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‘Omega Multistage Interconnection Network with High-speed Forwarding Technique Handling a Double-pattern Load’

by

Eleftherios Stergiou, Dimitrios Liarokapis, Spiridoula Margariti and Ilias Bobotsaris

Department of Informatics and Telecommunications

University of Ioannina

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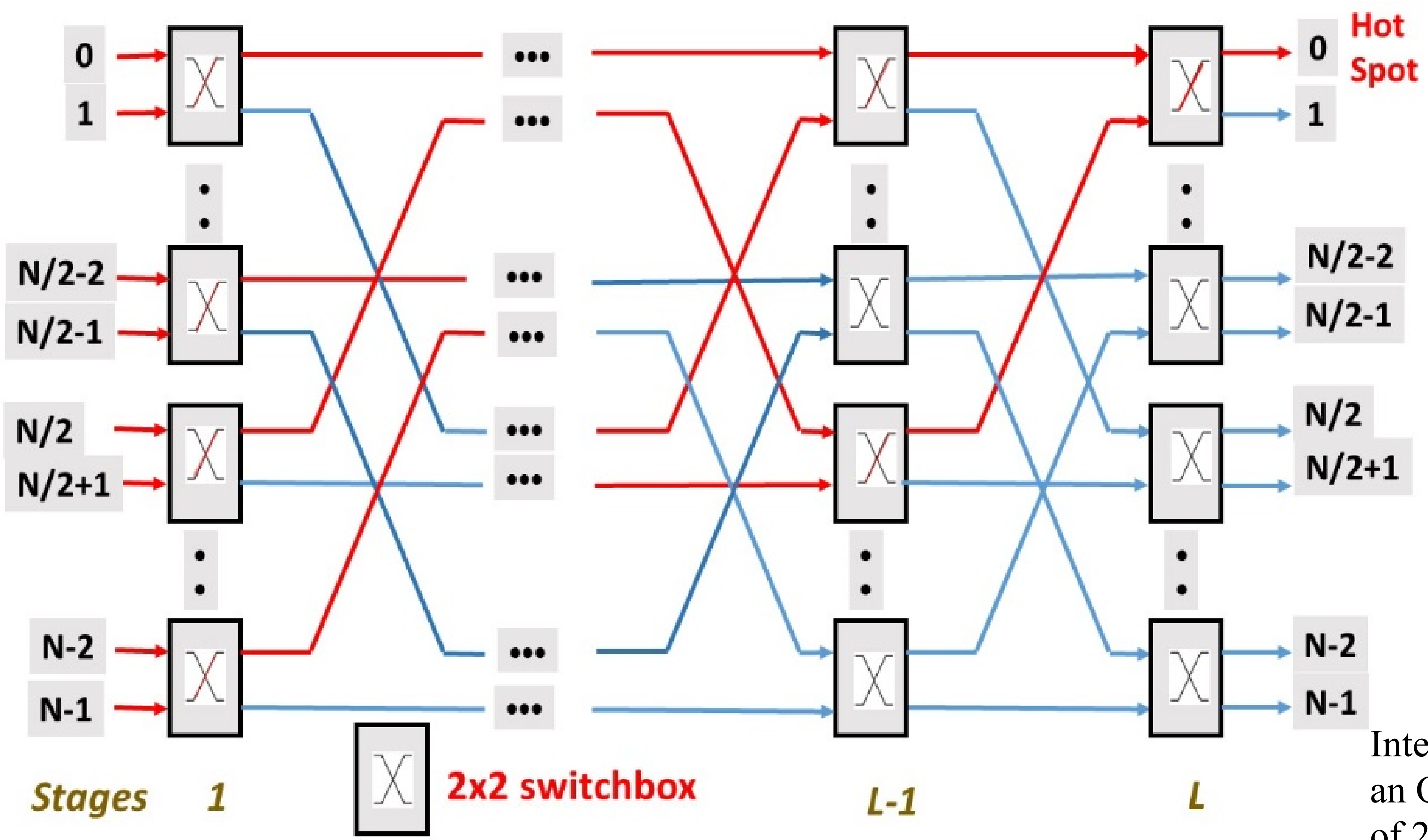
Omega type interconnection networks



