SNIPER ASSIGNMENT

Priyanshu Raj 2021UCP1148 A-2 batch

Experiment Details and Topology Comparison

In this experiment, i focused on comparing the performance of the Torus topology using two different core configurations: 8 cores and 16 cores. The comparison was carried out using several performance metrics, including throughput, hop count, and power consumption. This analysis aimed to evaluate how the Torus topology scales with increasing core counts and different frequencies, providing insights into its efficiency and suitability for various high-performance computing applications.

Topology and Routing Algorithm

Torus Topology:

- **Routing Algorithm**: The Torus topology employs a routing algorithm similar to dimension-order routing (DOR) used in mesh networks. However, it includes wrap-around connections, which reduce the maximum hop count by providing additional routing paths that connect the edges of the network.
- **Characteristics**: This topology improves connectivity and lowers average hop counts compared to a traditional 2D-Mesh topology. The wrap-around connections facilitate more efficient communication, especially in larger networks, thereby potentially enhancing throughput and reducing latency.

Test Cases and Programs

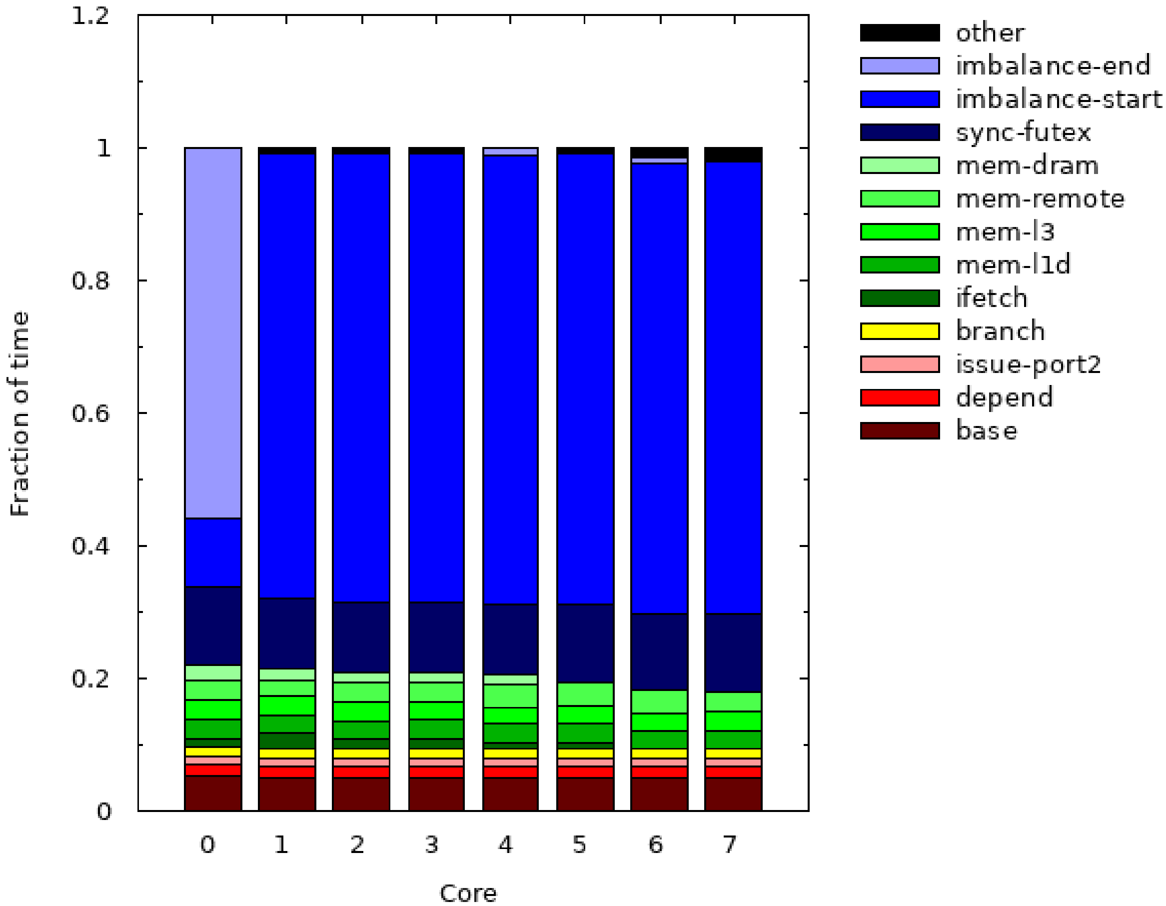
The performance evaluation of the Torus topology was conducted using a set of benchmark programs designed to stress different aspects of the network, such as data transfer efficiency and computational intensity. The benchmarks used include:

1. **Fast Fourier Transform (FFT)**:
    - **Description**: FFT is a computational algorithm to compute the Discrete Fourier Transform (DFT) and its inverse. It involves a significant amount of data exchange between cores, making it an ideal benchmark for assessing network throughput and latency.
2. **Matrix Multiplication**:
    - **Description**: This benchmark involves the multiplication of large matrices, which requires extensive communication between cores to exchange partial results. It is suitable for evaluating the impact of hop count on overall performance.
3. **N-Body Problem**:
    - **Description**: The N-Body problem simulates the dynamic interaction of particles under physical forces, requiring complex and frequent data exchanges. It tests the network's ability to handle high communication loads efficiently.

Table 1. Values for possible test combinations used in the experiments by the simulator

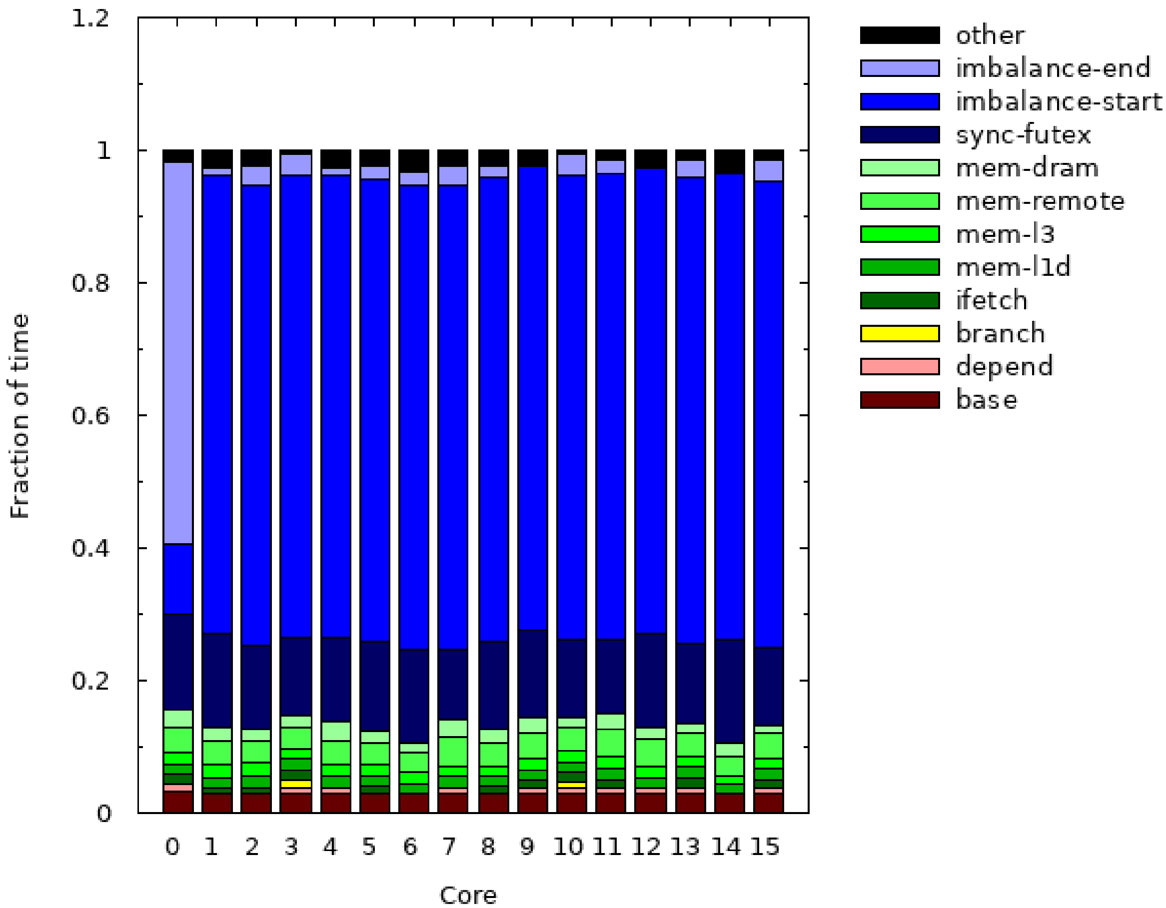
S. No.	Name	Specifications
1	Topology	Torus
2	Frequency	2.66 GHz,
3	No. of Cores	8,16
4	Cache Memory	icache=32Kb, associativity=4
		dcache=32Kb, associativity=4
		L2 cache=512 Kb, associativity=8
5	Global Freq	1 GHz
6	Benchmarks	FFT

