The torus network topology, which uses multidimensional network links to improve path diversity, is a potential candidate for exascale interconnects. In this Paper, They used torus network topology massively on ROSS(PDES) and simulate a massive exascale architecture.
The takeaway of the paper is that massively parallel simulation is a key enabler for effective extreme-scale network co-design.
Searching has happened for a better network topology that yields high performance.
Then Torus topology comes into picture as it has good local communication patterns and the path diversity means it has the minimal paths from source to destination.
One disadvantage of torus networks is that they have a high hop count when communication involves far ends of the network.

Torus Network:
A torus is a k-ary n-cube network with N = k^n nodes arranged in an N-dimensional grid with k nodes in each dimension.
Since each torus node is connected to its neighbour via a dedicated link, torus networks can yield high throughput for nearest-neighbor communication patterns.

Torus-Network Simulation:

To align the ROSS torus network model with the BG configuration, we model two LP types in the ROSS torus model:
The MPI process LP and the torus node LP.
The MPI process LP generates MPI messages that are forwarded to the torus node LP in the form of network packets. Each torus node LP is connected to its neighbors via channels having a fixed buffer capacity. The ROSS events in the torus model are of three types:
1. MPI messages: these messages are sent to/from MPI process LP.
2. Torus network packets: MPI messages are passed on to the torus node LPs by dividing them into network packets where the torus node LPs send and receive network packets. A full-sized network packet can be up to 512 bytes in our torus model.
3. Network packet chunks: similar to the BG network, when communicating between torus node LPs, the network packets are further divided into packet chunks of 32 bytes each.

Observation:
1. By Latency comparison of mpp-test on Intrepid BG/P and CCI BG/Q with ROSS 3-D and 5-D torus models.
Each packet traverses 8 hops between the source and destination (512 nodes on Intrepid and 1,024 nodes on CCI BG/Q with 1 MPI rank per node).

2.Validation of Torus Model with Blue Gene Architectures

3.Traffic Patterns:

a)Nearest Neighbour Traffic Pattern

b)Diagonal Pairing Traffic

Parallel Simulation Performance of Torus Network Models:
The simulation performance in ROSS is measured by using three parameters:
1.ROSS simulation efficiency,
2.committed event rate
3. the time to complete the simulation.
These metrics provide a picture of how ROSS performs with various network models and configurations. ROSS event efficiency determines the amount of useful work performed by the simulation.
To reduce state-saving overheads, ROSS employs an event rollback mechanism by developing event computations such that they can be reverse processed .
The simulator efficiency is inversely proportional to the number of rollbacks.
With no rollbacks, the simulator yields 100% efficiency.

Also, the ROSS event efficiency of the torus model simulation increases with increasing traffic work loads. As the injection rates increase, ROSS simulation has more events to process than it can roll-back.