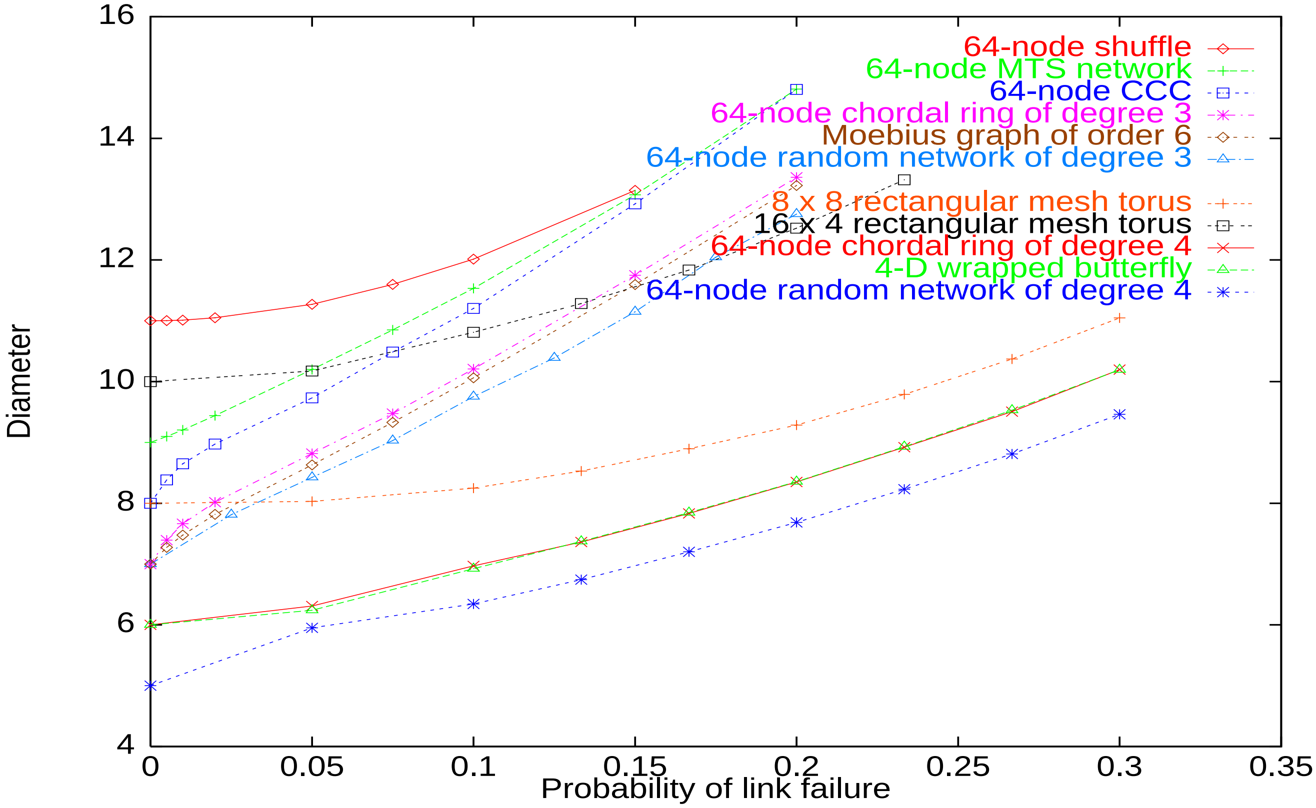
Motivation

- **Random Regular Graphs** exhibit **good fault tolerance** properties.

Diameter Vulnerability



- **They perform better than most static networks with regard to all the network measures.**

Definition of some graphs

Moebius graph of order n (Solomon [1982])

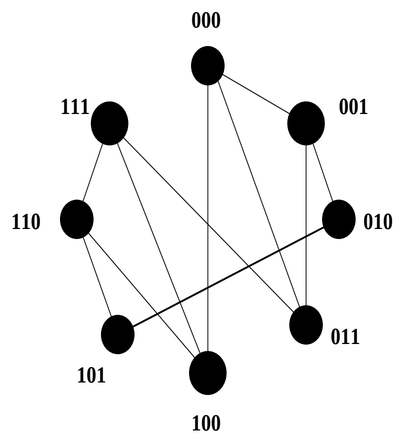
- Graph $G = (V, E)$ with vertex-set $V = 2^n$.
- $(u, v) \in E$ iff $u = f(v)$ or $u = g(v)$
- $f(s_0 s_1 \ldots s_{n-1}) = s_1 \ldots s_{n-1} \overline{s}_0$
  $g(s_0 \ldots s_{n-3} s_{n-2} s_{n-1}) = s_0 \ldots s_{n-3} \overline{s}_{n-2} \overline{s}_{n-1}$

