Improving a Hypercube Structured Distributed Hash Table

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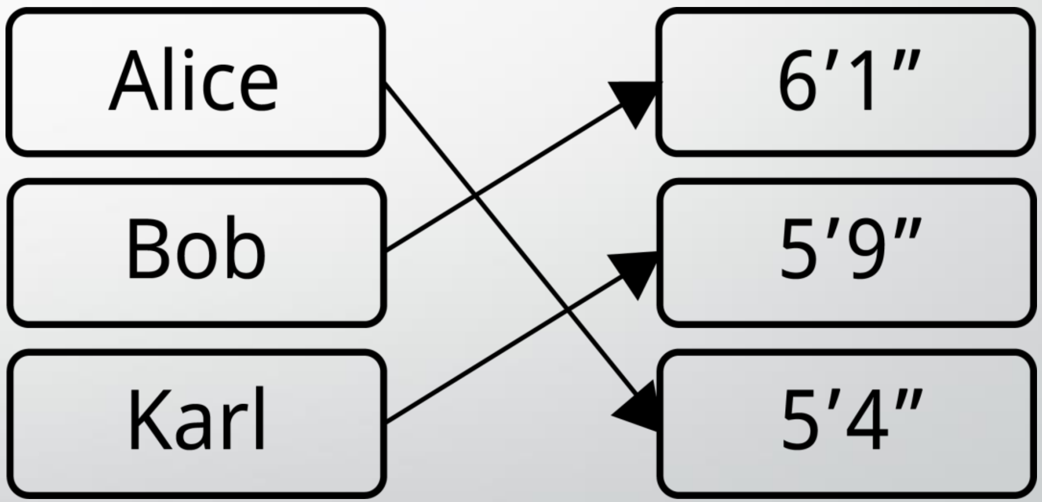
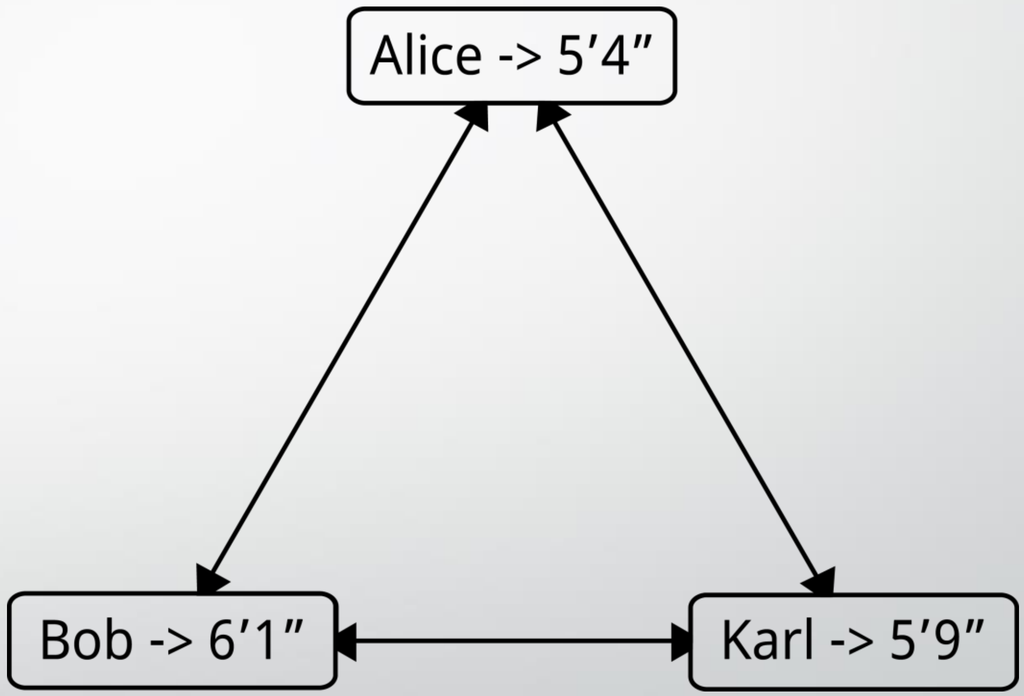
What is a Hash Table?

- Store data
- Map keys to values
- Can *get*, *set*, or *delete*



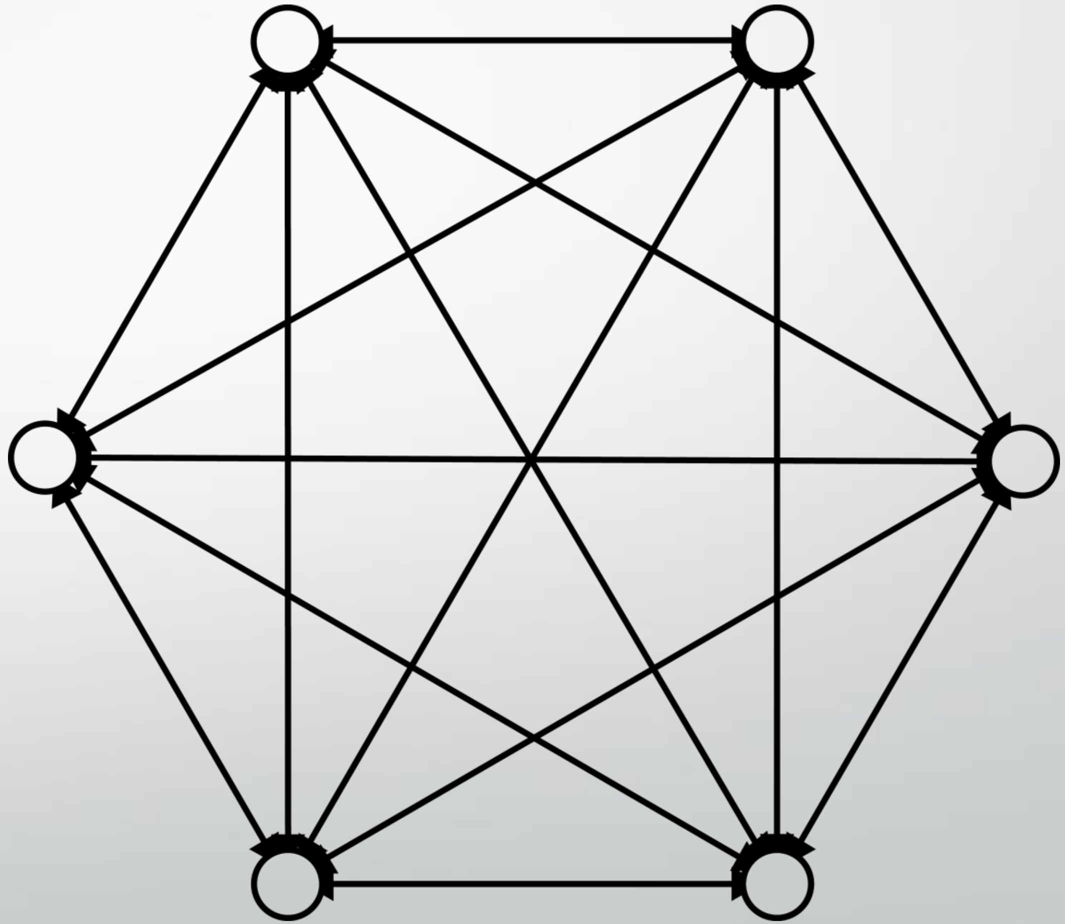
What is a Distributed Hash Table?

