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Performance Evaluation of Delta Networks Operating via Cut-Through Switching under Hotspot Traffic

by

Eleftherios Stergiou, Glavas Evripides and Spiridoula Margariti

Department of Informatics and Telecommunications

University of Ioannina

Conference site: http://infotech-bg.com/

Multistage interconnection networks (MINs)

Multistage interconnection networks (MINs) are used to manufacture the communication frame of **high-performance networking nodes**, for example:

- ✓ **terabit routes** and
- ✓ contemporary **Ethernet Switches**; also,
- ✓ apparatus modules for **connecting processor units with memory** elements in parallel systems.

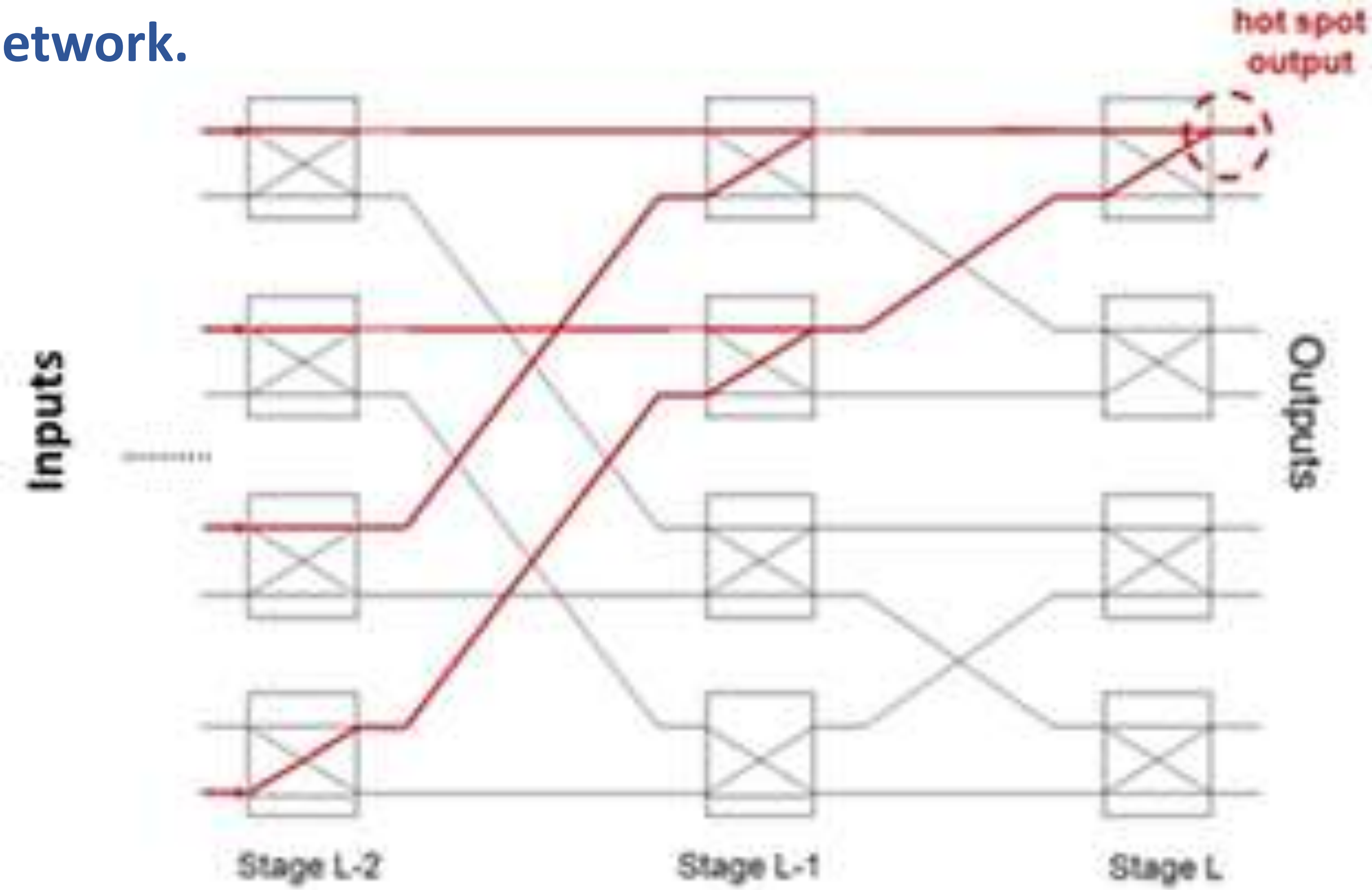
The **MINs**' widespread dissemination is owed to their:

- **Capability** to concurrently pass multiple packets and
- The very small **cost/performance factor**, in contrast to other constructions.