Multi-Tree Structured Graph $MTS_{m:t}$(Arden[1982])

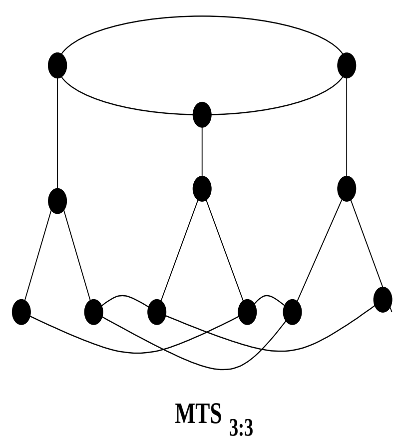
- m identical component tree(CT) of depth (t-1); each non-leaf has (t-2) sons and the root has (t-3) sons.
- The roots of the m CTs are connected to form a ring.
- Each level (t-1) node is connected to (t-1) other nodes and form at least one cycle.

Definition of some graphs

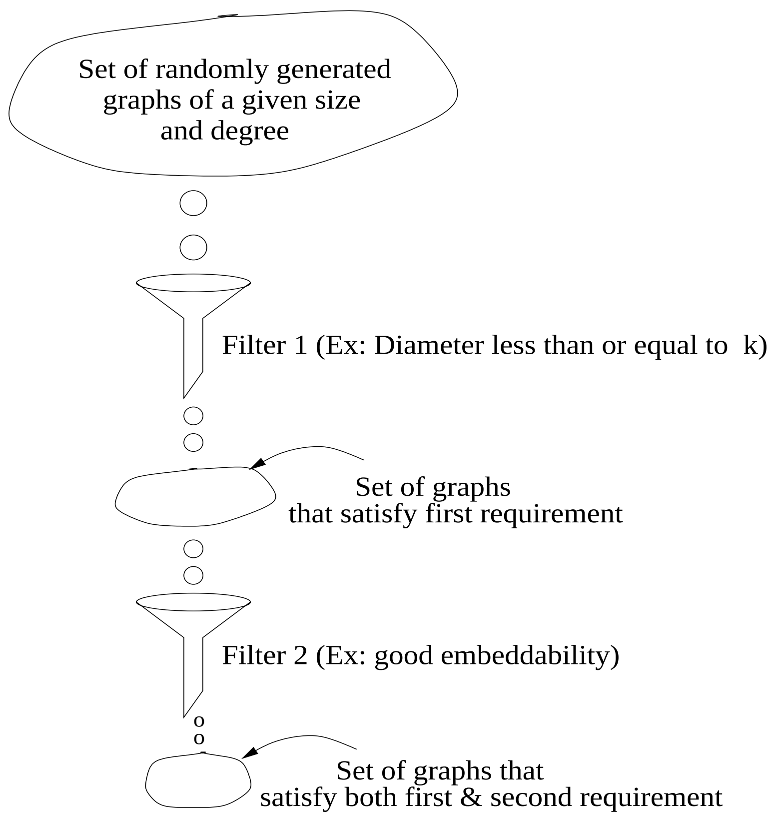
Moebius graph of order 3



Multi-Tree Structured Graph $MTS_{3:3}$



- **Randomized construction provides a simple, yet efficient, method for the synthesis of interconnection networks(ICNs).**
- **The pruning step or *filter* can be changed to select only those ICNs which satisfy a certain set of requirements.**



Embeddability of Random Graphs

<u>Our Goal</u>

To map any "software" communication graph onto any random "hardware" graph with minimum load, dilation and congestion.

- **Previous work mainly focussed on embedding of regular topologies.**
- **Randomized embedding: a promising approach.**
- **Our initial study considered tree embeddings since many distributed computations are tree-structured.**

Embeddability of Random Graphs

A Randomized Algorithm (Li[1997])