- Transparent
- Can still *get*, *set*, or *delete*
- Data spread across a network



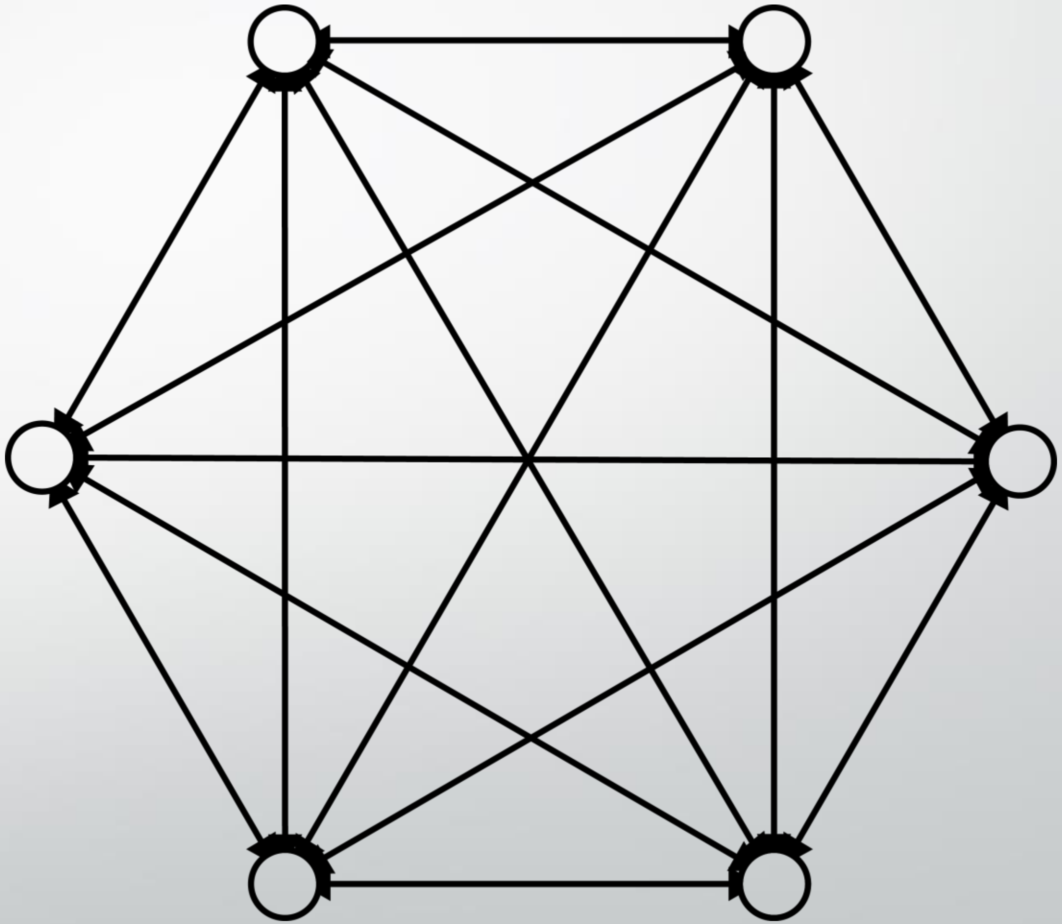
Unstructured Clusters

- n vertices
- n-1 edges per vertex



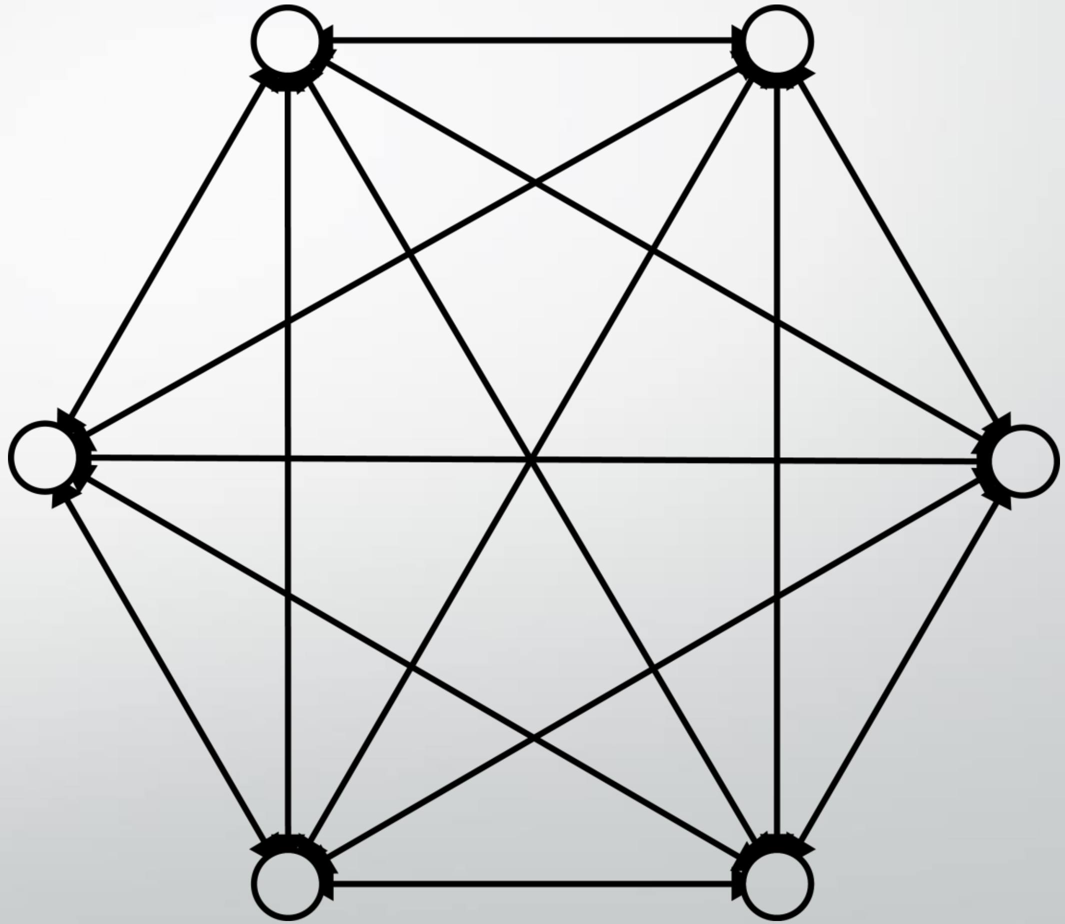
Advantages

- Max distance of 1
- Easy to maintain when small
- Adapts to change
- Redundant links



