Comparison Between Pre-computation and On-Demand Computation QoS Routing with Different Link State Update Algorithms

Haifeng Zhu

Supervisor Professor Raimo Kantola

Instructor Ph.D. Peng Zhang

Networking Laboratory, HUT

Contents

- Background
- Simulation Environment
- Simulation Results and Analysis
- Conclusions
- Future work

Background

- QoS Routing
- Path Computation Algorithm
- Inaccurate Routing Information

QoS Routing

- Routing for Best-Effort traffic

  OSPF and RIP use the shortest path to forward packets without considering the delay or bandwidth of the path

- QoS routing considers the quality constrains
  - Delay
  - Bandwidth
  - Jitter
- Link State update
  - Period-Based
  - Threshold-Based
    - Equal Class Based
    - Unequal Class Based

Path Computation Algorithm

- Pre-Computation Algorithm

  Paths from each node to all of the destinations are computed periodically or after a number of link state updates.

- On-Demand Computation Algorithm

  The path to a specified destination is computed every time a request is initiated

- Path caching architecture

  An extension to On-demand computation tends to reduce the processing costs

Pre-Computation Algorithm

✓ Scalability

The number of path computations is independent from the number of requests

✓ Fault tolerance

Alternative routes for bypassing the failure parts in the network can be computed in advance

✓ Load Balancing

Traffic can be balanced by directing different requests to several alternative routes properly

- Storage

Storage for QoS routing table is needed

- Processing load

For ad hoc network or network with fewer amounts of requrests, most of pre-computed paths may never be used. Thus lots of processing capability is wasted

On-Demand Computation Algorithm

- ✓Simpler implementation
    - ➢ Only one path to the specified destination is computed when new request is initiated
    - ➢ Routing table is not necessary
- ✓Storage

  Not necessary to maintain routing table, thus storage for routing table is saved
- Scalability

  Not scale well for large network that have many requests
- Processing load

  Networks with many requests will generate large computation overhead

Path caching architecture

- Path caching for on-demand computation
  - Cache for storing the paths that are computed on demands of the previous requests
  - On-demand computation is triggered only if the route needed cannot be found from the path cache
- Benefits

  Processing cost can be reduced due to less path computations
- Storage

  The storage of cache is comparable to or even more than that of the pre-computation algorithm
- Granularity of cache

  Network with proper selected hybrid granularity scheme for cache performs well with proper amount of storage

Inaccurate Routing Information

- Source of inaccuracy
  - ➢ Link states are not updated on time

    Broadcasting the LSAs for all changes in the network is infeasible due to the huge overhead to the network
  - ➢ LSAs may be lost
  - ➢ Temporal conditions like congestion in the network
  - ➢ Information aggregation in large network
- Problem

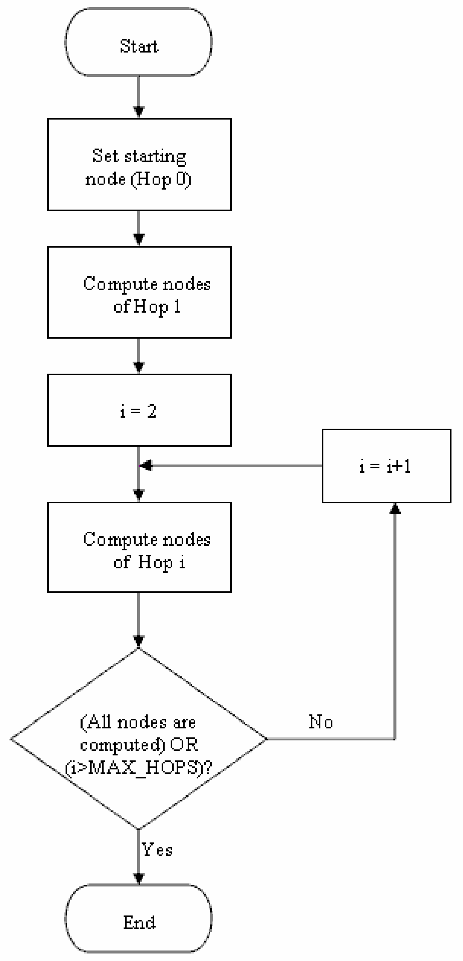
  Path selection base on inaccurate routing information may be non-optimal or incorrect
  - ➢ Non-optimal path selection decreases the utilization of the network
  - ➢ Incorrect path selection leads to more blocking