MINs ensures good quality of networking flows.

Delta type interconnection networks

A typical delta network.



Delta type interconnection networks

Delta MINs are a significant sector of banyan-type MINs that are self-routing devices having the main banyan property that there is exactly one unique path from each inlet to each outlet.

All packets obtain the same routing tag to reach a certain network outlet independently of the inlet at which they enter the network.

Rectangle formed delta networks also require square Switch Elements (SEs), which have an equal number of SE **inlets** and **outlets**.

Multi-layer MINs (MLMINs)

Multi-layer MINs (MLMINs) are contemporary constructions that improve the performance features provided by classic MINs.

Semi-layer MINs are a special subordinate class of MLMINs which have ordinary layer developing in the end of the department.

However, the existed studies of **Semi-layer MINs** provide results when they operate with the classic ‘**Store and Forward**’ (SaF) mechanism.

Cut-Through forwarding mechanisms

Beyond the classic and well-known SaF *forwarding mechanism*, other more effective techniques can forward data to its destination.
For example: ***Wormhole*** or ***Cut-Through*** **(C-T)**

Also contemporary studies on ***C-T packet forwarding*** methods have been presented by Levitin and Rykalova [5, 6], but this research is concerned with the specific case study of *torus-type* interconnection networks.

Each *forwarding method* has its own characteristics and, in combination with a specific *topology*, establishes a unique environment that needs specific investigation.

Hotspot serviced traffic pattern

The majority of the studies that exist in the literature regarding MINs' behaviour concern **uniform-type traffic**.

Nevertheless, data packets originating from a variety of modern applications and passing via MINs present **non-uniform traffic** schema.

In the *current study*, the **hotspot-type traffic** was selected as traffic scenario of crucial interest and selected as a traffic case study.

Definition:

Hotspot traffic is considered the data packet pattern where a portion of the traffic is targeted at single outlets, which are named hotspots.

The **hotspot traffic** is an ordinary scenario. A typical example:

When a *server* has been set up in some environment and a *numerous of clients* access it frequently to get data and services.

Semi-layer delta-type MINs with C-T mechanism

Here were selected as a basic test-bed for investigation:

A ***Semi-layer Delta type*** **MINs** using ***Cut-Through forward method*** and handling ***hotspot*** **traffic**.

As the joint effects of the C-T forwarding method and the hotspot traffic pattern on the MINs' performance have not received adequate research attention.

Simulation

For this study:

An appropriate simulator for Semi-layer MINs that was able to handle:

- various MIN’s sizes and
- various load patterns is developed.

✓ This simulator was developed with C++ language and is able of running various MIN schemas.

✓ Any **SE** was simulated by two or more **non-shared buffered queues** modules.

✓ All buffers operate according to the **First-Come First-Served** (**FCFS**) principle.

Via this simulator:

the *throughput* of multilayer **delta type networks** using simulations is assessed.

Simulation

In addition in this simulator:

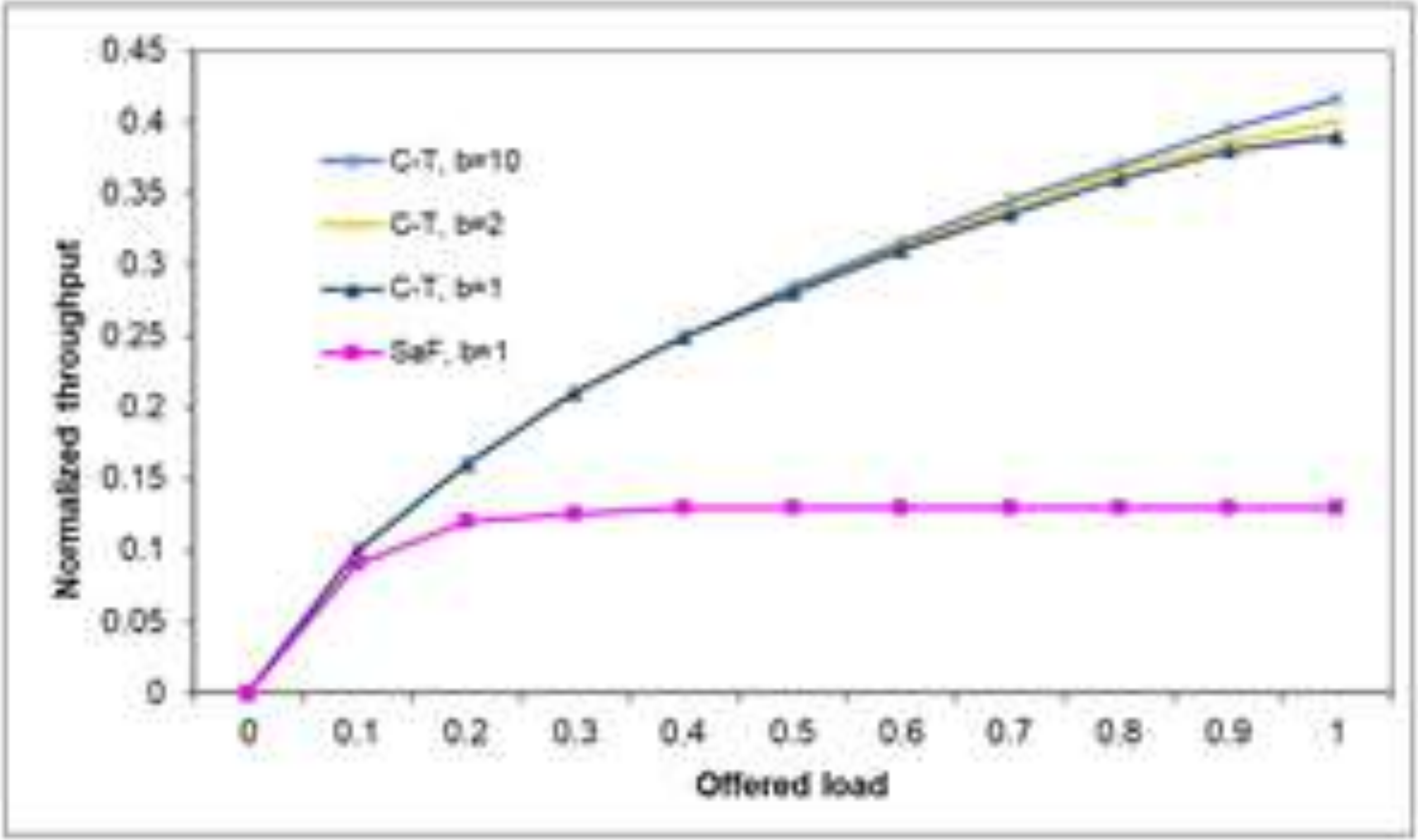
- Any ***buffer*** is simulated via a ***matrix*** with a size equivalent to the *buffer size*.

- While we are in an arbitrary stage, which has parallel queues ready to forward packets into the next stages, those queues are selected – by simulator – to send packets in *a random manner*.

- By this method, asymmetric packet-forwarding phenomena are avoided.