Internal structure of an Omega MIN consisting of 2 x 2 switchboxes

Investigate scenarios and Contribution of this paper

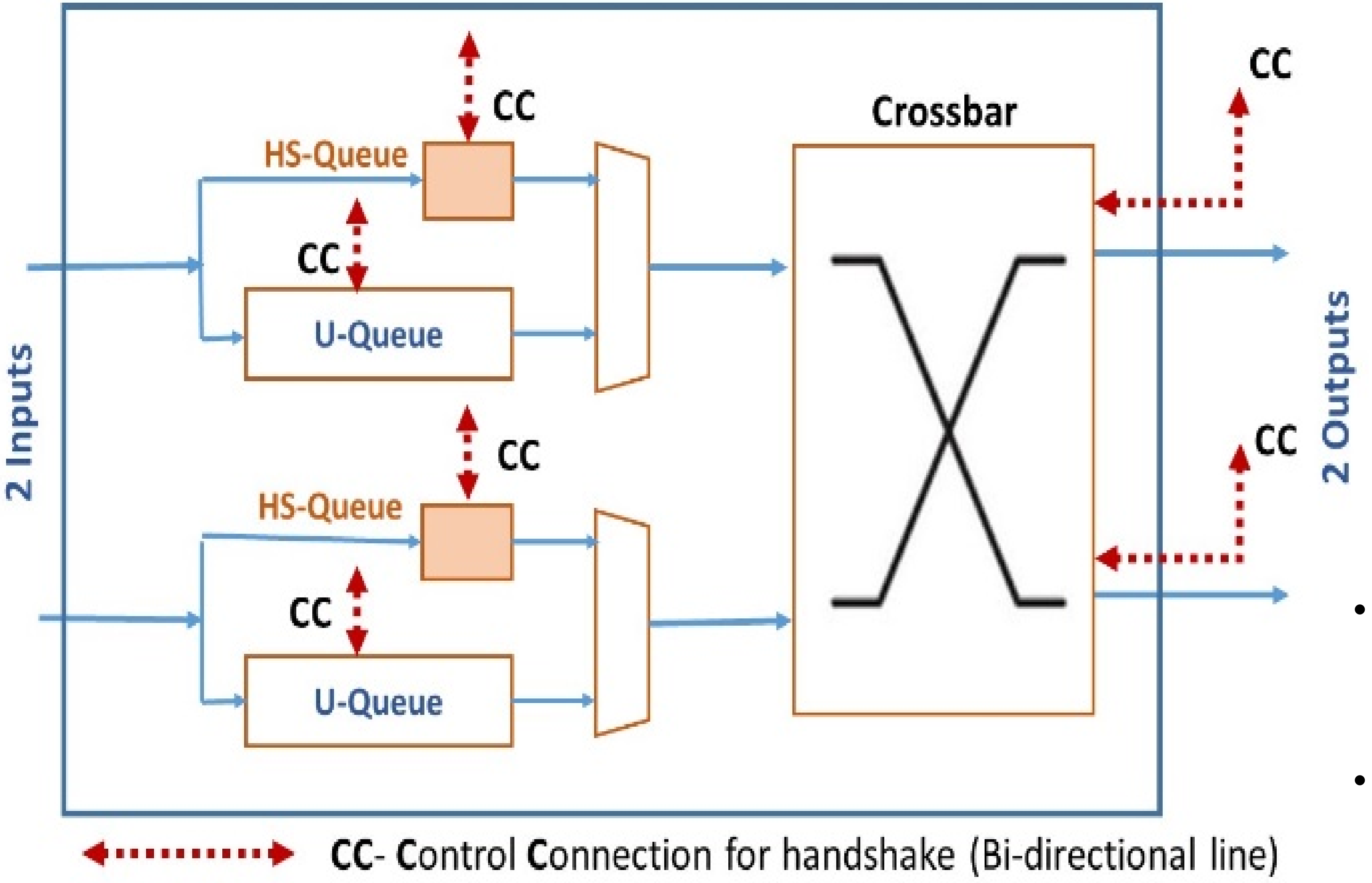
An **Omega-type MIN** is used with a **novel switchbox** operating with a **special regulated forwarding method.** In particular we investigated its behaviour when **two types of traffic patterns** act on it simultaneously.