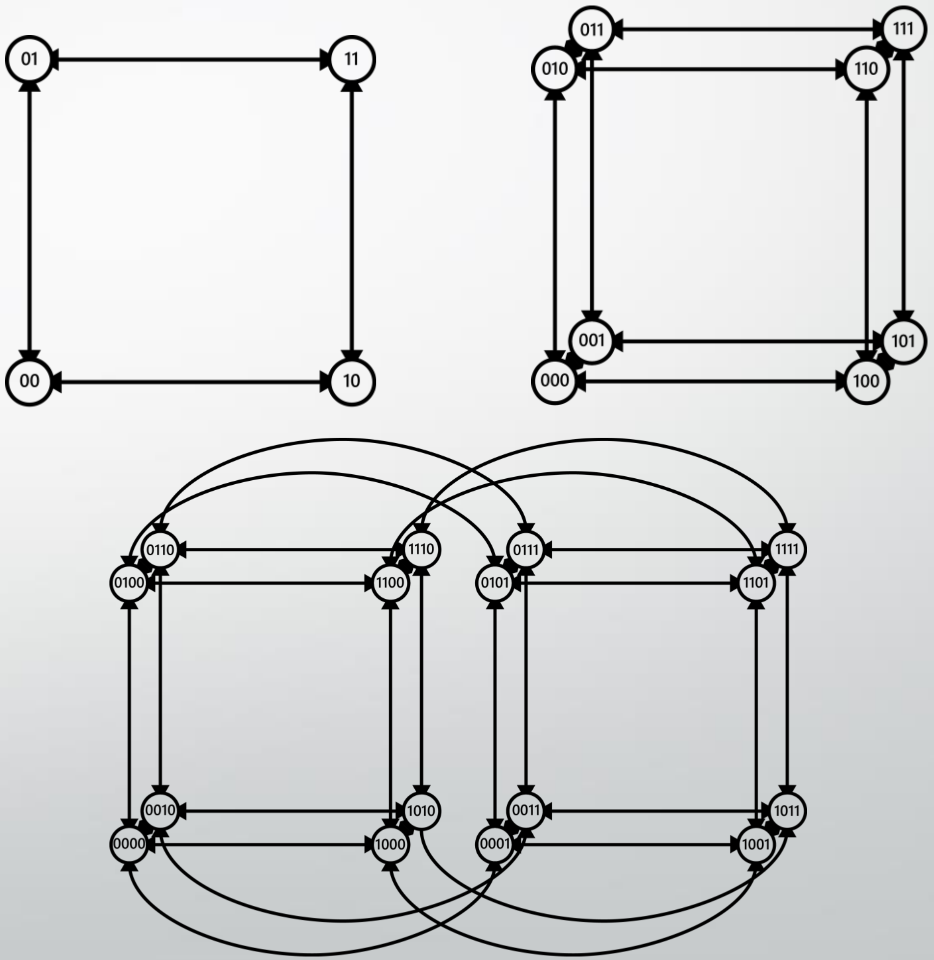
Disadvantages

- Slow at large sizes
- Search is slow



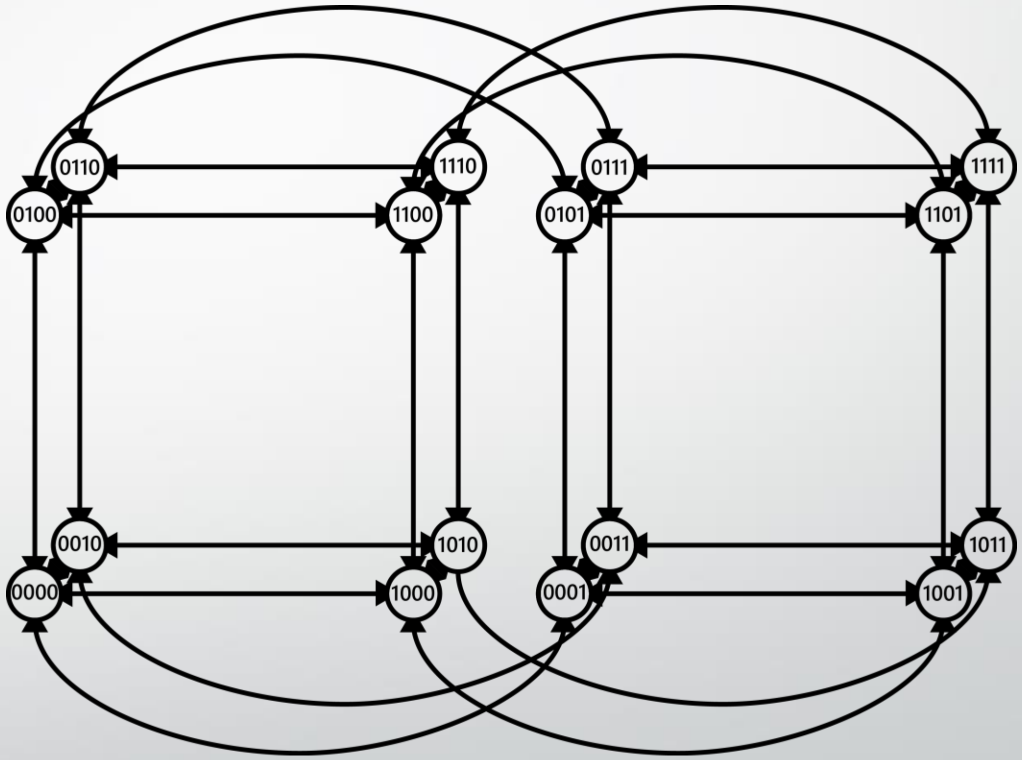
Hypercubic Networks

- 2^n vertices
- n edges per vertex
- Recursive design
- Labelled vertices



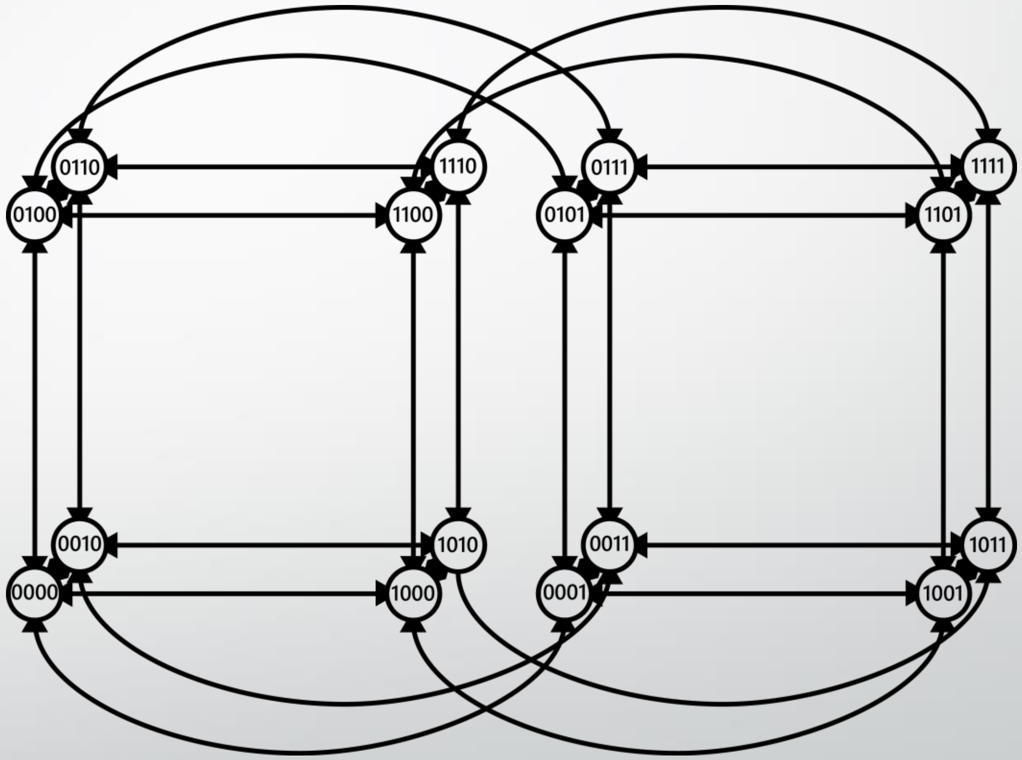
Advantages

- Short max distance
- Redundant links
- Dynamic growth
