CoNe Freiburg

IIF INSTITUT FÜR INFORMATIK FREIBURG

# Peer-to-Peer Networks

## 9 Skip-Net and Skip-Graph

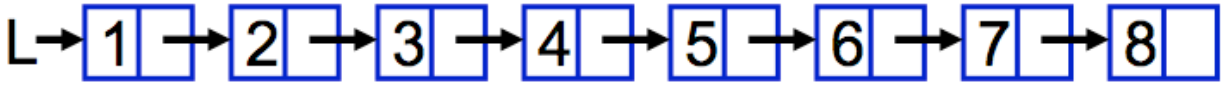
Christian Schindelhauer
Technical Faculty
Computer-Networks and Telematics
University of Freiburg

UNI FREIBURG

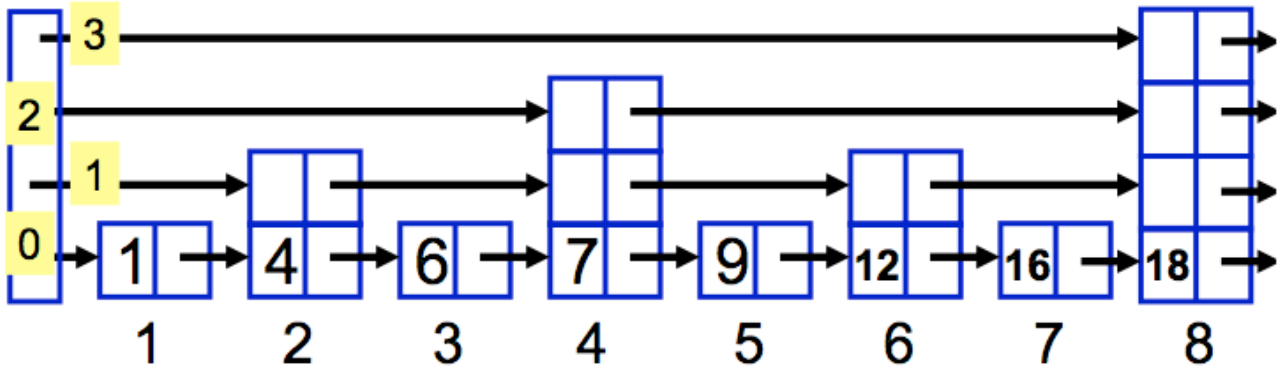
CoNe Freiburg

# Skip-Lists

- Start with a directly connected list




- Toss a coin to select nodes with probability 50%
- Connect elements in the next level as simple directed list
- Repeat recursively until no elements are left

