# SlimNoC: A Low-Diameter On-Chip Network Topology for High-Energy Efficiency and Scalability

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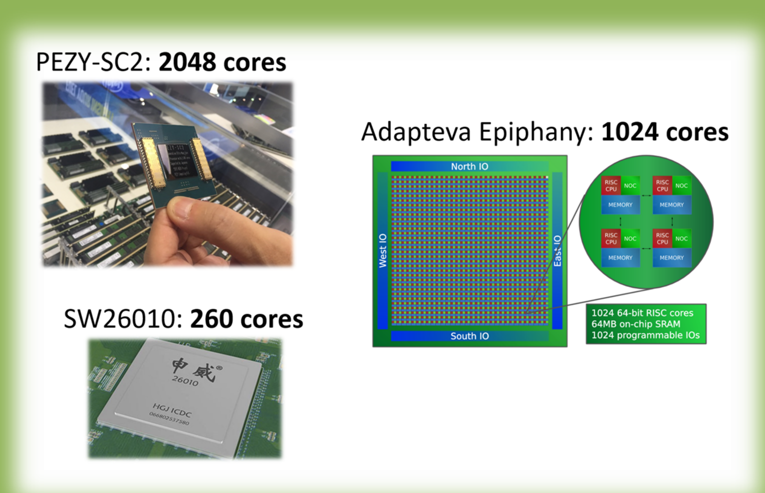
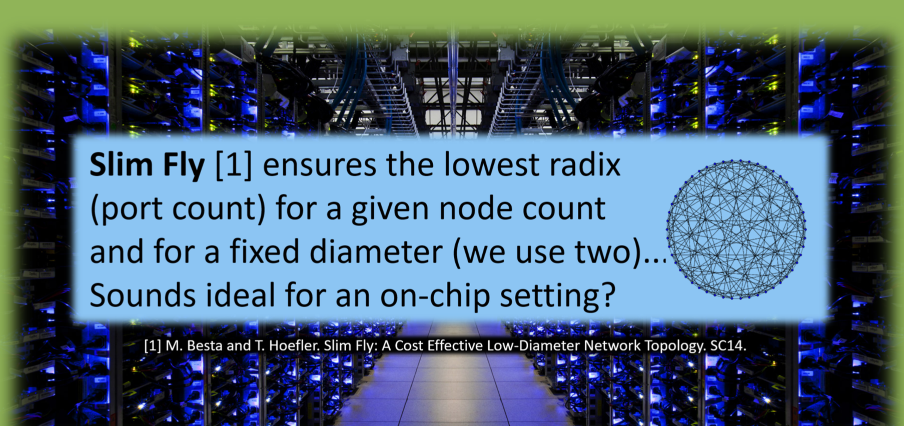
## (1) Key motivation

Massively parallel chips require energy-efficient, cost-effective, and high-performance topologies

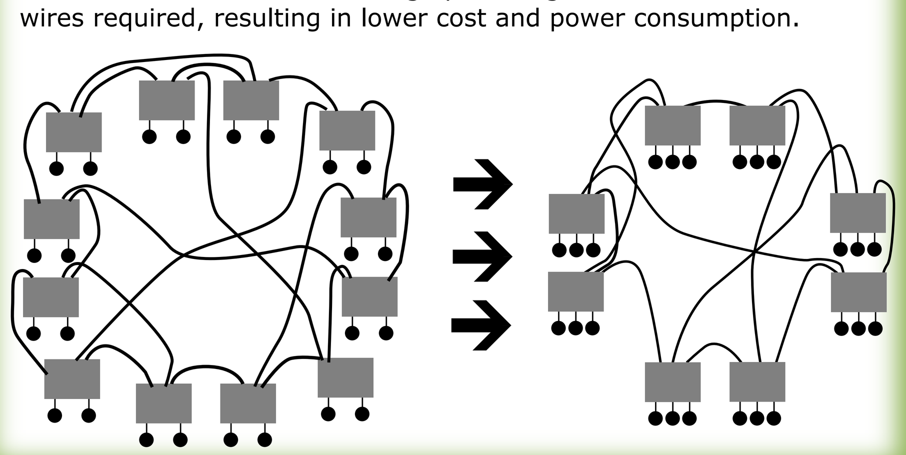



## (2) Inspiration: Slim Fly

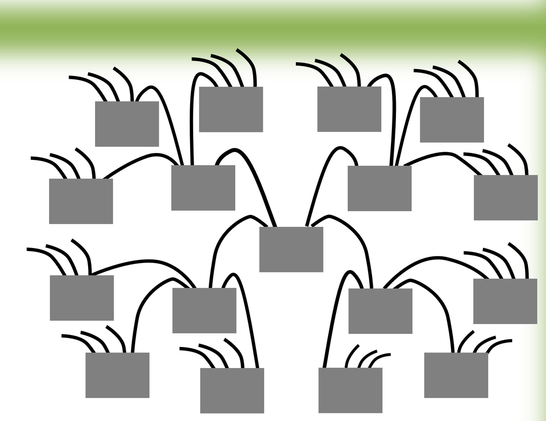



### Key idea:

Lower diameter and thus average path length: fewer routers and wires required, resulting in lower cost and power consumption.