- Search is fast



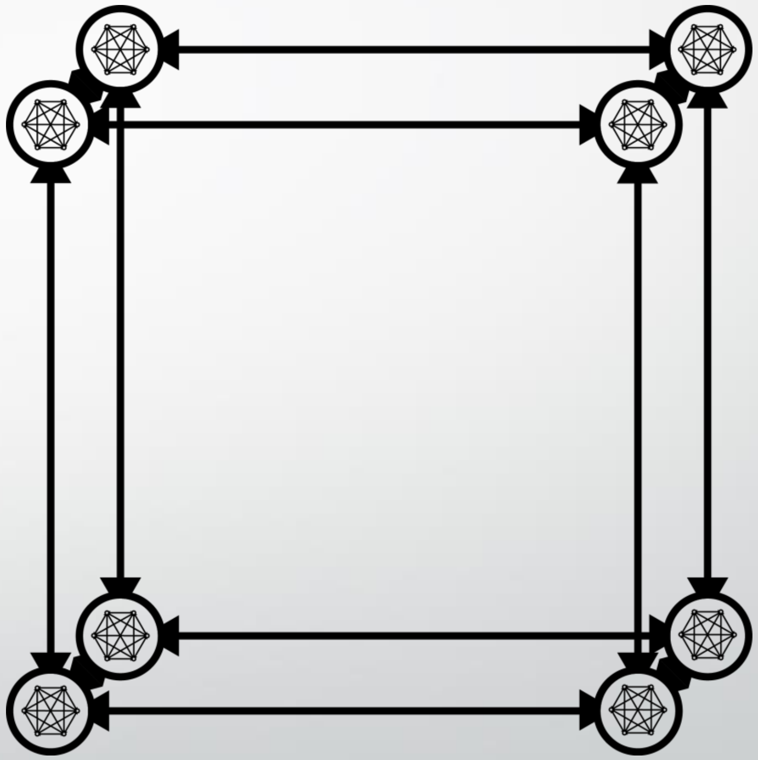
Disadvantages

- Hard to maintain
- Weak to change



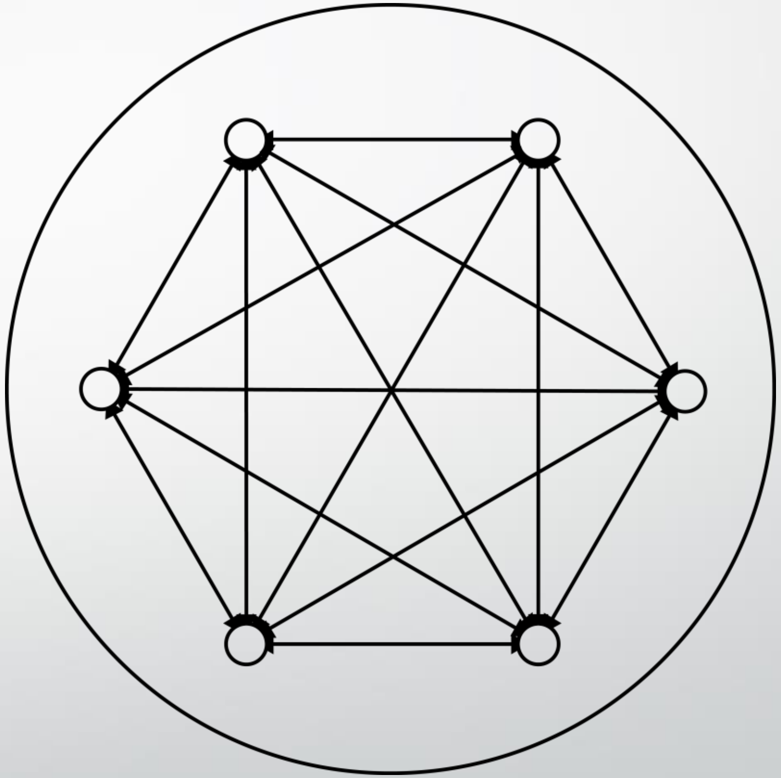
PeerCube

- Cluster at each vertex
- Cluster data replication
- Limited cluster size



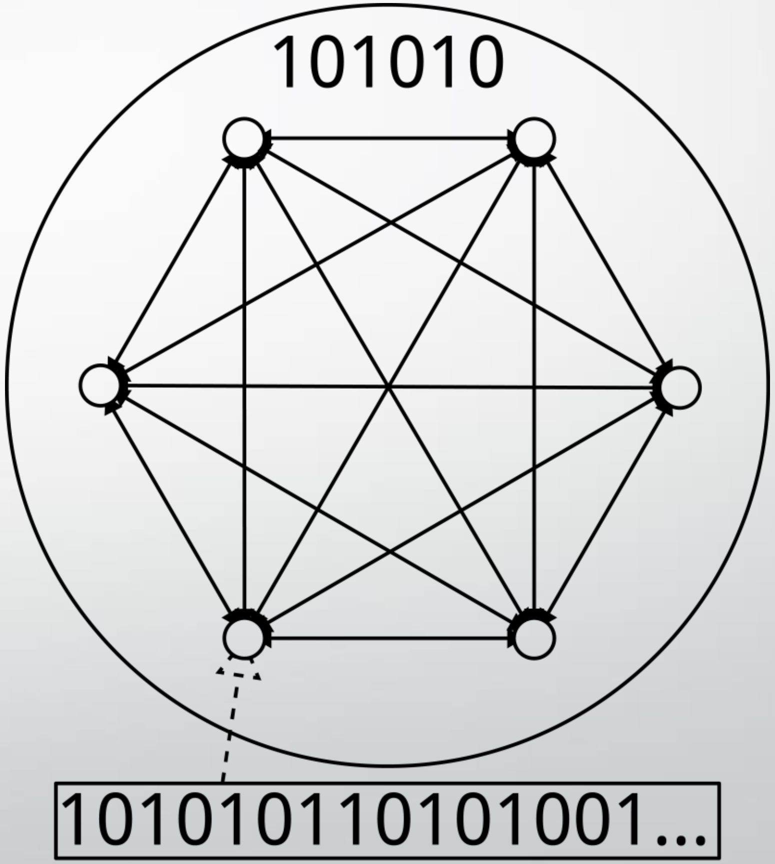
PeerCube Clusters

- Grow and Shrink
- Merge and Split