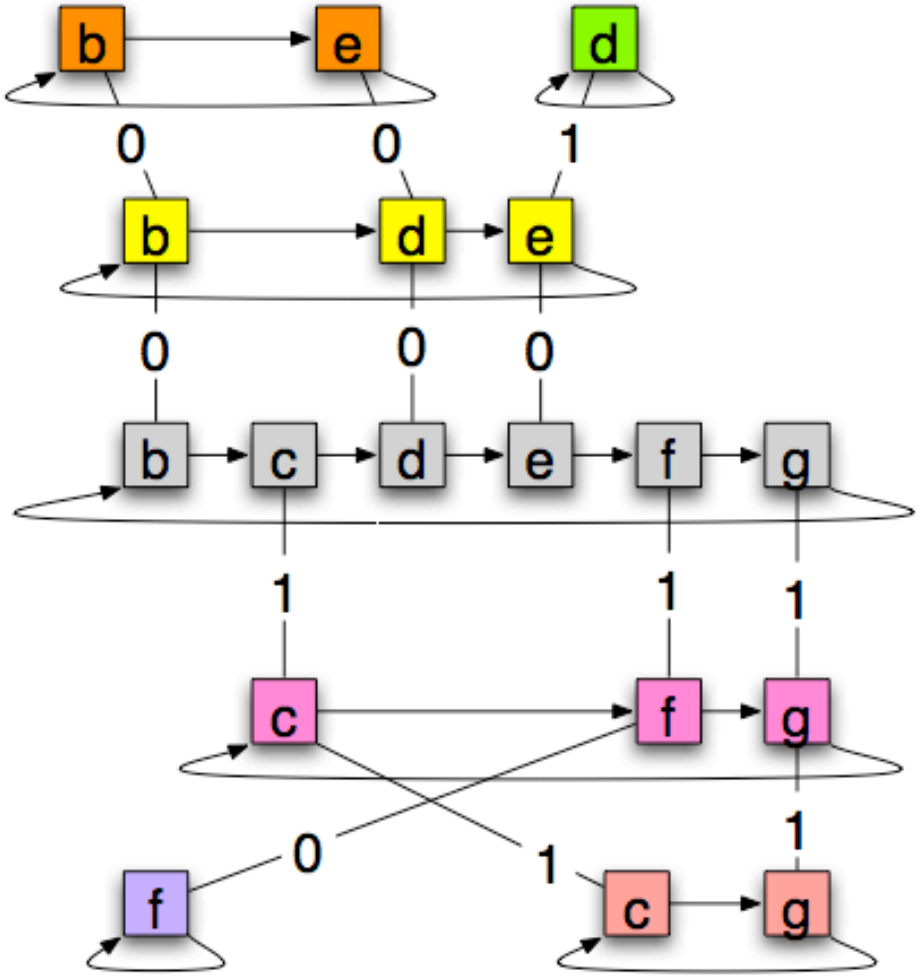



UNI FREIBURG

CoNe Freiburg

# Skip-Graphs

- J. Aspnes and G. Shah. Skip graphs, 2003
- Idea
  - „Heads“ and „Tails“ of a coin toss recursively participate in an own game
- Properties
  - highly resilient
  - Diameter and degree O(log n) with high probability
  - Ordering of data remains



