Fault-tolerant Path and Disjoint Path Construction in Data Center Network based on Augmented Cube

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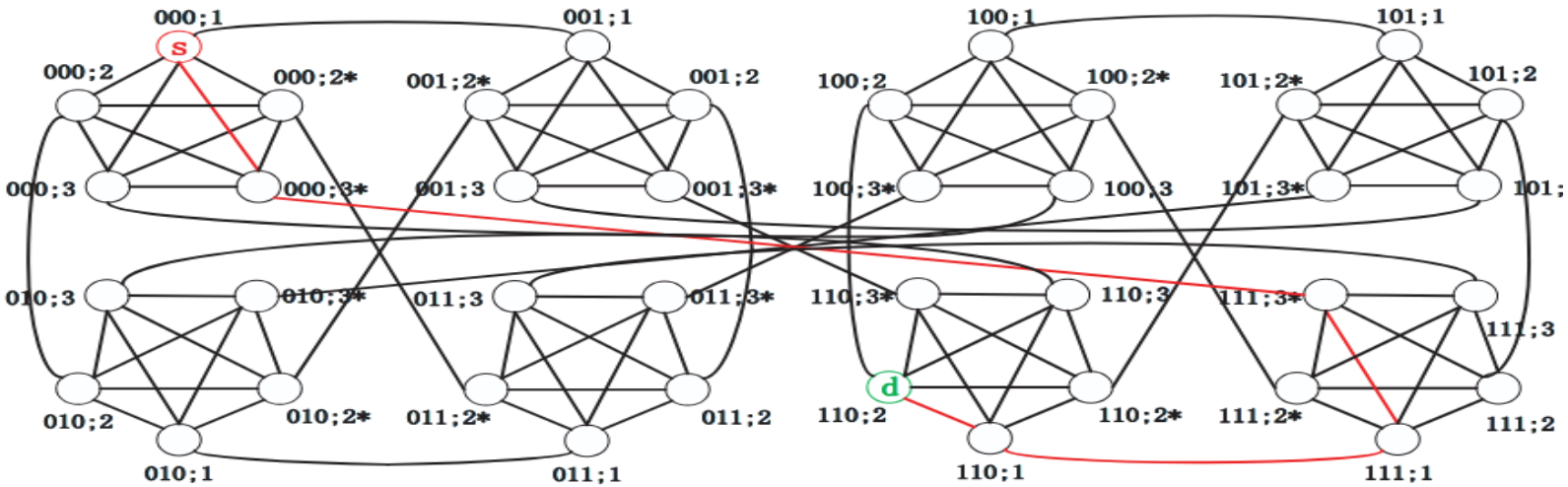
Problems & Ideas

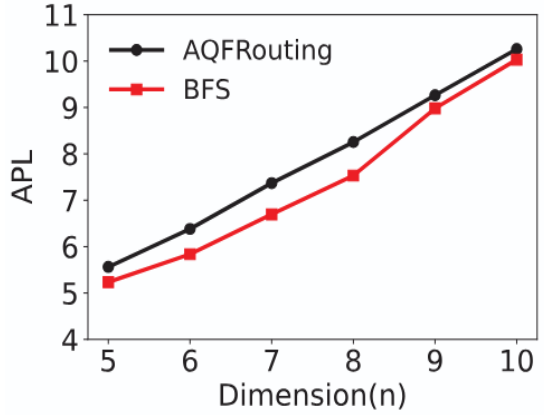
- Problems of DCN fault tolerance：
  - – Traditional single-path routing fails easily when nodes fail, causing service interruptions.
  - – Existing disjoint path algorithms have high time complexity and long path lengths, unsuitable for large-scale DCN.
- Ideas： We propose fault-tolerant path algorithm and the disjoint path algorithm, optimizing via recursive bipartition and cross-edge techniques.



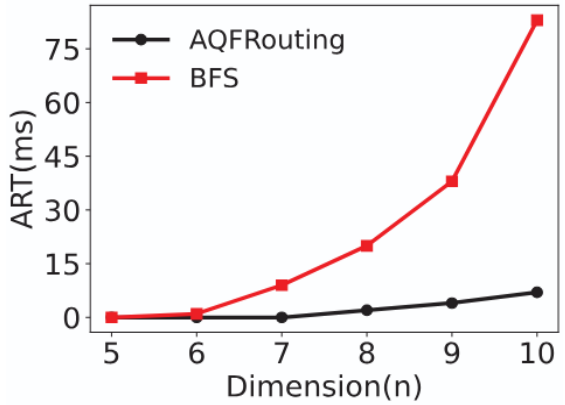
This is the unicast communication situation between two nodes. We establish a fault-tolerant route in the presence of a faulty node by **recursive bipartition** .

Main Contributions

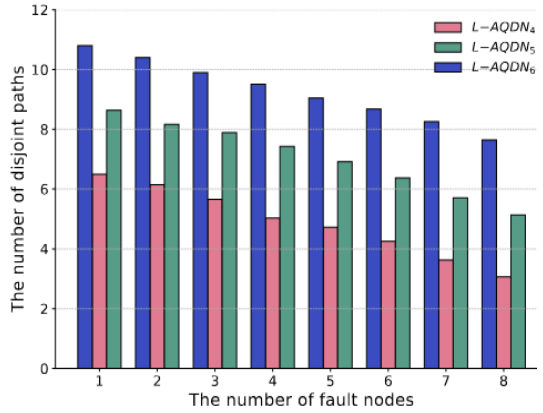
- Contributions:
  - We prove that the connectivity of $AQDN_n$ equals 2n - 1, and design a routing algorithm that guarantees communication between any two fault-free nodes when the number of faulty nodes is at most 2n - 2;
  - We propose an efficient disjoint path algorithm AQDN-DP that constructs 2n - 1 disjoint paths with time complexity $O(n^2 \log n)$, leveraging recursive bipartition and cross-edge optimization;
  - Experimental results show that our methods reduce path length and runtime compared to baseline BFS, while maintaining strong fault resilience.



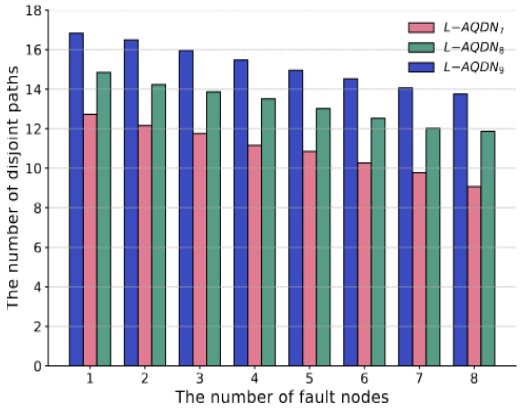
(a) APL of AQFRouting vs. BFS



(b) ART of AQFRouting vs. BFS



(c)



(d)

Performance comparison between proposed algorithms and BFS: (a)(b) show AQFRouting results; (c)(d) show disjoint path performance under $AQDN_n$