- Share data internally
- Smin and Smax



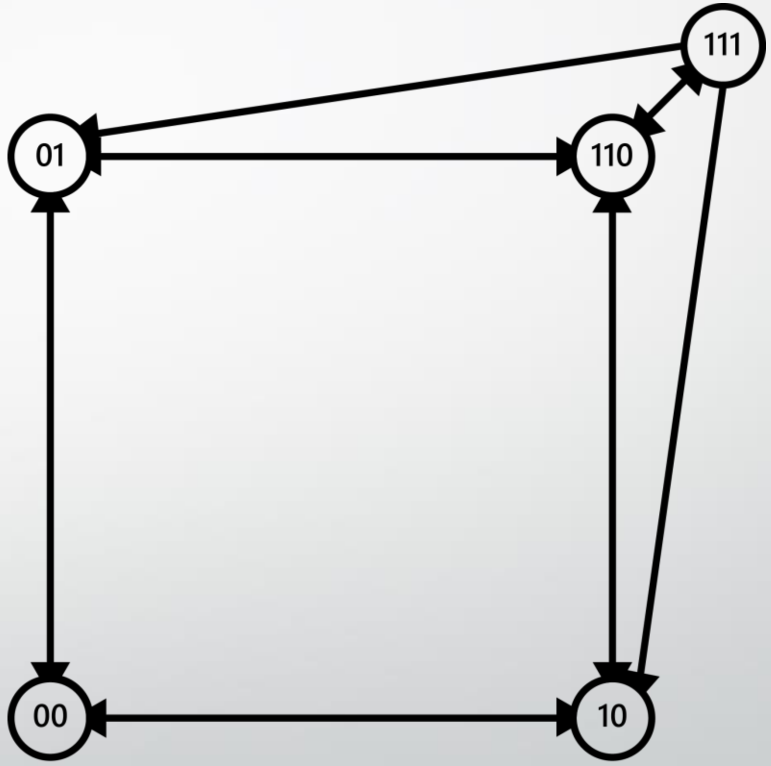
PeerCube Nodes

- Randomly assigned ID
- Prefixed by cluster label
- Not trusted



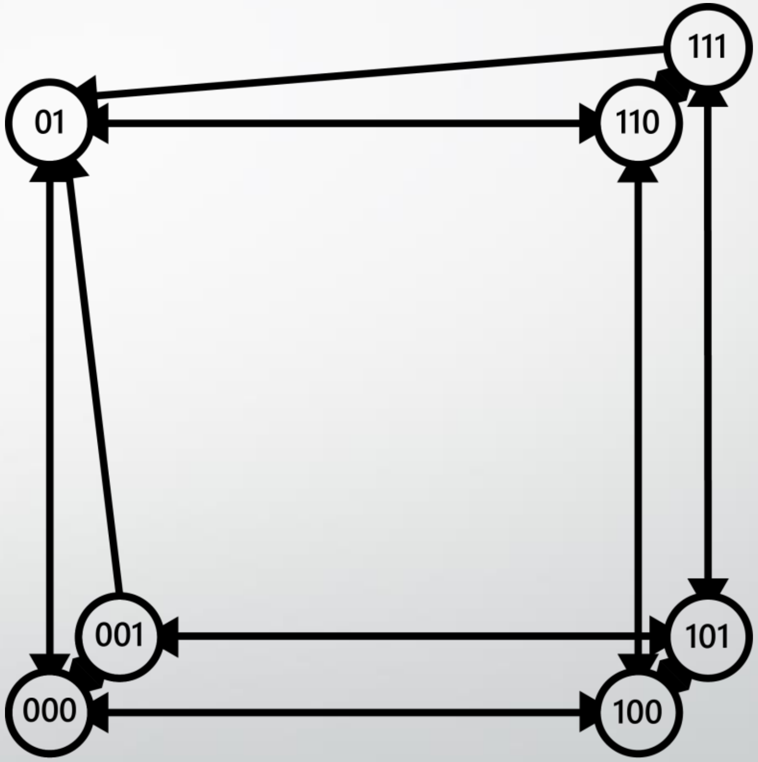
Cluster Splitting

- When the cluster is larger than Smax
- Makes two clusters smaller than Smax
- Links can be unidirectional