CoNe Freiburg

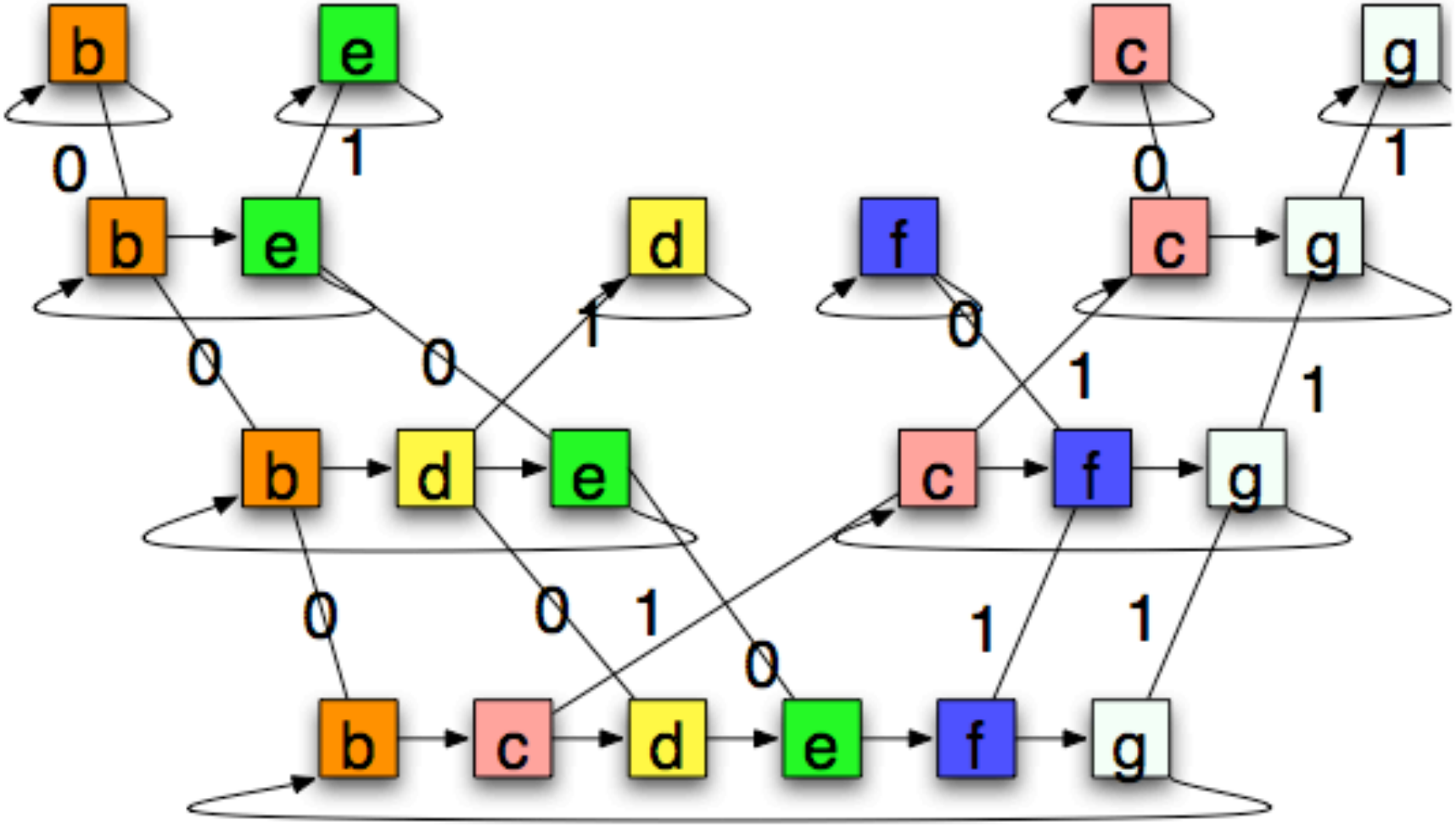
# Skip-Net

- Same data structure invented twice in parallel
- Harvey, Jones, Saroiu, Theimer, Wolman, SkipNet: A Scalable Overlay Network with Practical Locality Properties 2003
- Prinziple
  - Data is sorted stored on peers on a ring
  - Node-ID serves as random number for skip-graph
- Lookup for Data
  - Choose the farthest pointer on the ring which does not pass the peer storing the data
- Lookup for numeric node-ID
  - Recursively choose ring with same prefix
- # hops: O(log n) w.h.p.
  - if the node-IDs are chosen randomly

