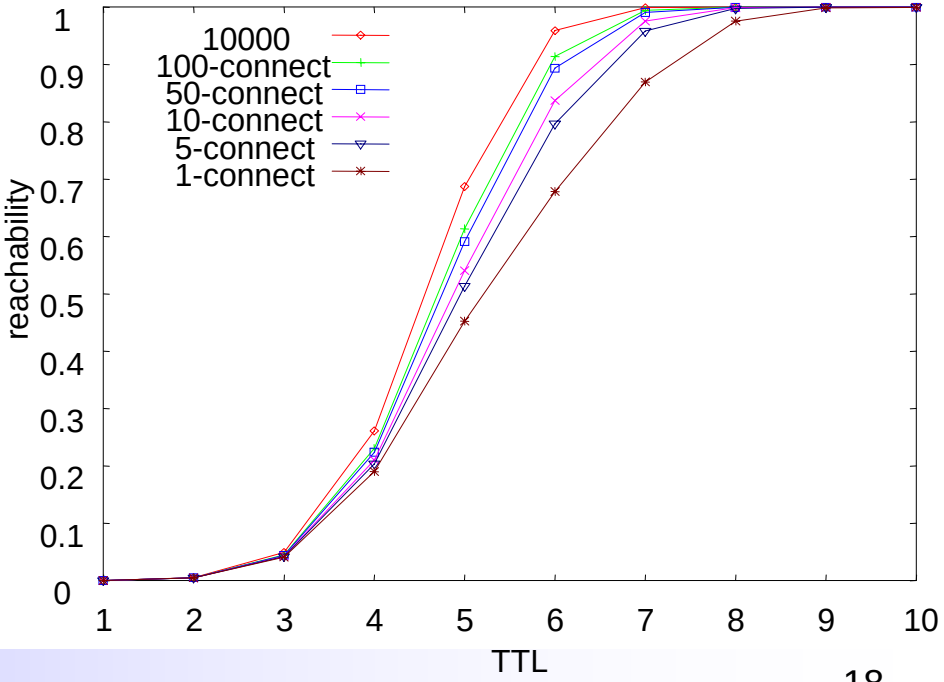


- Maximum interconnection leads to higher reachability.




connected by random nodes

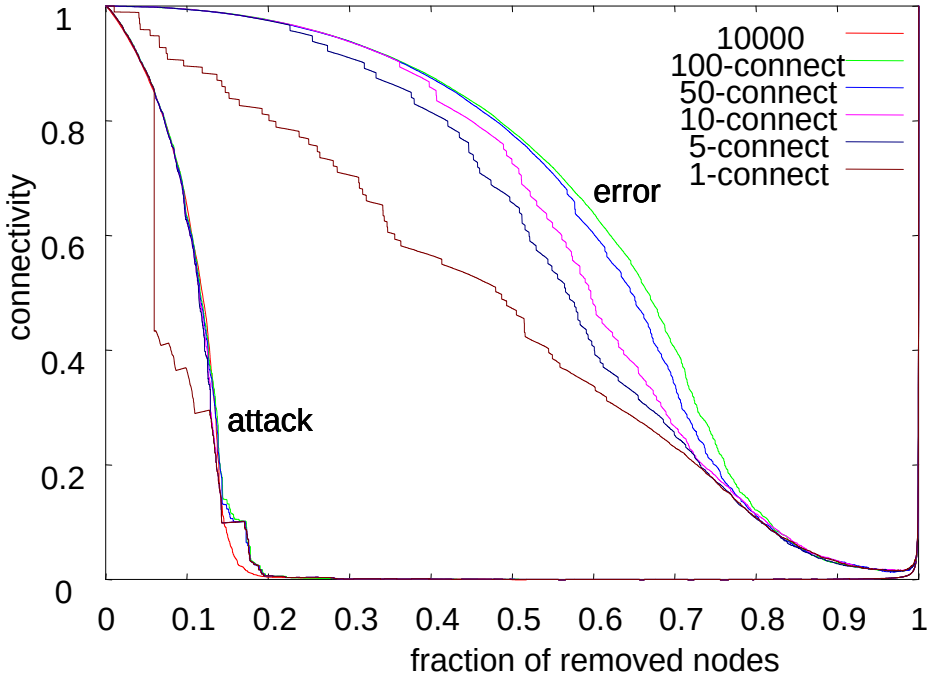
connected by high-degree nodes



# Connectivity



- Maximum interconnection is more robust against random removal, but it is fragile under intentional attacks.




connected by random nodes

connected by highest-degree nodes