Performance comparison of QoS routing algorithms applicable to large-scale SDN networks

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December 7, 2016

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Quick look

This article:

- summarized traditional QoS Architecture,
- analyzed algorithms with
  - bandwidth guarantees
  - bandwidth-delay constraint

  measured by
  - bandwidth rejection ratio(BRR)
  - route length

Traditional QoS Architecture

Traditional QoS Architecture

Two main QoS Architectures today:

IntServ involves prior reservation of resources before sending, per-flow state

DiffServ Mark the packets with priority at the border of network, no prior reservation, per-class state

Bandwidth-constrained routing algorithm

MHA: Minimum Hop Algorithm

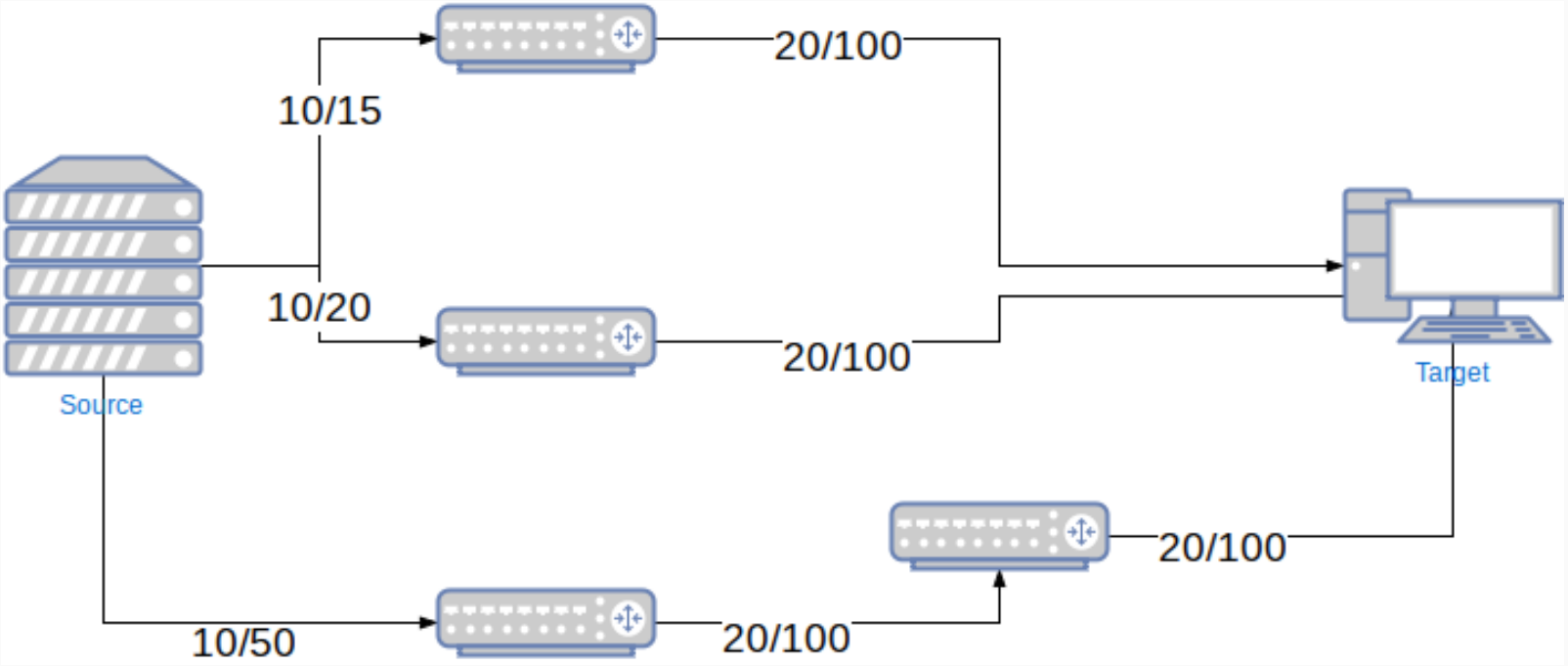

Figure 1: Current network

MHA: Minimum Hop Algorithm

Consider a flow requiring 10 bandwidth:

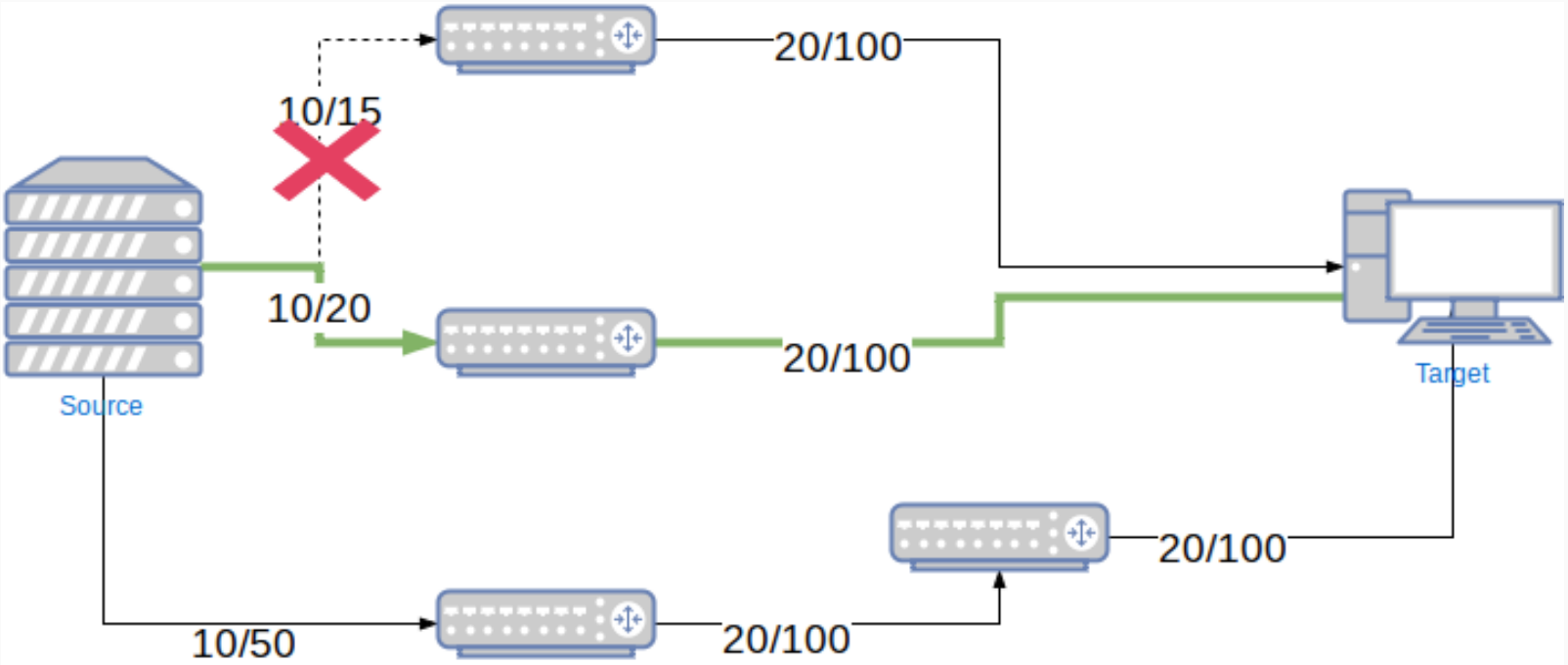

Figure 2: MHA Algorithm

Remove edge that cannot satisfy bandwidth requirement, then choose path with minimum hop