UNI FREIBURG

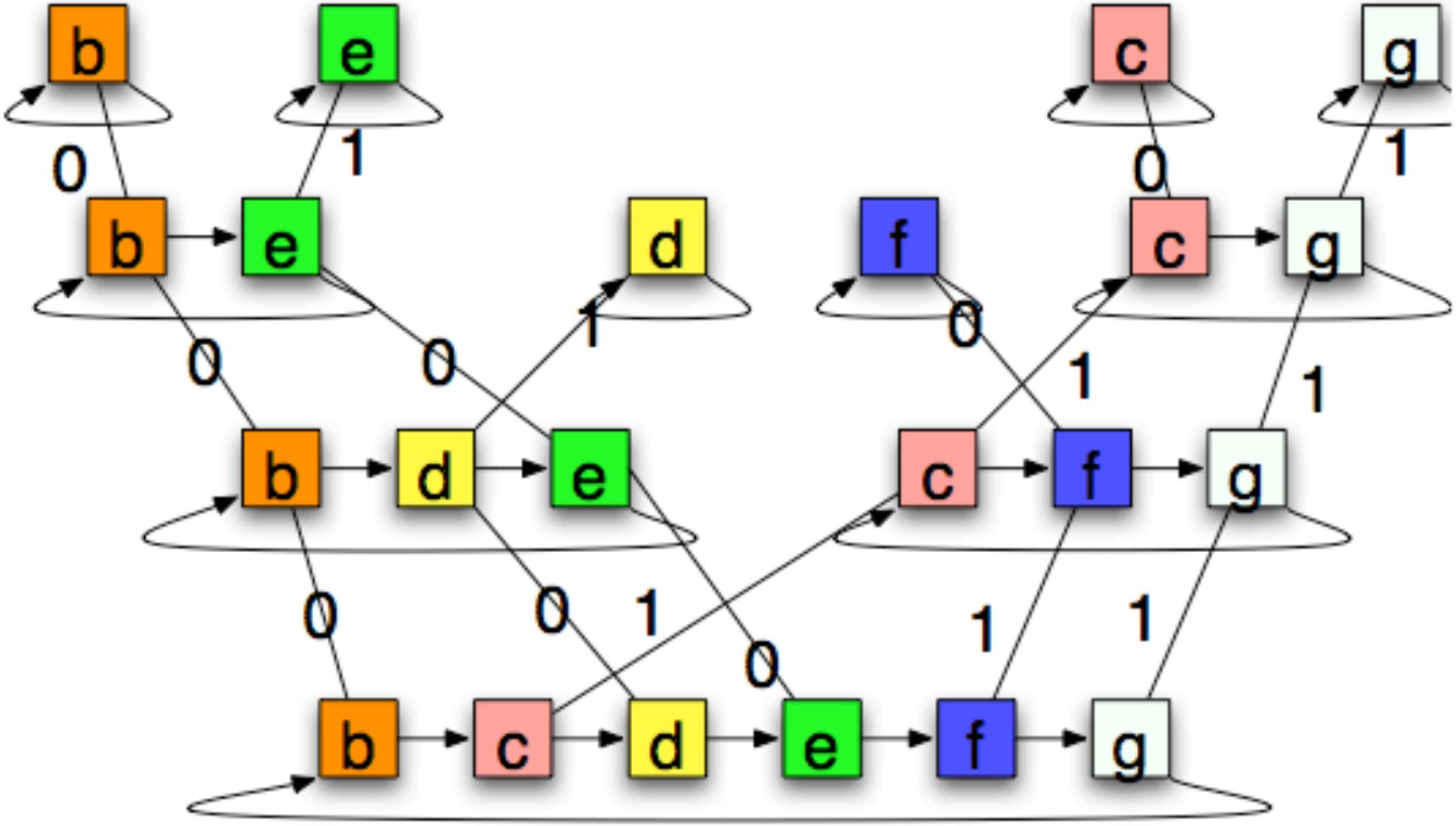
CoNe Freiburg

# Search for Name-ID



CoNe Freiburg

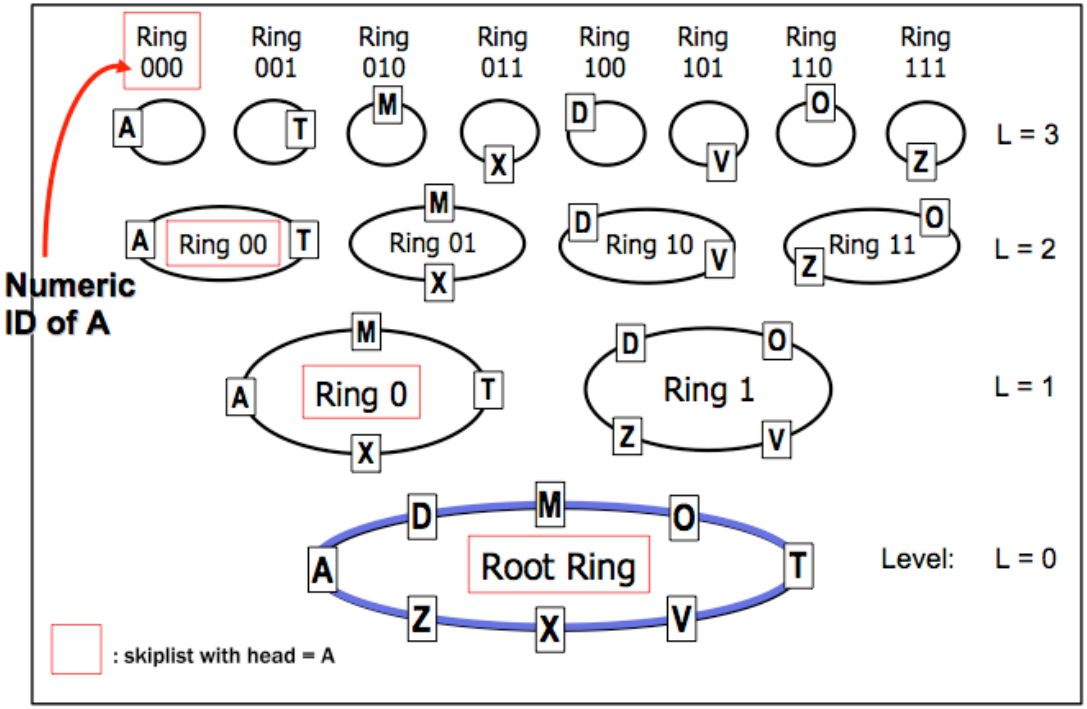
# Search for Num-ID



CoNe Freiburg

# Alternative Representation

- From: P2P Network Structured Networks of Pedro Garcia Lopez, Universitat Rovira I Virgili



CoNe Freiburg

# Inserting Peers

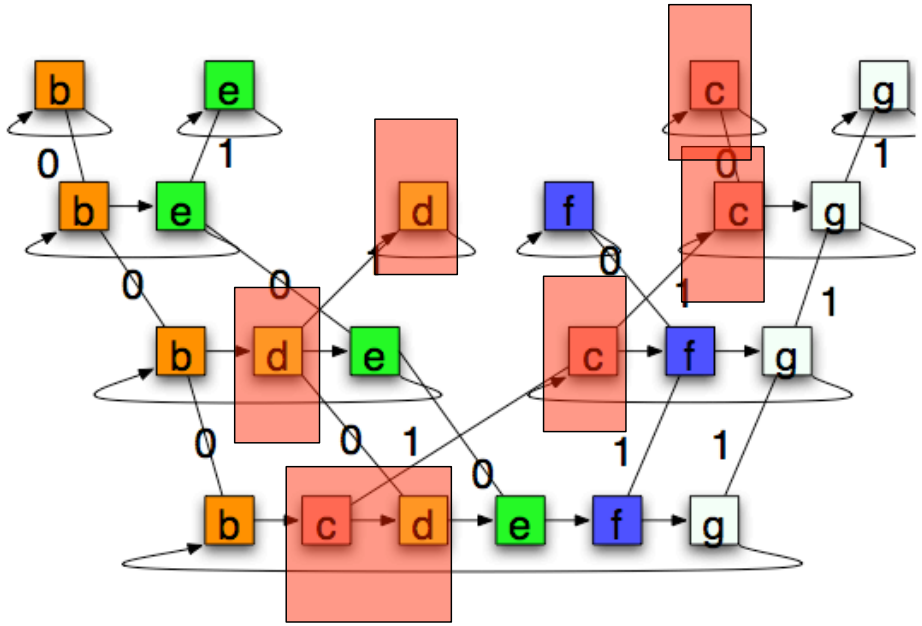
- J. Aspnes and G. Shah. Skip graphs, 2003
