

*Department of Computing Science  
Illinois Institute of Technology*

## **Simulation Software - Capability Comparison**

**Marko Zivkovic and Shangping Ren**

Department of Computing Science  
Illinois Institute of Technology  
10 W. 31st Street, Chicago, IL 60616

Telephone (312) 567-3993  
Email {mzivkovi, ren}@hawk.iit.edu

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# Abstract

This document presents the functional differences between NIRGRAM and HORNET simulation programs. Since these programs have both common and unique characteristics, the specification for each software is presented separately. In addition, the comparison table is provided to illustrate the difference in qualities. It is important to say that the presented information about NIRGRAM and HORNET is obtained from developers User Manual and available research papers.

## 1 NIRGRAM

NIRGRAM is a cycle accurate simulator designed for testing NoC(Network on Chip) System Requirements:

1. Linux OS
2. SystemC C++ (System Driven Simulation)
3. G++ compiler

## 2 NIRGRAM Configuration Tools

In order to create simulation, NIRGRAM requires the configuration of:

1. Topology: Topology is a design of NoC. NIRGRAM offers:
  - 2-dimensional mesh
  - 2-dimensional torusEach of these architectures is size configurable(rows  $x$  columns).
2. Switching Technique: Switching Mechanism is used to divide packet into Flits. This option is important for the communication between the cores.
3. Virtual Channels: Virtual Channels (VC) configuration presents the number of virtual channels per physical channel. Flits(smaller part of the package) goes to VC. This mechanism is called wormhole mechanism.
4. Buffer Parameters: Buffer represents a memory for the Flits and it is structured as FIFO (first in, first out)
5. Clock Frequency: Clock Frequency may be specified. Default speed is 1 GHZ.
6. Routing Mechanisms: The supported Routing Algorithms are:
  - Source Routing (used for mesh and torus)
  - XY (used by mesh)
  - Odd-Even(OE) (used by mesh)
7. Application: The available applications are:
  - CBR (Constant Bit Rate)
  - Packet Size
  - Load Percentage (channel bandwidth)
  - Destination (randomly of specified)
  - Inter Flit Interval (Flit per cycle)
  - Bursty (Flit/Channel traffic) measures events/time period

## 8. Performance Metrics

- average latency per packet for each channel
- average latency per Flit for each channel
- average throughput for each channel

NIRGAM can generate the script which is readable by Matlab. The result will be a performance graph. NOTE: NIRGAM offers ability to extend configuration tools. The additional application can be loaded into NIRGAM.

## 2.1 HORNET

HORNET is a newly created software and one of the most sophisticated simulation programs. It is developed by MIT. Since it is a new program, there are not many available documents about it. The information provided in this paper is based on MIT documentation and analysis.

The main qualities of HORNET is support up to 1024 cores, highly configurable tools and cycle precision.

System Requirements:

- Linux OS
- C++ compiler
- Boost C++ library
- Python 2.5
- Automake/Autoconf/Libtool
- Binutils and GCC for cross-compiling to MIPS

## 2.2 HORNET Configuration Tools

HORNET offers configuration of:

- Topology: supports all currently know topologies. Some of them are Ring, 2 and 3 dimensional Mesh/Torus. Moreover, HORNET offers ability to design and test new NoC topologies.
- Virtual Channels:
- Memory Hierarchy : supports arbitrary number of private or shared cache levels and memory coherence is ensured.
- Bandwidth Configuration: gives the way to control the transfer rate between the cores for more realistic simulations.
- Power and Thermal Configuration: uses ORION and HOTSPOT built-in applications to simulate accurate energy and thermal modeling. The results include not only average and peak thermal and energy statistics for entire chip, but also per tile and time period.
- Routing Algorithms Selection: support 1) Oblivious Routing 2) Static Routing and 3) Adaptive Routing. The wide range of routing schemas such as DOR, VALLIANT, ROMM and BSOR are supported and the data is generated as a table.
- Application deployment: supports 32 and 64 bits application deployment.

## 2.3 Direct Comparison

The Tables below shows the comparison between NIRGAM and HORNET through the most required and important options.

Topology	NIRGAM	HORNET
2-DIM	✓	✓
3-DIM		✓
MESH	✓	✓
TORUS	✓	✓
RING		✓
CUSTOM		✓

Table 1: Topology Comparison

Routing Algorithms	NIRGAM	HORNET
XY	✓	✓
ODD-EVEN (O-E)	✓	✓
DOR		✓
VALLIANT		✓
ROMM		✓
BSOR		✓

Table 2: Routing Algorithms Comparison

	NIRGAM	HORNET
Memory Hierarchy	n/a	✓
Virtual Channels Configuration	✓	✓
Bandwidth Configuration	✓	✓
App. Deployment (Built-in)		✓
Thermal Modelling	n/a	✓
Energy modelling	✓	✓

Table 3: Functionality Comparison

Monitoring	NIRGAM	HORNET
Real-Time	✓	✓
Latency/Avg/Peak	✓	✓
Per Chip/Per Core	n/a	✓
Catching Exceptions	Average	High
Generating Script	MathLab	Command Line
Energy Usage	✓	✓
Thermal	n/a	✓

Table 4: Monitoring trace Comparison

Performance/System	NIRGAM	HORNET
INSTALLATION/SET UP	AVERAGE	HIGH COMPLEXITY
EXPANDABILITY	✓	✓
Perf. Speed	FAST	SLOW
Accuracy per cycle	Average	High
Core Limitation	up to 64	up to 1024

Table 5: Performance trace Comparison

### 3 Conclusion

The crucial difference between NIRGAM and HORNET is their configuration abilities where HORNET absolutely is superior. On the other hand, NIRGAM is easy to use and provides very nice way to present performance results. It is important to realize that capabilities of HORNET are much more extended and

applicable to more complex and core-numbered hardware environment. Even though the programs are not tested in reality, it is evident that HORNET is much more functional from the competitor.