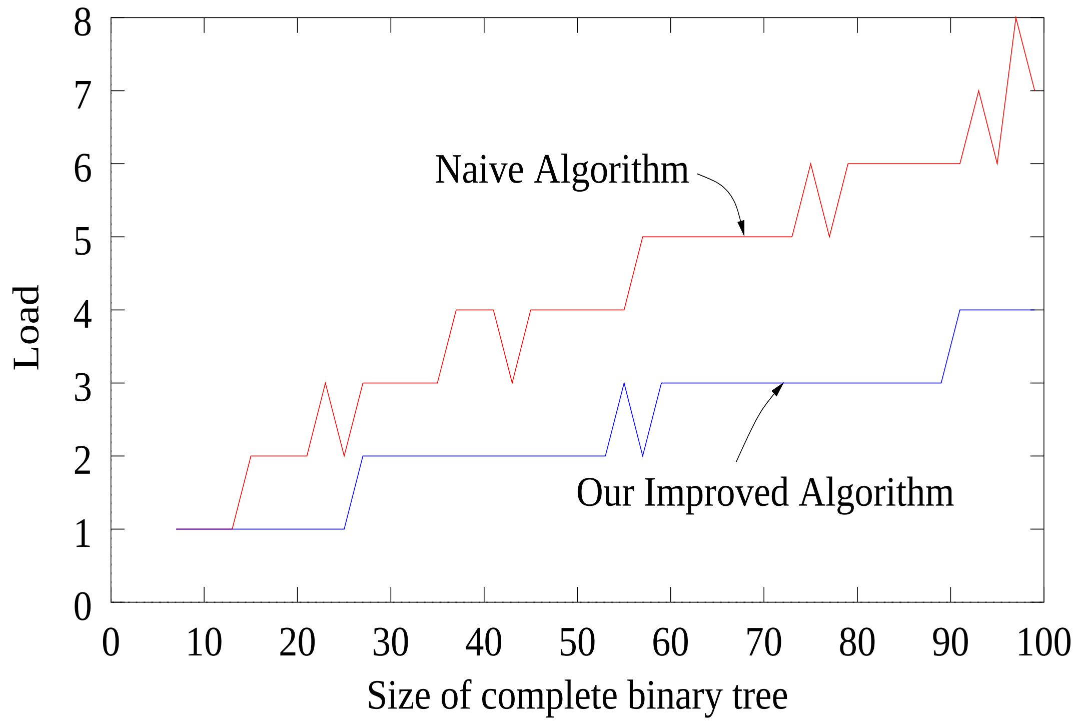
The children of a tree node are randomly and *uniformly* **mapped to the neighbors of the host node to which the tree node is mapped.**

Our Randomized Algorithm

1. **Find least load among neighbors of the host node to which a tree node has been mapped**
2. **Create list of neighbors with this least load**
3. **Randomly map child of tree node to one of the nodes in the list**

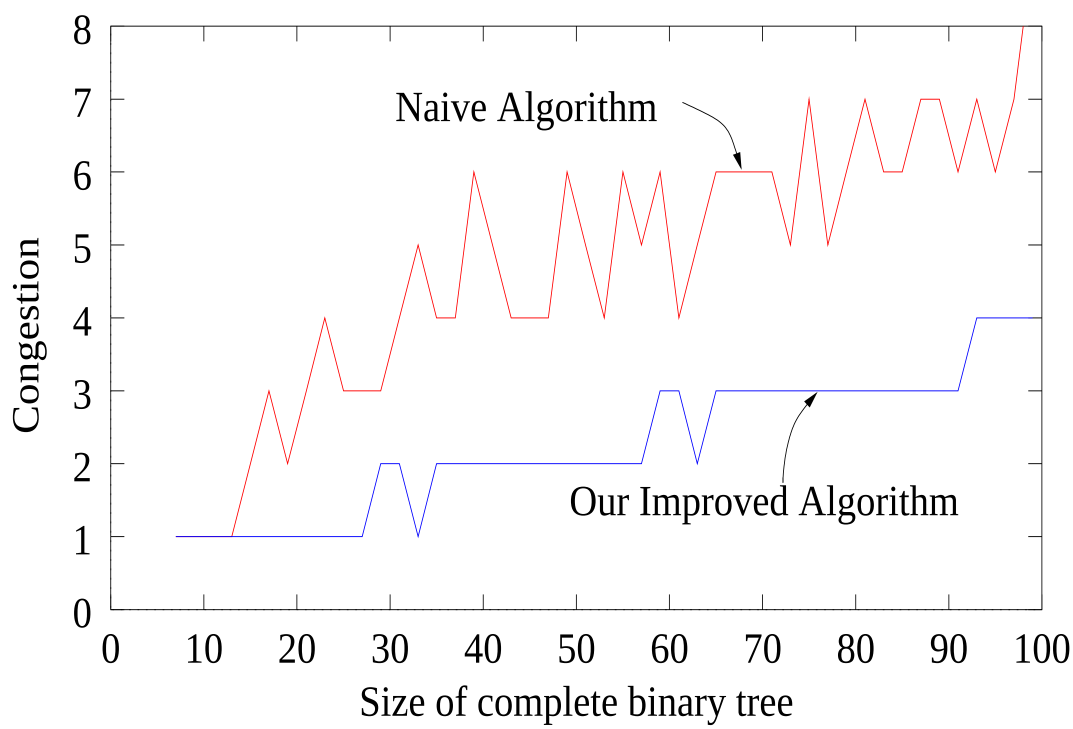
Embeddability of Random Graphs

- **We consider embeddings of trees onto host graph of size 32, degree 3 and minimum diameter found.**
- **Dilation is restricted to 1.**