Simulation Environment

- QoS Routing Simulator
  - QRS was develop at Helsinki University of Technology
  - QRS model the network as a combination of different kinds of components
  - A certain number is allocated for every main QOSPF actions to simulate the practical cost in real implementation
  - Networks with different topologies are modeled with configuration files
- New routing algorithms and components
  - Pre-computation algorithm
  - On-demand computation algorithm
  - Traffic generator

    For generating traffic with bandwidth requirement

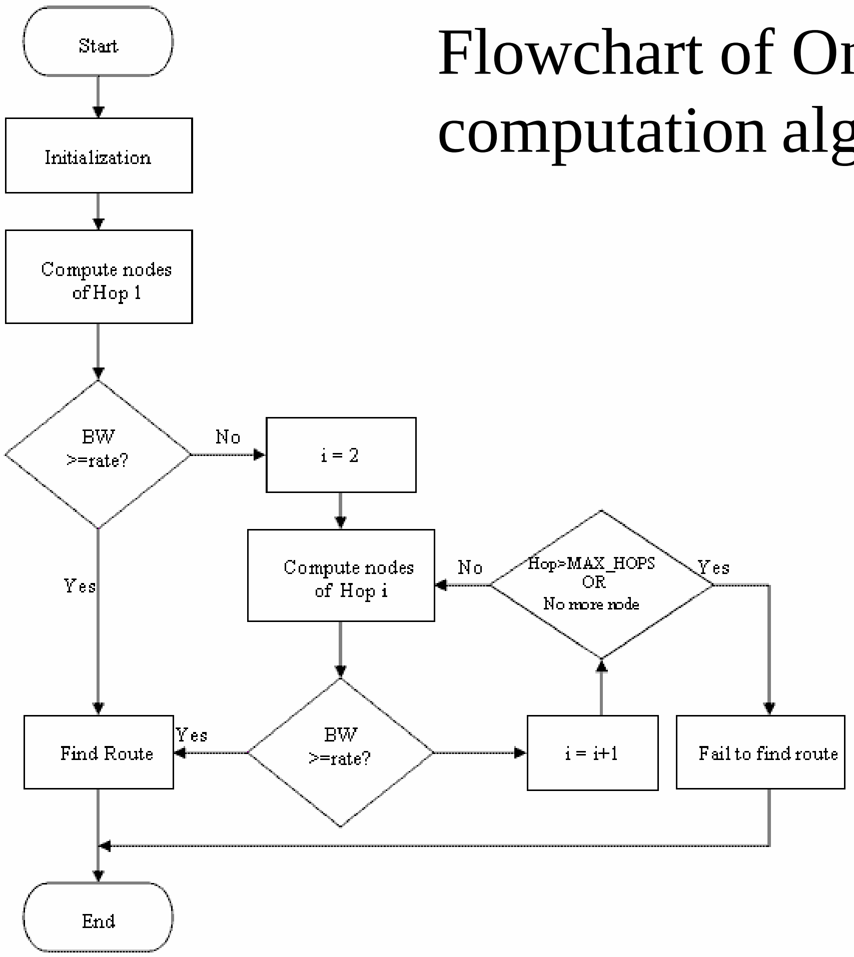
New routing algorithms (1/2)



Flowchart for computation of Bellman-Ford routing table

When a request is initiated, entries in the BF routing table are checked

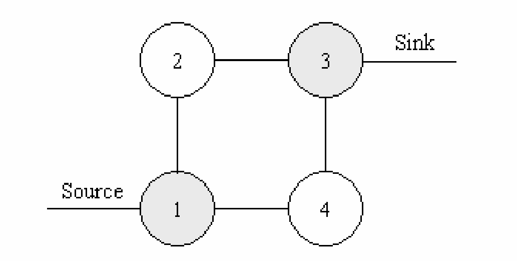
New routing algorithms (2/2)