8 cores:



other
imbalance-end
imbalance-start
sync-futex
mem-dram
mem-remote
mem-l3
mem-l1d
ifetch
branch
issue-port2
depend
base
1.2
1
0.8
0.6
0.4
0.2
0
Fraction of time
0
1
2
3
4
5
6
7
Core

16 cores :



1.2
1
0.8
0.6
0.4
0.2
0
Fraction of time
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Core
other
imbalance-end
imbalance-start
sync-futex
mem-dram
mem-remote
mem-l3
mem-l1d
ifetch
branch
depend
base

Analysis of Torus Topology Throughput

Below table provides throughput data for different topologies, including the Torus topology, across various frequencies and core counts. Let's focus specifically on the Torus topology to analyze its throughput performance:

Processing Cores	Topology	Throughput (# of Packets/ms)			
		f=2.66 GHz	f=3 GHz	f=4 GHz	f=5 GHz
8-Cores					
	Torus	45	50	82	103
16-Cores	Torus	31	34	55	59

Key Observations

1. **8-Core Configuration:**
    - At 2.66 GHz, the throughput is 45 packets/ms.
    - Increasing the frequency to 3.00 GHz results in a throughput of 50 packets/ms, indicating a modest increase.
    - A significant boost in throughput is observed at 4.00 GHz, reaching 82 packets/ms.
    - At 5.00 GHz, the throughput peaks at 103 packets/ms.
2. **16-Core Configuration:**
    - At 2.66 GHz, the throughput is 31 packets/ms, which is lower than the 8-core configuration at the same frequency.
    - At 3.00 GHz, the throughput improves slightly to 34 packets/ms.
    - A more substantial increase is seen at 4.00 GHz, with throughput reaching 55 packets/ms.
    - At 5.00 GHz, the throughput further increases to 59 packets/ms.

Analysis

- **Frequency Impact:**

    - For both 8-core and 16-core configurations, increasing the frequency leads to higher throughput. This indicates that the Torus topology benefits from higher processing power, as expected.
    - The rate of throughput increase is more pronounced at higher frequencies (4.00 GHz and 5.00 GHz), suggesting that the Torus topology can effectively utilize the additional processing power available at higher frequencies.
- **Core Count Impact:**
    - The 8-core configuration generally shows higher throughput compared to the 16-core configuration at the same frequency levels. This could be due to increased communication overhead or contention among cores in the 16-core configuration.
    - Despite this, the 16-core configuration still shows improvement in throughput with increasing frequency, although the gains are not as pronounced as in the 8-core setup.

Conclusion

The Torus topology exhibits a clear dependency on both core count and frequency. While it scales well with increased frequency, the absolute throughput values for the 16-core configuration are lower than those for the 8-core configuration at corresponding frequencies. This suggests that while the Torus topology can handle higher processing power effectively, its performance gains are somewhat limited by the increased complexity and communication overhead associated with higher core counts. However, the overall trend indicates that higher frequencies significantly enhance throughput, making the Torus topology a viable option for scenarios where frequency scaling is feasible.