Results show performance of our algorithm is close to optimal i.e. $\lceil M/N \rceil$
where M **= size of guest graph**
N **= size of host graph.**

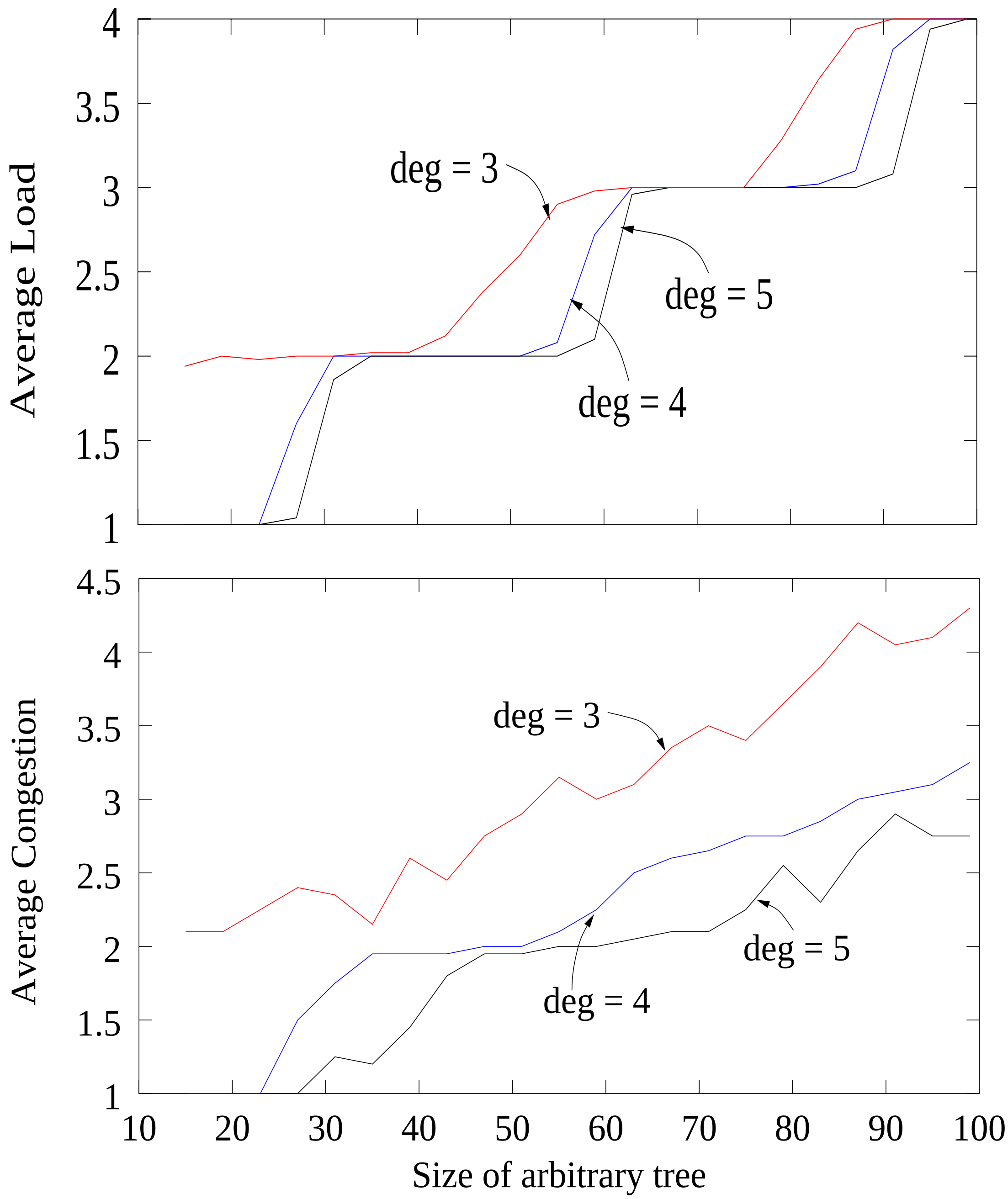
Congestion can also be minimized by considering minimum congested edges in our improved algorithm.