WSP: Widest shortest path

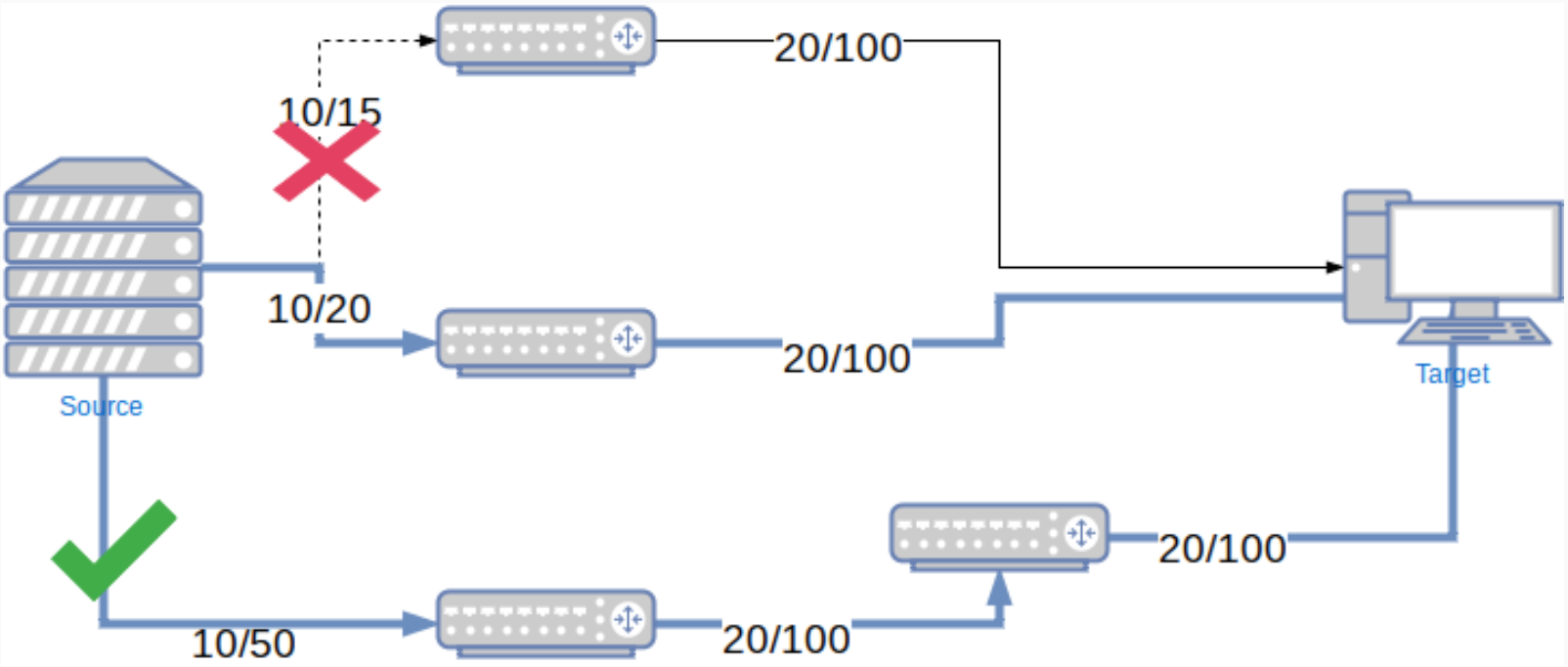

Figure 3: WSP Algorithm

Choose K-shortest paths, then select the one with the highest available bandwidth.

Similar algorithm: SWP(Shortest widest path)

MIRA: Minimum interference Routing Algorithm

Given *multiple* Source-Destination pairs, how to route to satisfy as many pairs as possible?

Unfortunately this is a NP problem. Therefore, heuristics are used:

- *Critical path* whenever their capacity is reduced by 1 bandwidth-unit, the maxflow value of one or more the other SD pairs also reduces by 1 bandwidth-unit.
- Find the least critical feasible path

DORA: Dynamic Online Routing Algorithm

Offline Phase PPV(Path potential values) for each link is calculated for each SD pair.

1. Calculate the shortest disjoint paths(SDP_i) of each SD pair i.
2. For each SD pair(i) and link l, $PPV_{i,l} = \sum_{j \neq i} 1_{l \in SDP_j} - 1_{l \in SDP_i}$

Online Phase BWP(BandWidth Proportion)

$$weight_l = (1 - BWP)PPV + BWP \frac{1}{residual\_bandwidth} \tag{1}$$

Then use Dijkstra algorithm to compute weight-optimized feasible path.