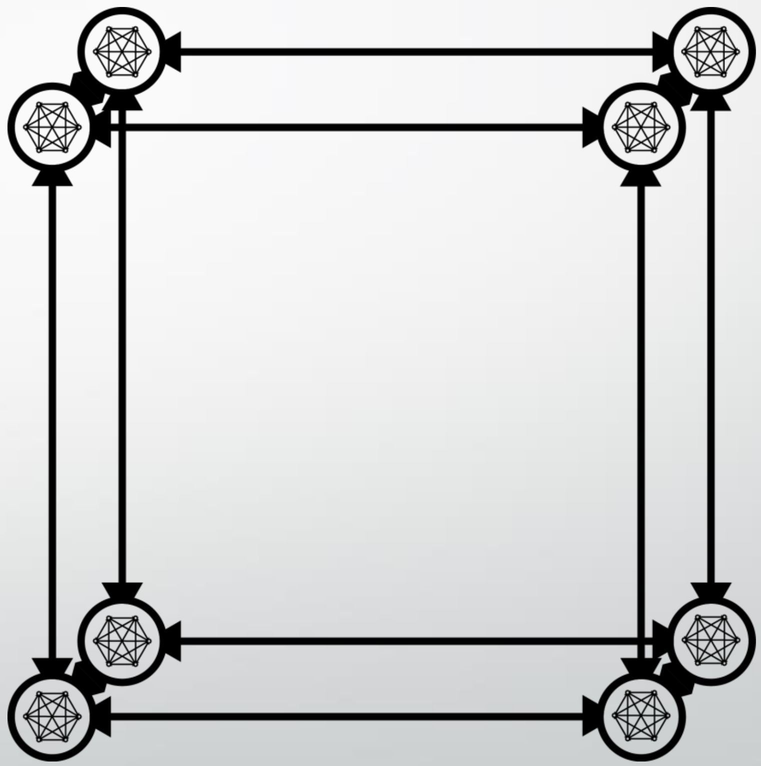
Cluster Merging

- When the cluster is smaller than Smin
- Makes one cluster larger than Smin
- More than two clusters can merge



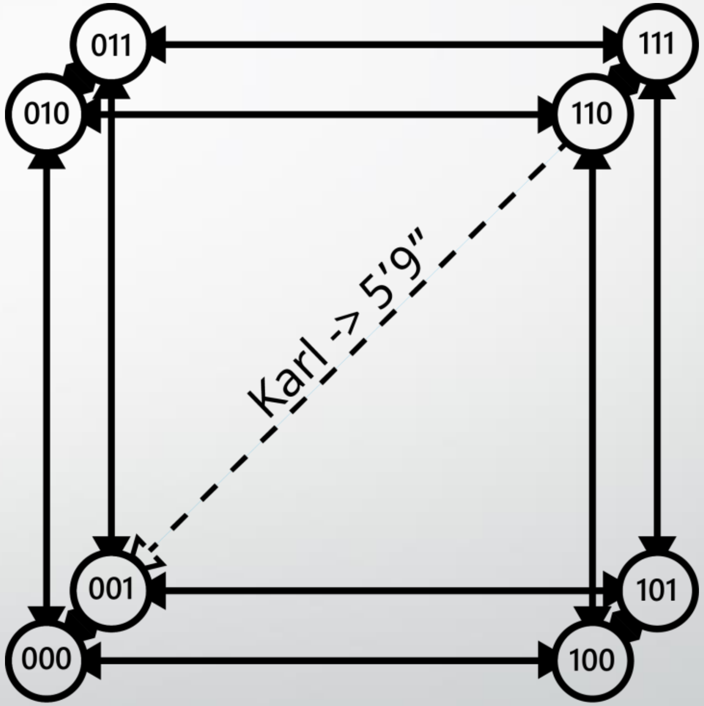
Problems

- No data prioritization
- All data is in memory



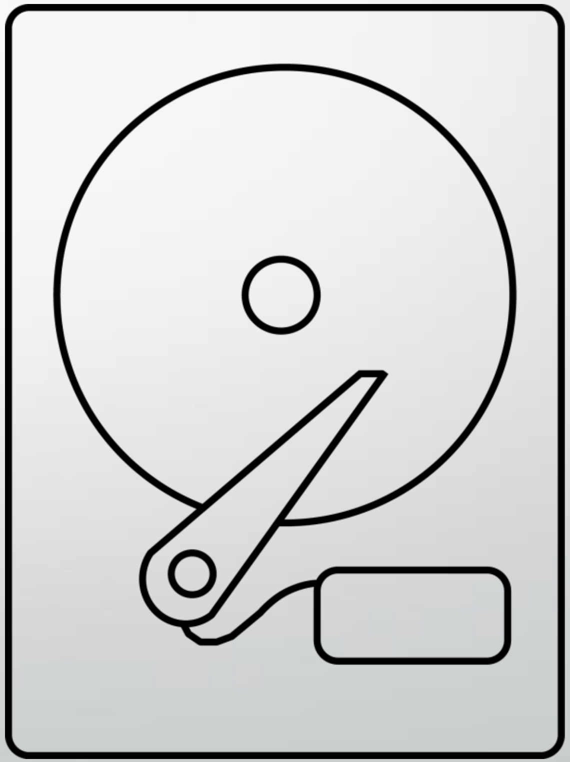
Hot Data Caching

- Cache frequently accessed data
- Preempt structure
- Key-specific links
- Latency decrease