Our improved algorithm performs better with regard to both load as well as congestion.

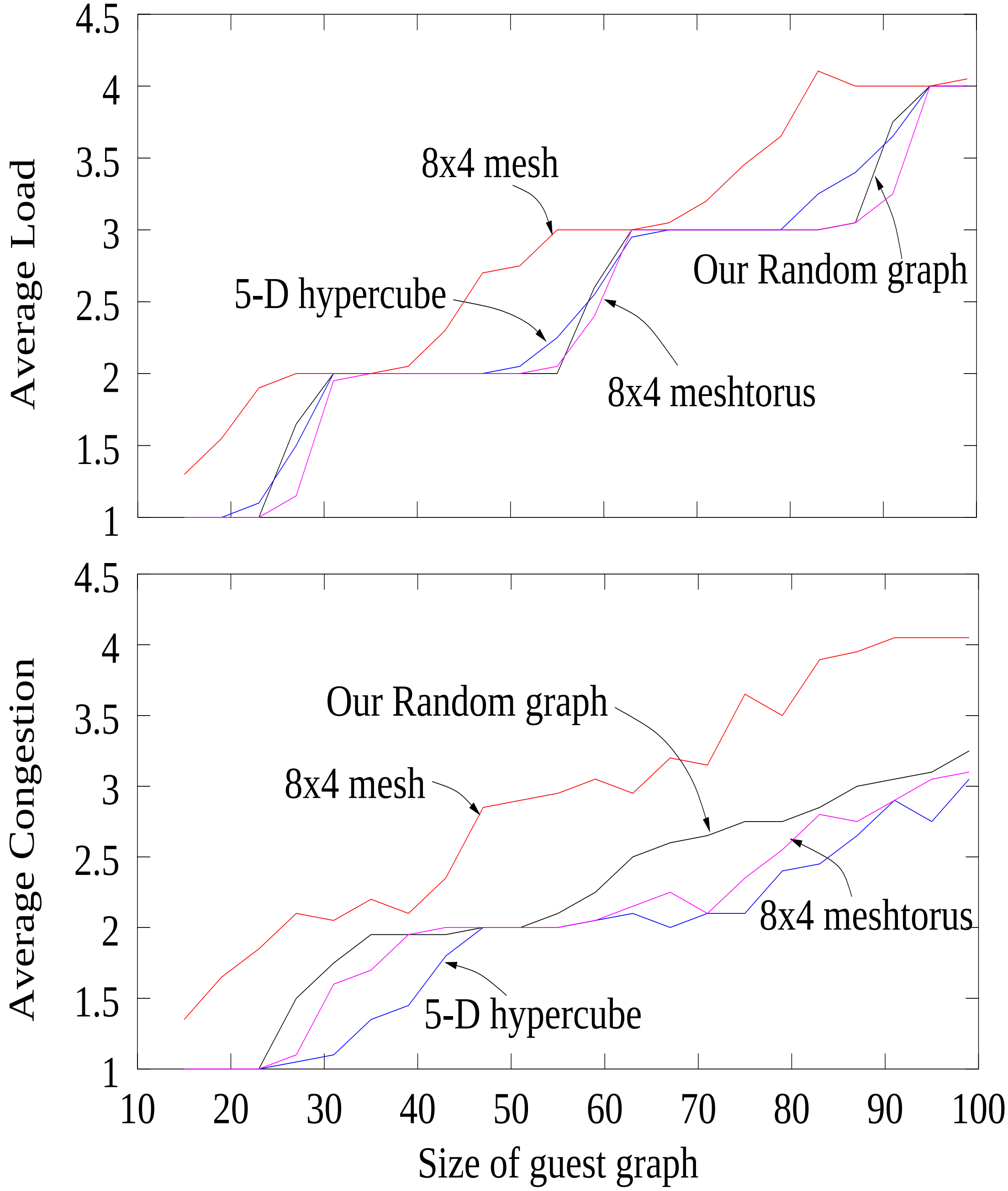
Embedding of arbitrary trees

Embeddings of arbitrary trees of degree 3
on random graphs of size 32 and varying degrees



Embedding on various graph types

Embedding of random trees of degree 3
on various graph types of size 32



Future Work

- The general case of mapping arbitrary graphs onto each other is NP-complete. Heuristic optimization methods will be used to approximate optimal mapping function.
- The algorithm will be extended to accomodate dilations greater than 1.
- A simulation environment to evaluate embeddability will be designed and implemented.
- Performance of random regular graphs with regard to other properties such as scalability and routability, will be examined.