Oblivious Reconfigurable Networks

- Directed graph whose edge set changes (reconfigures) over time.
- Reconfiguration is pre-scheduled, oblivious to traffic demand.
- Oblivious routing is used to route arbitrary traffic on a fixed schedule.
- Here we consider 1-regular; in our paper we generalize to d-regular.

A fun challenge:
Construct a red, green, and blue matching for six nodes such that between any two nodes, there is a path that traverses at most two edges from different matchings.
Is it possible to construct such matchings for eight nodes?

Performance Metrics

- Maximum Latency: How long does it take to send one message?
- Throughput Guarantee: How much traffic can the ORN support?
- Can route all demand matrices with row/column sums bound by throughput value $r$ without overloading any edges.
- Latency and throughput are in conflict!

Our Result

For every throughput $r$, what is the lowest latency $L$ achievable by an ORN design that guarantees $r$?

Let $L^*(r, N) = h(N^{1/(h+1)} + (εN)^{1/h})$ where $h = \lfloor 1/2r \rfloor$ and $ε = h + 1 - 1/2r$.

- **Upper bound**: for infinitely many $N$, there exists an ORN design on $N$ nodes that guarantees throughput $r$ and whose maximum latency is $O(L^*(r, N))$.
- **Lower bound**: for every ORN design on $N$ nodes that guarantees throughput $r$, the maximum latency is at least $Ω(L^*(r, N))$.

**Upper Bound**
- We construct two ORN designs depending on the region of the curve.
- Design 1 uses a connection schedule based on an $h$-dimensional hypercube topology with Valiant load balancing (VLB).
- Design 2 uses Vandermonde vectors as well as a more complex routing protocol (still with VLB).

**Virtual Topology**

**Lower Bound**
- Lower bound for uniform traffic is easy to prove using a simple counting argument, but is only half as strong in throughput.
- Traffic-oblivious bound uses LP and duality, while also using the same counting argument.

**Future Work**
- Optimal ORN designs for all large enough $N$ (not just infinitely many)
- Semi-oblivious reconfigurable networks (i.e. non-oblivious routing)
- Practical implementation of optimal ORN designs from upper bound