Achieving the Performance of Global Adaptive Routing Using Local Information on Dragonfly Network

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Introduction

- The Dragonfly network has been deployed in the Cray Cascade architecture and, also, proposed for the next generation supercomputers.
- Universal globally adaptive routing (UGAL) is state of art routing for dragonfly networks.
- Practical adaptive routing schemes such as UGAL-L, UGAL using local queue information, performs noticeably worse than UGAL-G which assumes each router has queue occupancy knowledge of all other routers of network.
- However, implementing UGAL-G in real systems is not practical since the global information cannot be maintained accurately.

- Objective: *Develop a routing scheme that can achieve the performance of UGAL-G using only the local information available to router.*

Research Approach

- The idea is to train a deep neural network with local information maintained by a router and UGAL-G's routing decisions and use the trained model to make the routing decisions.
- This new routing scheme is called **UGAL-ML**.
- UGAL-ML is UGAL-based routing that selects MIN path or VLB path based on local information of router.

Methodology

This research consists of three sub-tasks: (1) collect the counters maintained by router with UGAL-G's routing decision, (2) training a neural network model for each router and (3) using trained models to drive routing function (UGAL-ML) and evaluate the performance.

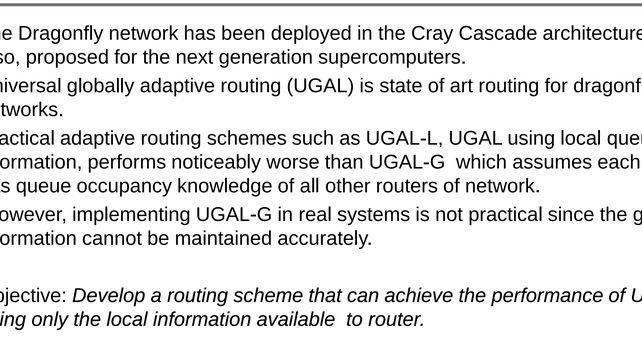
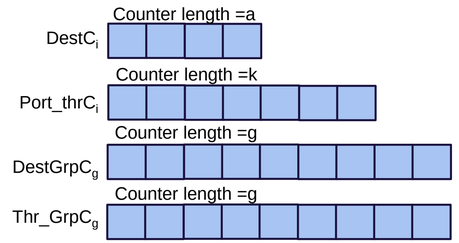


Fig 1: UGAL routing selects min path or non min path to routes the packets.

Data Collection

- Each router maintains local port queue occupancy and link usage statistics counter [2].
- $DestC_i$: Counter that records number of packets sent to router *i* inside same group.
- $Port\_thr_i$: Counter that records number of through packets, packets originated from other routers in the same group, passing through port *i* inside same group.



- $DestGrpC_g$: Counter that records number of packets sent to a different group *g*.
- Thr_GrpC_g: Counter that records number of through packets, packets originated form other routers, sent to a different group *g*.
- Uniform and Adversarial traffic patterns with different injection rates were simulated in Booksim 2.0 [3] using UGAL-G routing simulator to store the local information as well as routing decision for each packet.
- The local information stored include the port occupancy for minimal path, the port occupancy for non minimal path, the hop count for the minimal path, the hop count for the non minimal path and the link usage counters over 50 cycles.

UGAL_ML Routing Implementation

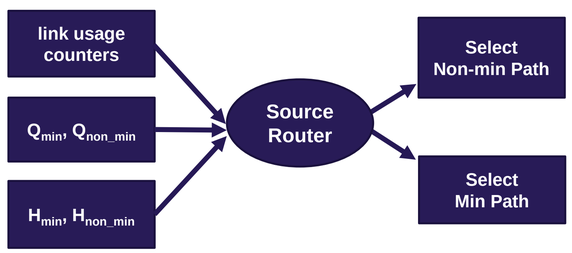


Fig 2: In UGAL-ML routing, source router takes local information and predicts the routing decision.

- Fully connected dense deep neural network (DNN), with 10 hidden layers with 0.2 dropout on each layer and ReLU is used as activation function, is trained with router local information and UGAL-G's routing decision.
- In order to save the spatial information of network, we have trained neural networks for each routers.
- Load DNN models of each router to booksim.
- Source router passes the snapshot of local counters to its corresponding model.
- Model returns routing decision to select min path or non-min path.

Results

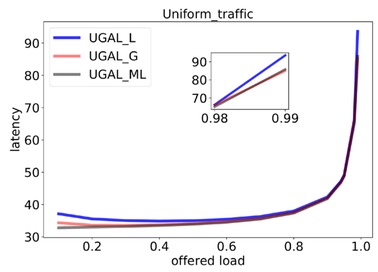


Fig 3: Latency curve of Uniform traffic pattern

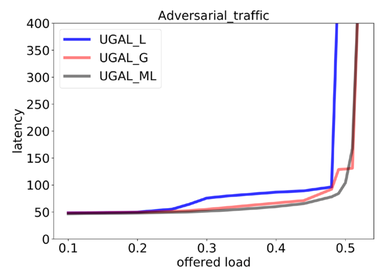


Fig 4: Latency curve of Adversarial traffic pattern

- Figure 3 shows at low load, UGAL-ML and UGAL-G has the similar latency; and both have lower latency than UGAL-L. At high load, all three schemes have similar saturation throughput.
- Figure 4. shows UGAL-ML and UGAL-G have a similar saturation throughput, which is higher than that for UGAL-L.

Conclusions

- This research work can be used as a groundwork for future defining a routing algorithm that uses local router information and do routing as good as routing that have global network traffic information.
- In the future, we plan to further train UGAL-ML to achieve high performance for other traffic patterns and other Dragonfly topologies.

References

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