- Algorithm
  - Lookup of correct place according to node name
  - Insertion into higher ranks
- Runtime: O(log n) hops and O(log n) messages with high probability

UNI FREIBURG

CoNe Freiburg

# Fault Tolerance

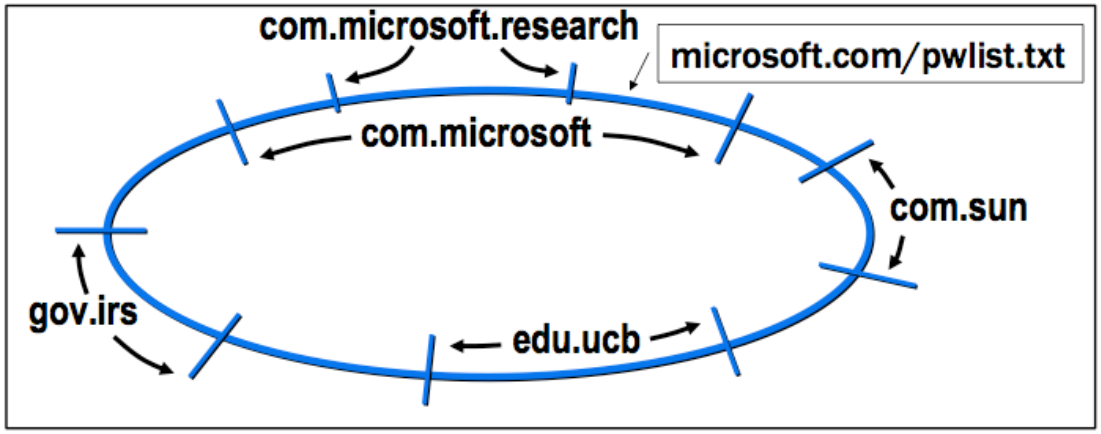
- Independent Node failurs
  - can be compensated by using the upper rings
- Partial network failures
  - can be repaired by removing the partial ring in higher levels