This work expands on past research on the following issues:

- A novel **2x2 regulated switchbox** is introduced which uses two special buffers (one for **uniform traffic** and the other for **hotspot traffic**) and operates via ***wormhole routing*** enhanced with a ***special software-forwarding method***.
- The forwarding method that is used by this switchbox is controlled by the MIN's CPU and regulated by a **regulator variable**.
- The proposed device can handle and properly regulate two different types of loads (**uniform** and **periodic hotspot**) simultaneously, and the device can quickly mitigate the '*tree saturation*' effects that may occur inside this device.

Using the **regulator**, the MIN can manage many traffic scenarios, giving flexibility to the fabric's administrator.

A 2 x 2 regulated switchbox (RSB) forwarding two classes of traffic



- **U-Queue** buffer for **uniform-type flit** storage, and
- **HS-Queue** buffer is a latch for **hot-type flits** storage

Wormhole forwarding mechanisms

In the Omega MIN being studied here, the ***wormhole*** method is used as the basic routing technique.

Wormhole routing is a forwarding method in which a packet is fragmented at the inputs into many small digit units of data (flits), which are then sent over an internal path in a snake manner.

- The use of the wormhole routing mechanism by MINs has the benefit of not requiring buffers to store whole packets.
- The **routing tag** is included in the header flit, which flows to the proper network pathway.
- The wormhole routing technique works perfectly for *uniform traffic*.

Enhanced Wormhole mechanism with special software-regulator

So, the **wormhole** routing mechanism is enhanced with a **special software-regulator** to overcome the problem of resource blockage due to asymmetric overload.

If the next two buffers (***U-Queue*** and ***HS-Queue***) have free space, then a special **regulator-counter (*R*)** is used in the forwarding process.

If this **regulator-counter $R \geq 0$**, then flits are sent to the **U-Queue** and regulator is decreased by 1

If this **regulator-counter $R = 0$**, then flits are sent to the **HS-Queue**, and regulator is initialised with a value equal to ***R***.

This ***counter R***, is the ***regulator*** of the system, and its initial value is determined by the device administrator via the MIN's controller.