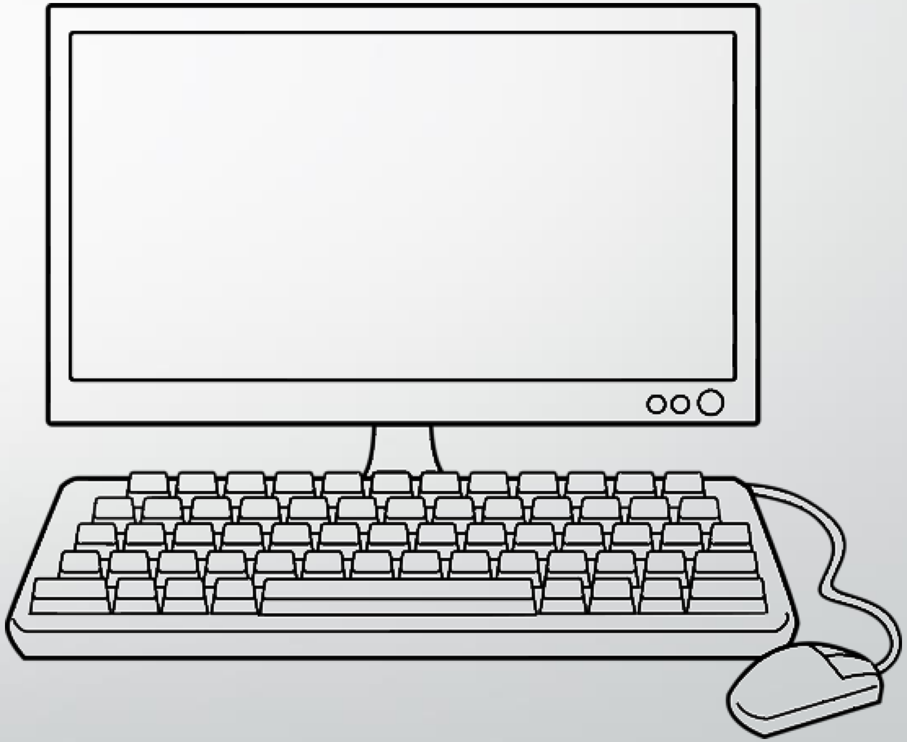
Cold Data Paging

- Page infrequently accessed data to disk
- Saves RAM
- Minimal latency increase

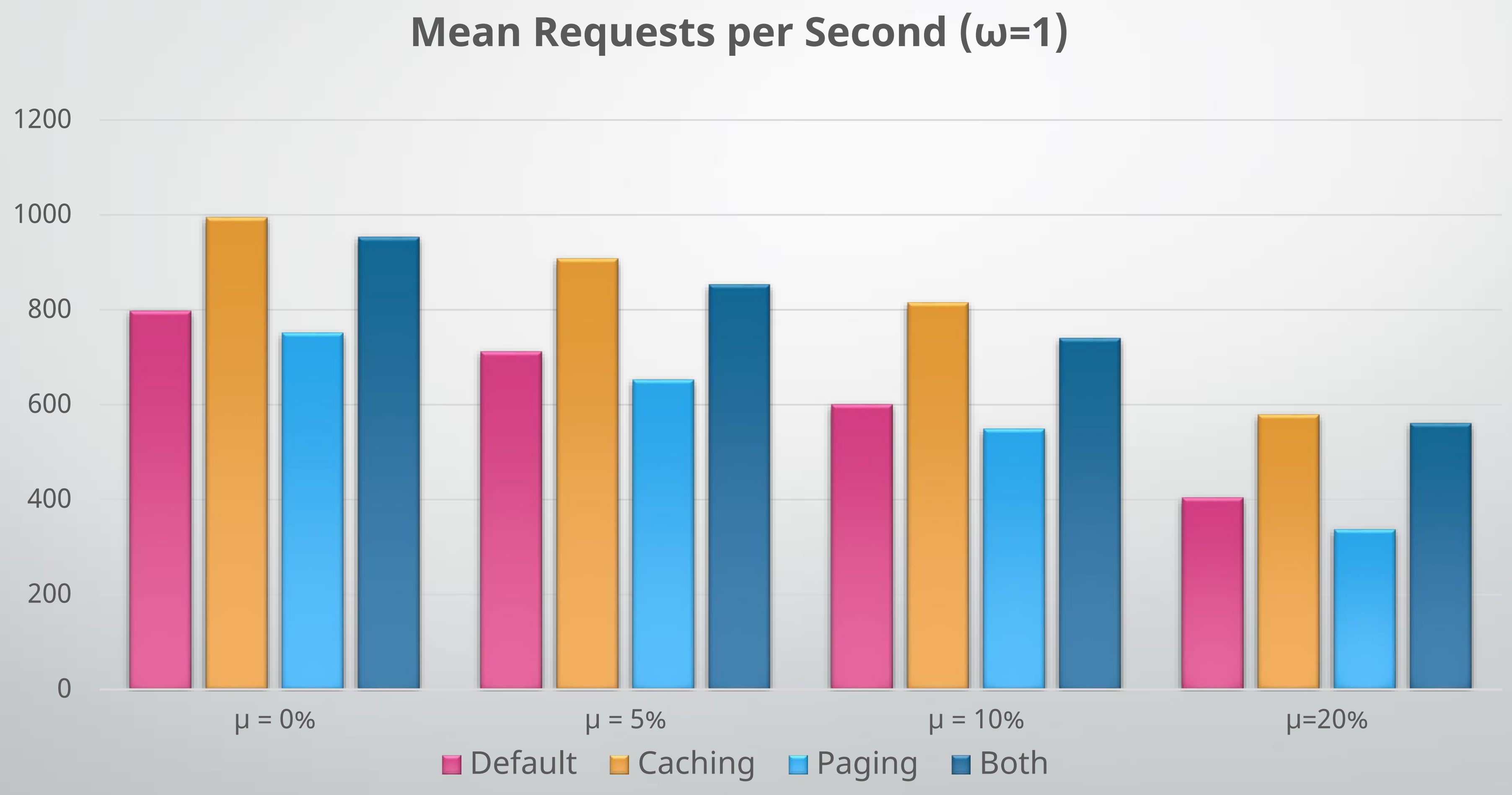


Simulation

- Combinations of μ, worker threads, and algorithm modifications
- Mean requests per second
- Mean 95^{th} percentile latency
- Every minute for 30 minutes