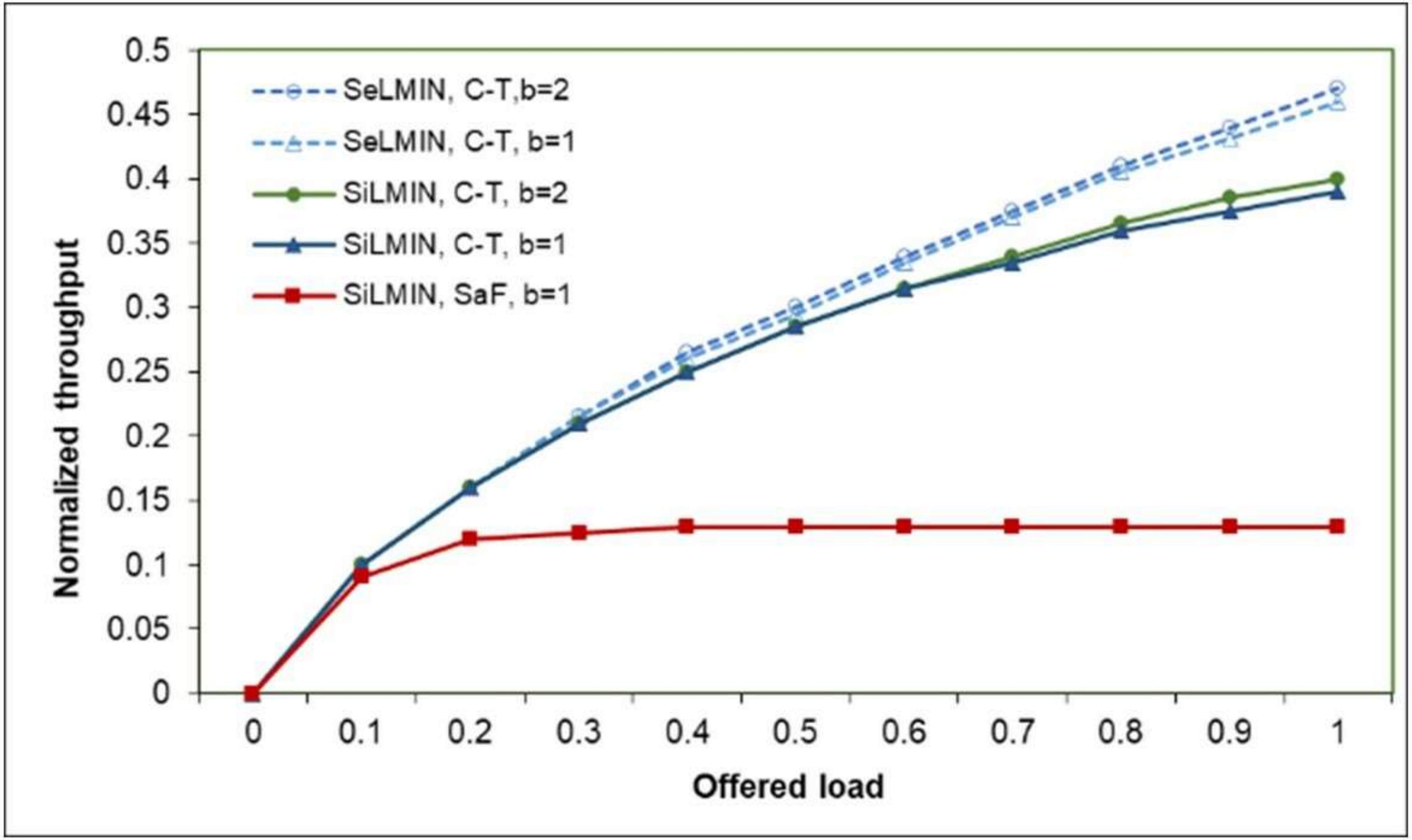
Simulation

RESULTS



Normalized throughput versus offered load with **10% hotspot ratio** of single MINs operating via the **C-T** (or SaF) technique and accommodated with buffer values equal to 1, 2, or 10 respectively.

Throughput



Normalized throughput versus offered load with 10% hotspot ratio of **single-** and **semi-layer MINs** operating via the **C-T** (or **SaF**) technique

Conclusion

In this study, ***single-layer*** and ***semi-layer delta-type*** interconnection networks operating via the **C-T mechanism** and **hotspot traffic** are investigated.

- The results of this study are compared with MINs that have corresponding network properties but operate with the classic **SaF technique**.
- The ***semi-layer delta-type MINs*** appear to be more powerful, than the equivalent corresponding ***delta-type single-layer MINs*** both operating also via the **C-T mechanism** .
- Also, the ***semi-layer delta MINs*** are very productive in comparison to equivalent fabrics in terms of network properties that operate via the **SaF mechanism**.

Thank you for your attention!

Varna September 2020!