CoNe Freiburg

# Locality of Content and Routing

- Locality of content
  - underlying ordering
- Alternative mapping of data
  - data can be stored using num-id
- Locality of Routing
  - if the hosts are sorting along domains then local routing within a domain can be facilitated where possible



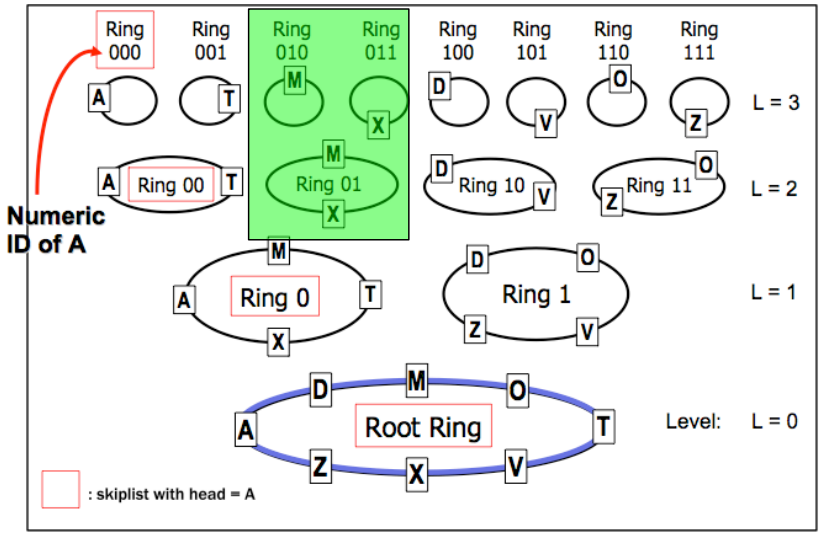

UNI FREIBURG

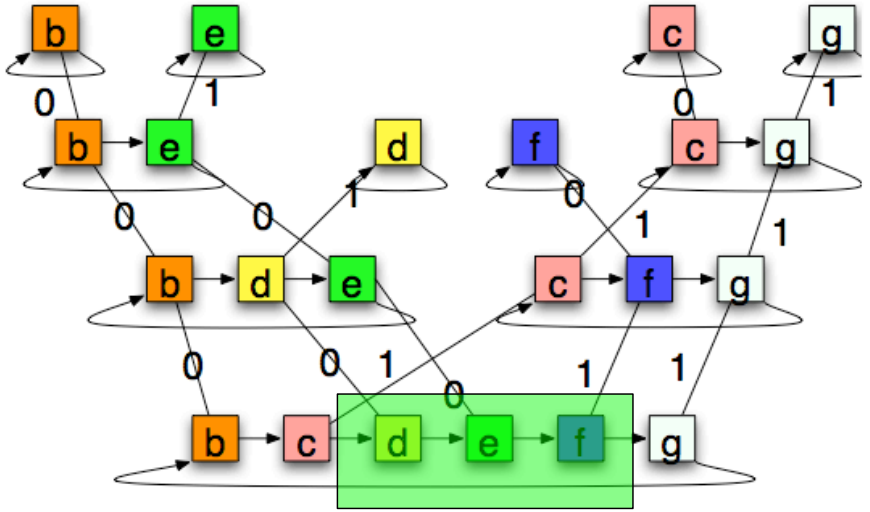
CoNe Freiburg

# Range Search

- Num-ID range search
- Name-ID range search
- Intersection of Num-ID and Name-ID