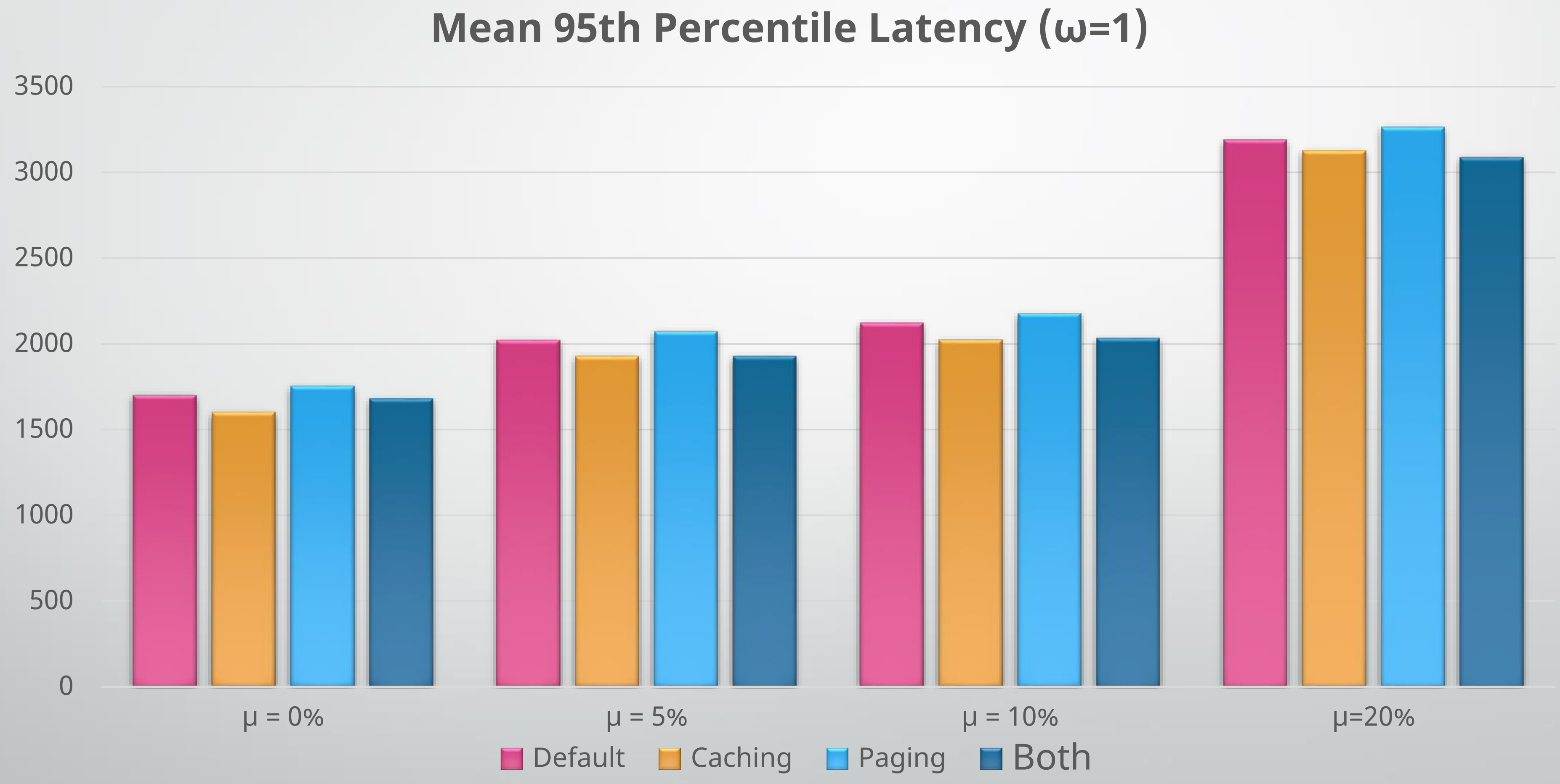


Results



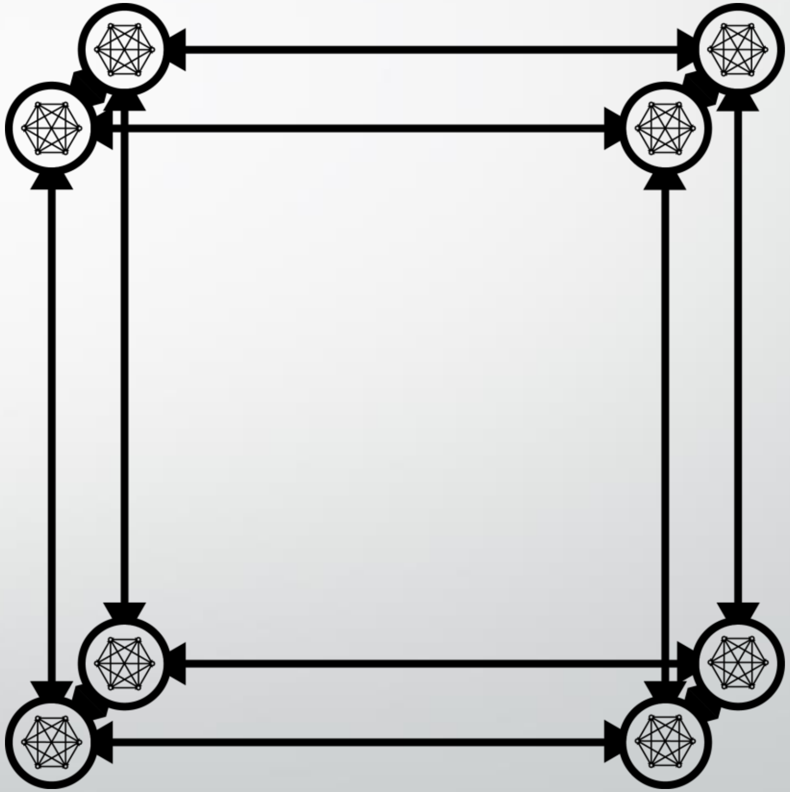
Mean Requests per Second (ω=1)
1200
1000
800
600
400
200
0
μ = 0%
μ = 5%
μ = 10%
μ=20%
Default
Caching
Paging
Both

Results


Mean 95th Percentile Latency (ω=1)
3500
3000
2500
2000
1500
1000
500
0
μ = 0%
μ = 5%
μ = 10%
μ=20%
Default
Caching
Paging
Both

Significance

- Matches PeerCube model
- Paging
  - Minimal negative impact
  - Major positive impact
- Caching
  - Slightly lower latency
  - Much higher throughput



Acknowledgements

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Questions

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