Simulation

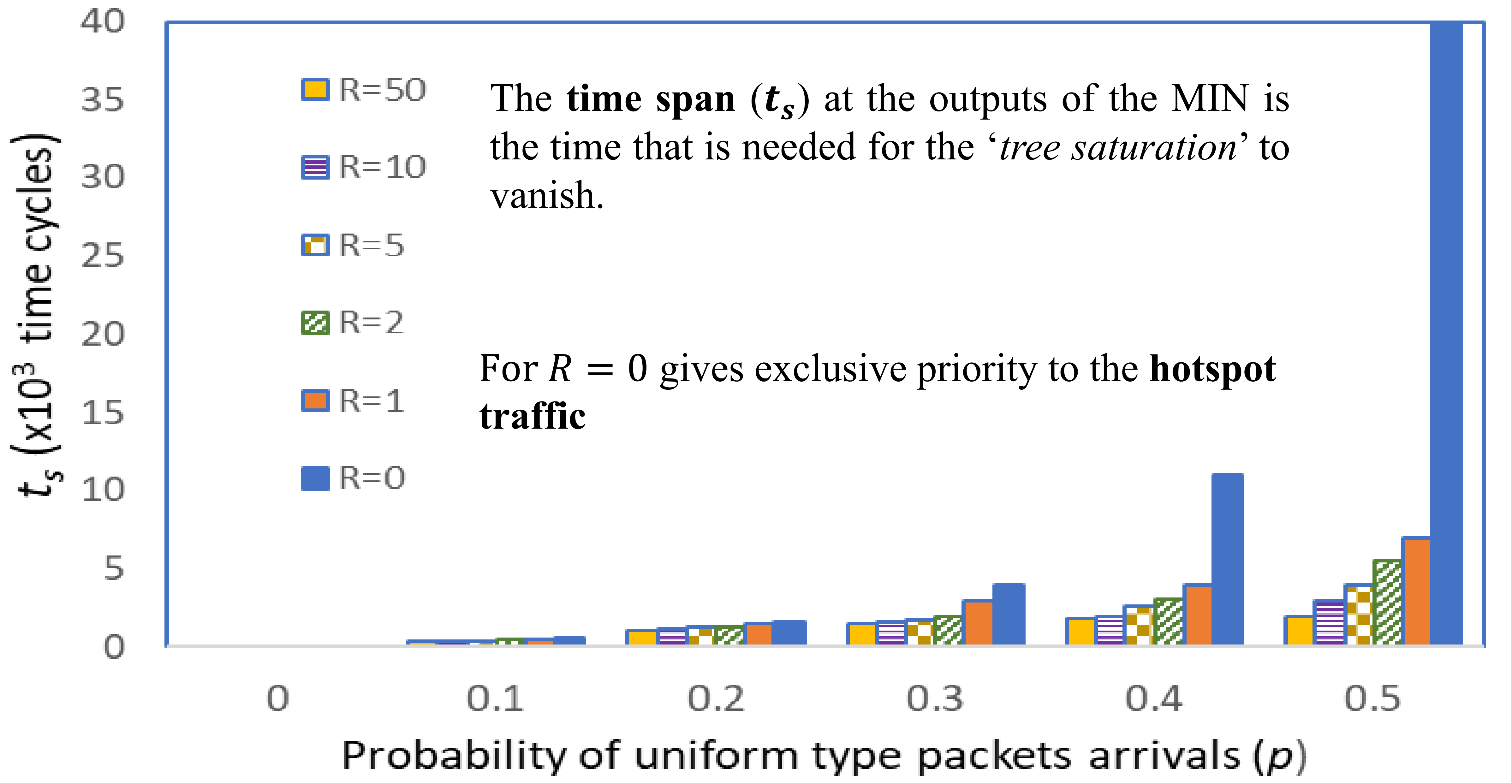
For this investigation

- ✓ We developed an appropriate simulator for Omega MINs that was able to handle:
  - various MIN’s sizes and
  - various load’s sizes of two class patterns of traffic (*uniform* and *periodic hot spot*)
- ✓ The 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.
- ✓ Any ***buffer*** is simulated via a ***matrix*** with a size equivalent to the *buffer size*

1st series of experiments:

- The Omega MIN (i.e. 1024x1024) is constructed with **SRBs**, which have:
  - **U-Queue** buffer with space equal to 200 flits, and
  - **HS-Queue** buffer with space equal to 5 flits.
- The packets that arrived at the inputs had a size equal to 20 flits.
- The probability of **uniform-type packets** varies from **0** to **0.5**
- The **hotspot traffic** surges for $\mathbf{4 \times 10^3}$ **consecutive time-cycles** with a probability of **0.1**.
- In the first series of experiments, the **Regulator** ($\boldsymbol{R}$) was set to specific values: $(\boldsymbol{R} = \mathbf{0, 1, 2, 5, 10, 50})$.