Benchmark: BRR

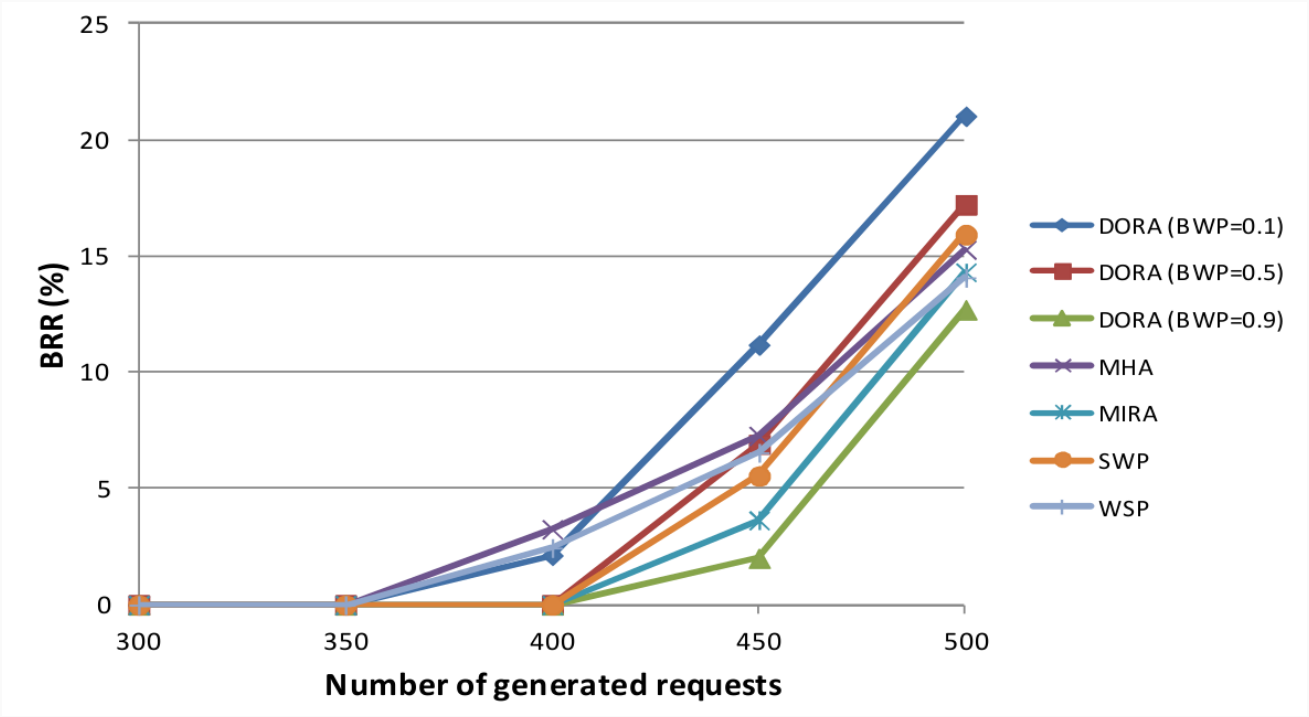

Figure 4: BRR for different bandwidth constrained algorithms, on toy network proposed in MIRA paper