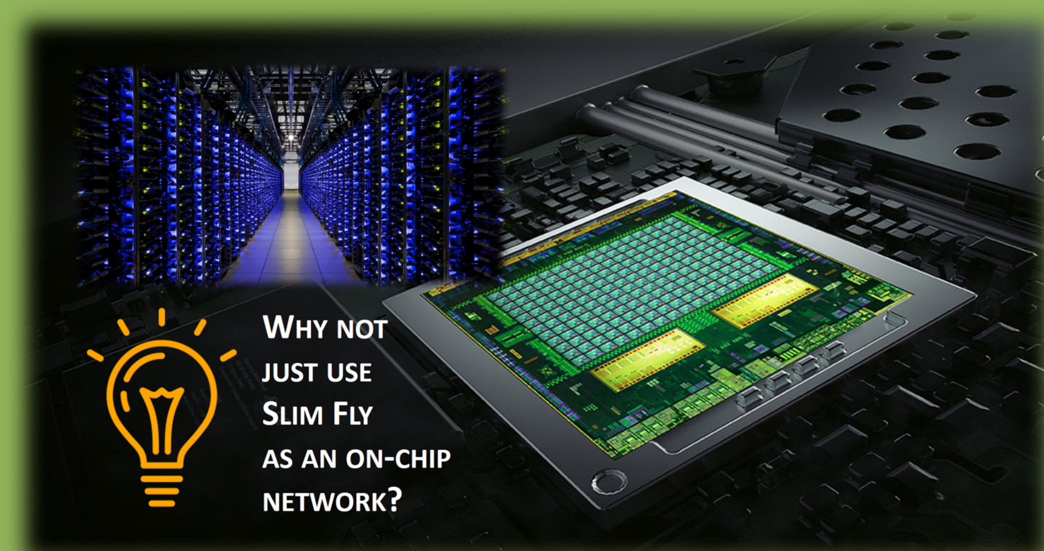
### Key method:

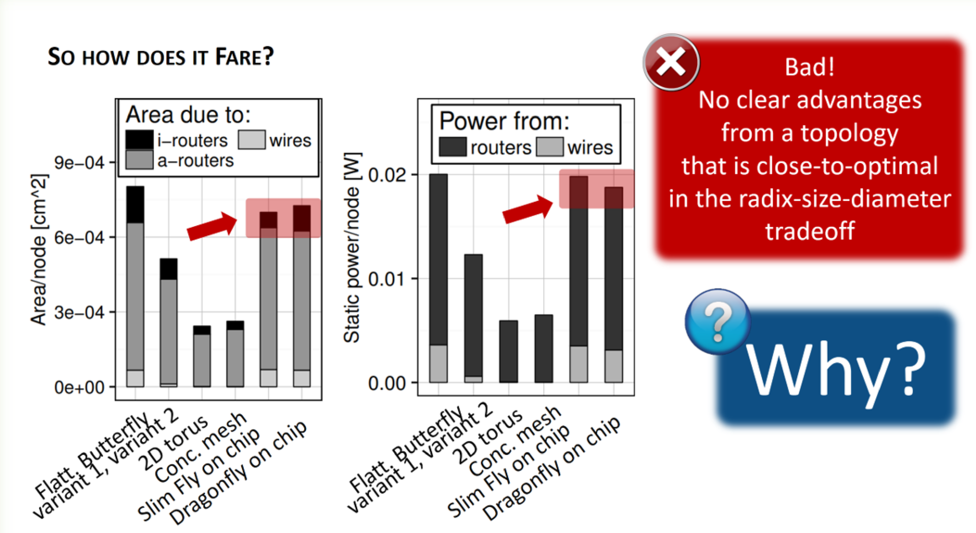


Optimize towards the Moore Bound: the upper bound on the number of vertices in a graph with given diameter D and radix k.