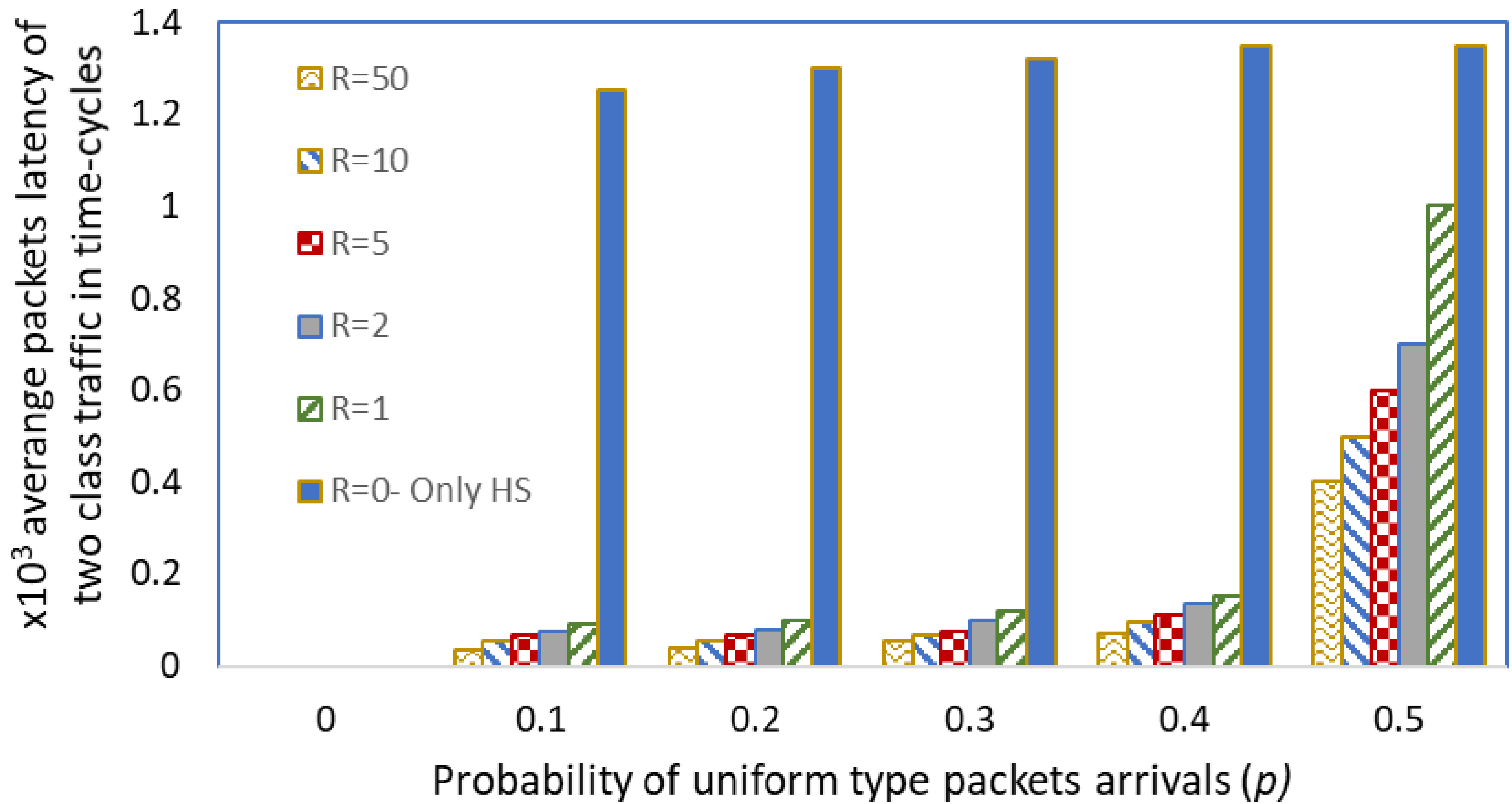
Average time span of uniform traffic delay increment (t_s) versus the probability of the uniform-type load in a 1024 x 1024 Omega MIN for various values of the Regulator R



The **time span** (t_s) at the outputs of the MIN is the time that is needed for the '*tree saturation*' to vanish.

For $R = 0$ gives exclusive priority to the **hotspot traffic**

Average latency of packets of two traffic patterns (in time-cycles) versus the uniform-type load in a 1024 x 1024 Omega MIN for various values of the regulator R



Conclusion

In this study, a ***regulated switchbox*** (***SRB***) is introduced to achieve better service for two types of load patterns (*uniform* and *periodic hotspot* traffic).

- This *switchbox* is used in Omega-type MINs.
- The forwarding technique applied inside the MIN is the **wormhole** method, accompanied by a special **forwarding schema** regulated by a **global regulator variable (*R*)**.
- This **regulator** is a regulatory mechanism for the overall operation of the system.
- By properly adjusting the **regulator** (***R***), tree saturation and network overloads can be completely inhibited, and a decreased hotspot phase at the outputs can also be achieved.