- Running time:
  - O(log n) for first element
  - Then constant time for each successing elements



CoNe Freiburg

# Extensions

- Increase the basis
  - e.g. use dice instead of coin
  - reduces degree
  - increases diameter
- Replace duplicate pointers
  - with more pointers

UNI FREIBURG

CoNe Freiburg

# Using SkipNet in DHTs

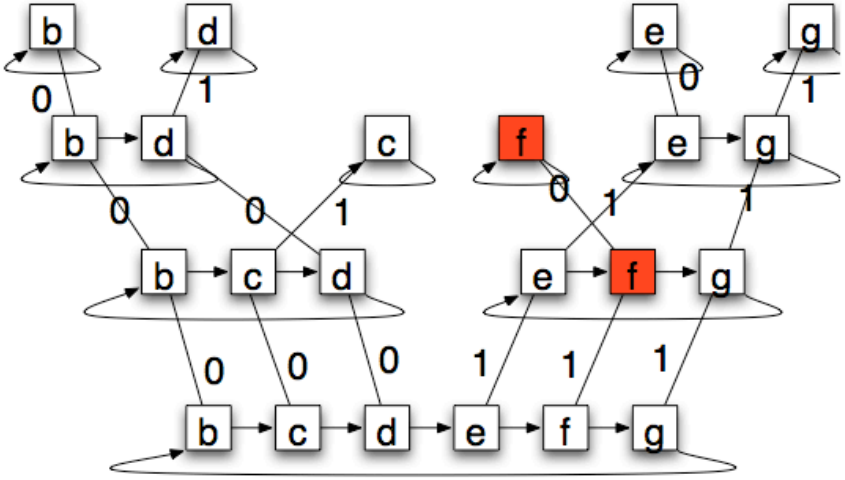
- Omit Hash Table
- Single Overlay
  - Use numbering of Chord in Chord
- Multiple Overlay
  - Use multiple P2P network structures at the same time

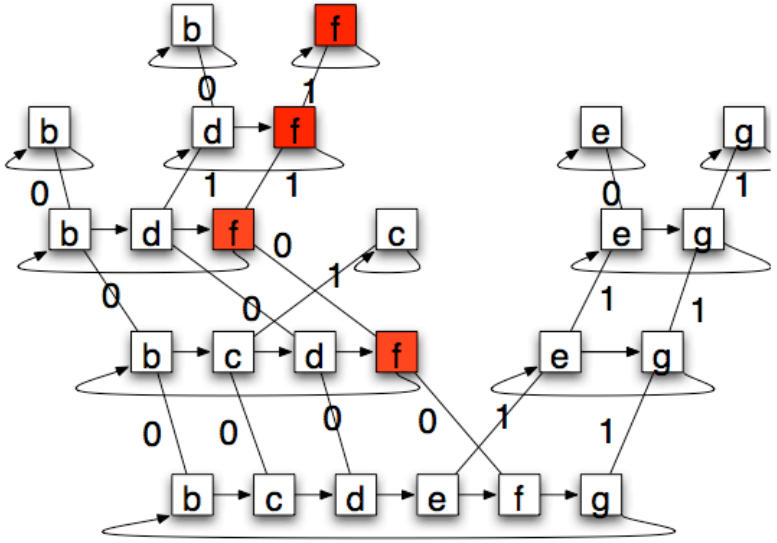
UNI FREIBURG

CoNe Freiburg

# Skip-Net with Random Numbers

- Harvey, Munro, „Deterministic Skip-Net“
- Rotation of nodes if unbalance is detected
- Rotation:
  - Insert a node in the other layer if there is a too long sequence of same level nodes
- Rebalance Skip-Net
- Network construction without randomness and without probabilistic analysis
- Lookup: O(log n) in the worst case



CoNe Freiburg

IIF INSTITUT FÜR INFORMATIK FREIBURG

# Peer-to-Peer Networks

## 9 Skip-Net and Skip-Graph

Christian Schindelhauer
Technical Faculty
Computer-Networks and Telematics
University of Freiburg

UNI FREIBURG