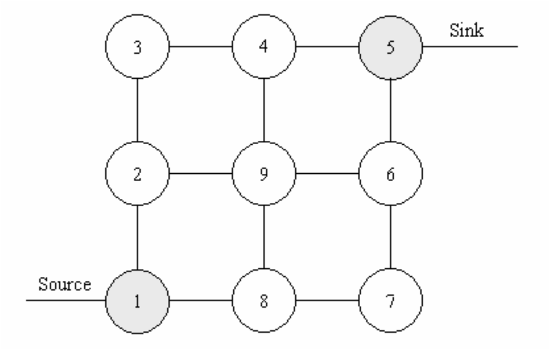
Flowchart of On-demand computation algorithm

Results and Analysis (1/3)

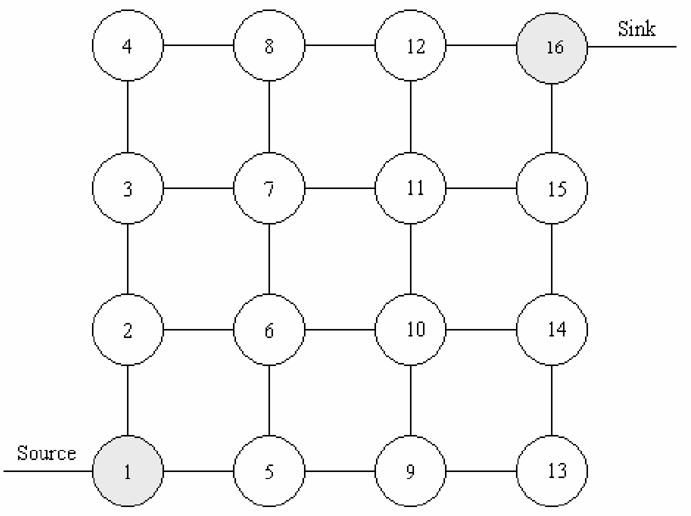
- Topologies



Matrix 2*2

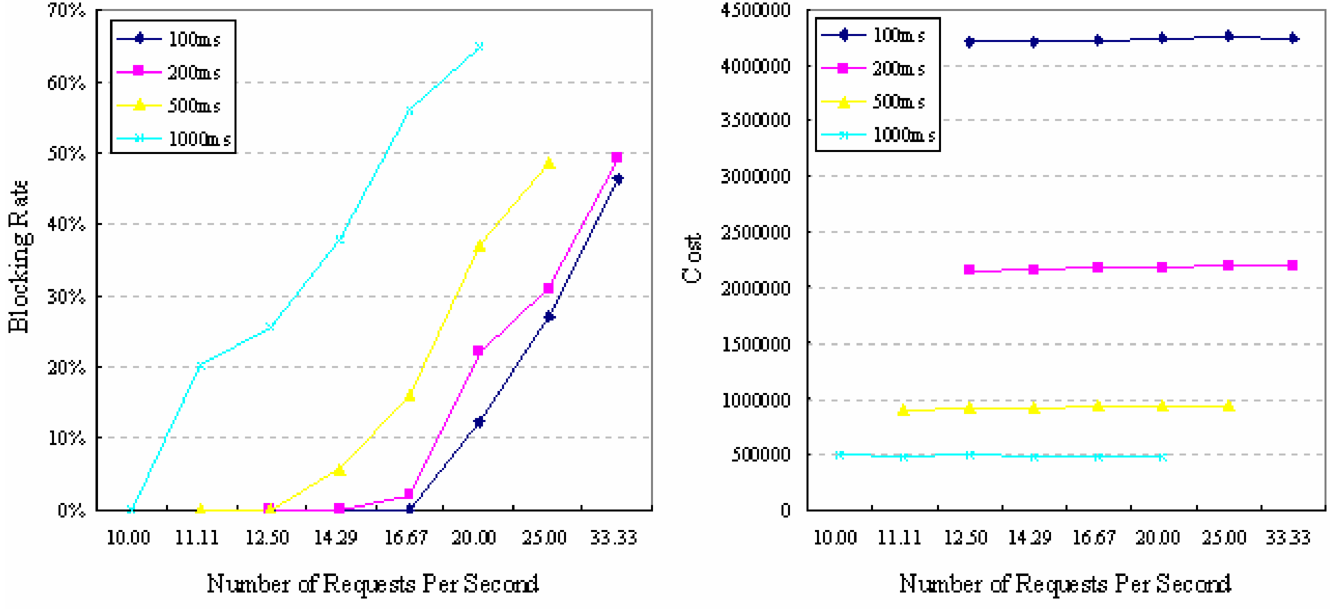


Matrix 3*3



Matrix 4*4

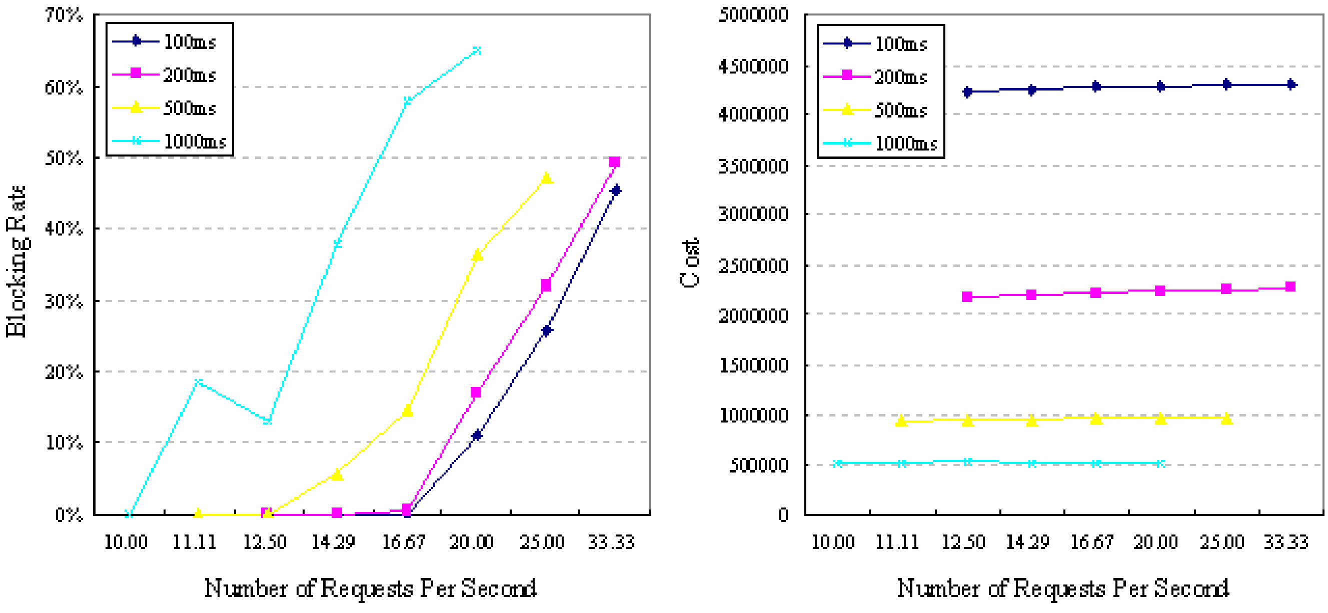
Results and Analysis (2/3)



Period-Based Link State Update Method with different periods (Pre-Computation)

- ➢For same request rate, the blocking rate grows with the period of link state update.
- ➢For link state period are 200ms and 100ms, the blocking rates are not much different between them, but cost of period=100ms is about twice as much as that of period=200ms

Results and Analysis (3/3)



Period-Based Link State Update Method with different periods (On-Demand Computation)

The blocking rates of on-demand computation algorithm are lower but the costs are higher compare to that of pre-computation algorithm

Conclusion

- In smaller networks, the on-demand computation has no obvious advantage in performance but has higher cost.
- The frequency of the link state update can affect the network performances and the costs significantly.
- The update triggering policy should be chosen carefully.
- Networks size is an important factor for performances and the costs.

Future Work

- More simulation works with larger and more complicated networks

  To model the practical network better

- Extension to the QRS simulator
  - More traffic models
  - More routing algorithms
- Study other factors that might affect the usage of the routing algorithms

Thank You!

Questions?