Benchmark: Route length

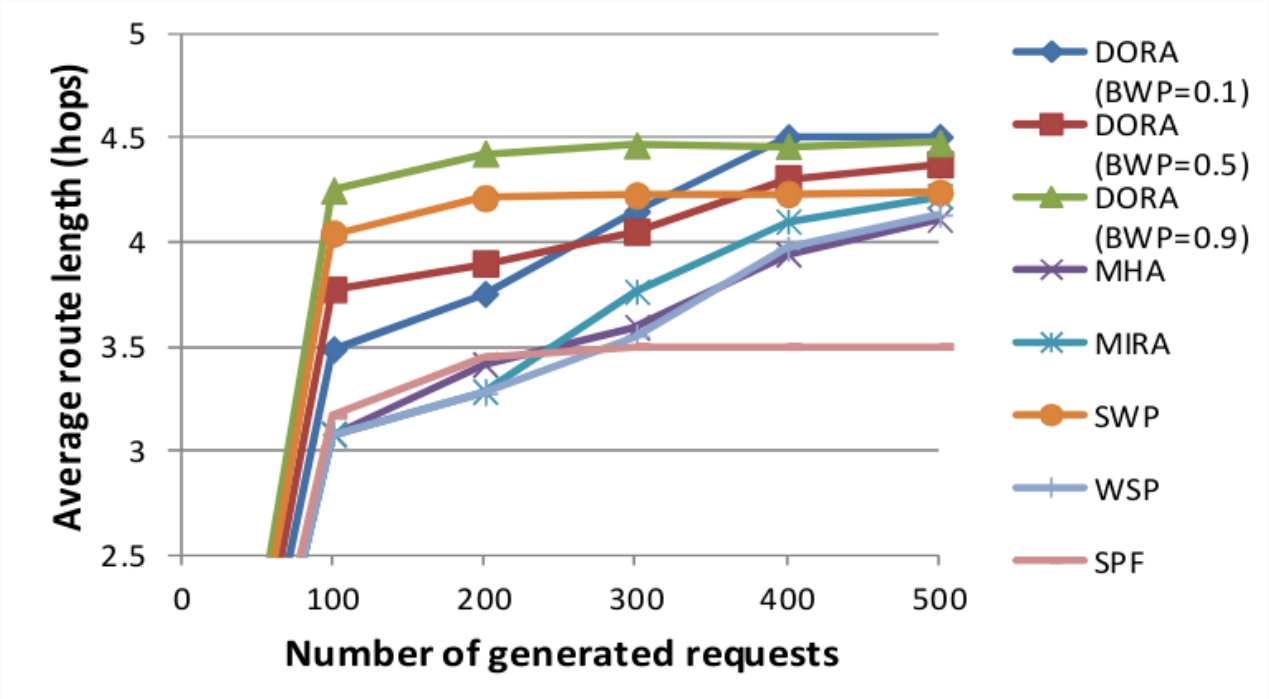

Figure 5: Average route length for different bandwidth-constrained algorithms, on toy network proposed in MIRA paper

Bandwidth-delay constained algorithms

MDA: Minimum Delay Algorithm

Remove all edges unsatisfying bandwidth request, then find path with minimum delay by Dijkstra.

Simple. less efficent.

MDWCRA: Maximum Delay-Weighted Capacity Routing Algorithm

- Calculate the shortest feasible disjoint path of each SD pair(length: delay)
- Find critial links(bottleneck) set of SD: C_{sd}
-

$$w(link) = \sum_{(s,d):link s \in C_{sd}} \alpha_{sd} \tag{2}$$

Different weight functionα:

- $\alpha = 1$: number of SD pairs for which the link is critical
- $\alpha = 1/delay_{s,d}$: critical link on high-delay SD pair should receive more concern

Benchmark: BRR

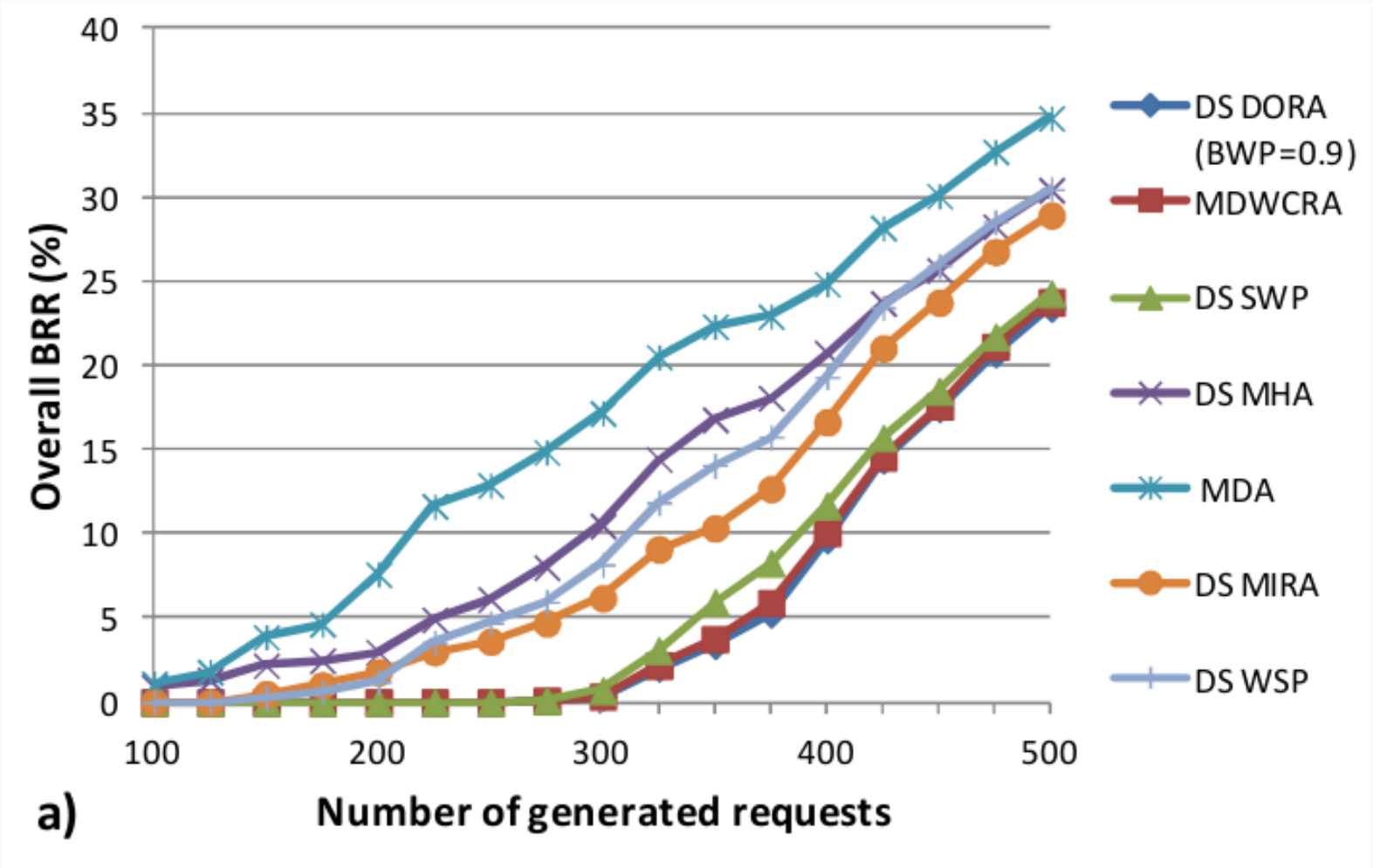

Figure 6: Overall BRR

Stdev of residual bandwidth

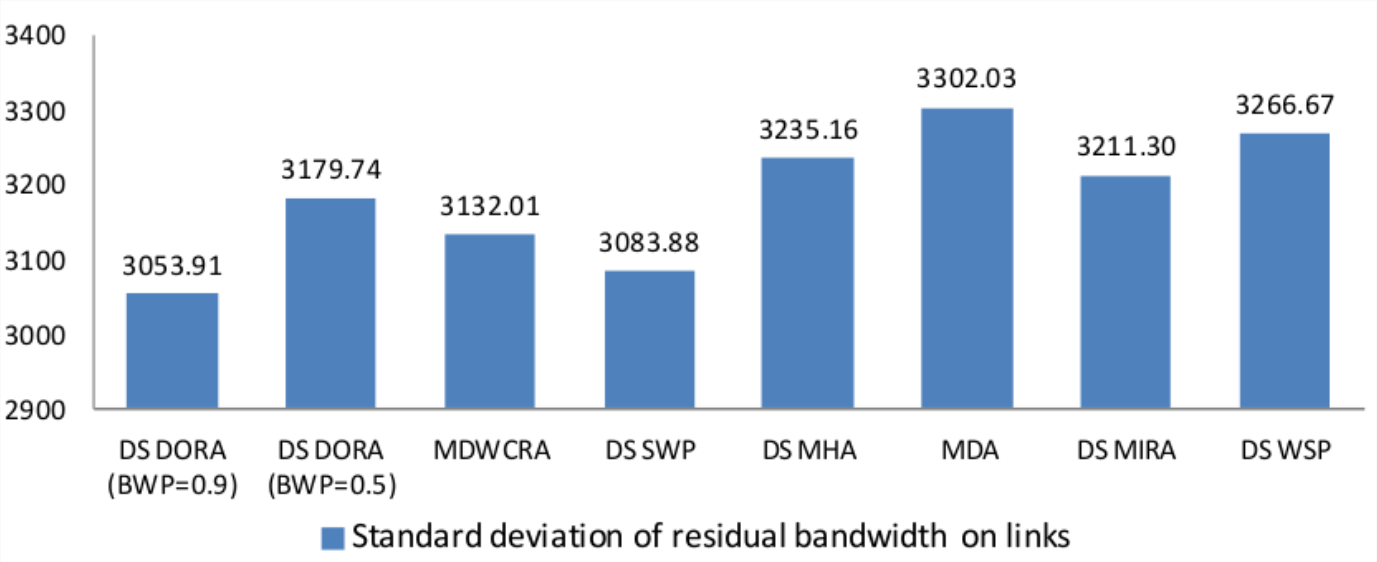

Figure 7: Standard deviation of residual bandwidth on links

Thanks for listening

Performance comparison of QoS routing algorithms applicable to large-scale SDN networks; Slavica Tomovic, Igor Radusinovic, Neeli Prasad; EUROCON 2015 - International Conference on Computer as a Tool (EUROCON), IEEE