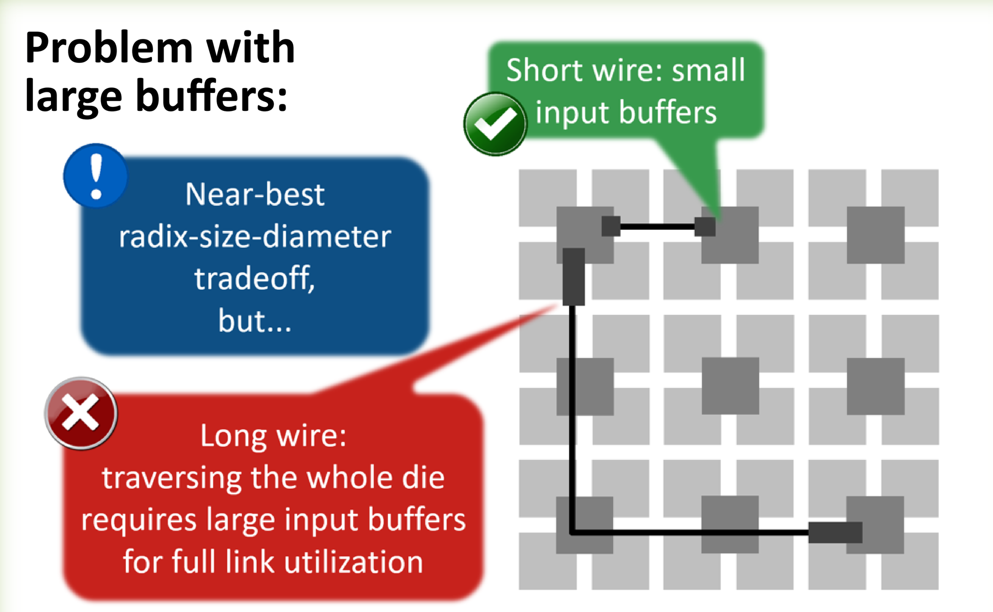
$MB(D,k) = 1 + k + k(k-1) + k(k-1)^2 + \ldots$

## (3) Slim Fly on a chip?



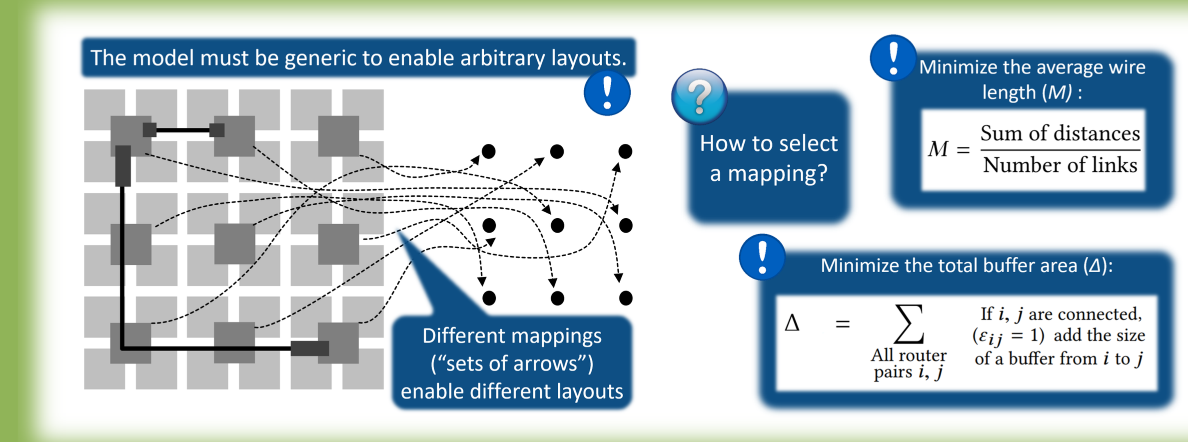

### Problem with large buffers:



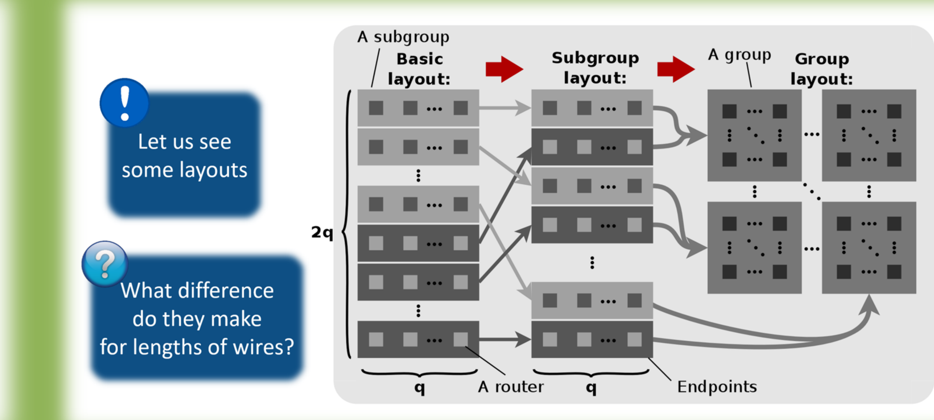

**Another problem: a lack of configurations satisfying various NoC technological constraints**

## (4) Slim NoC: Extending Slim Fly to the on-chip setting

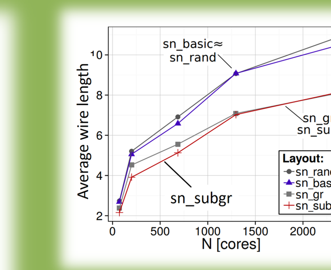
### (4.1) Generic layout models:




### (4.2) Efficient layouts:

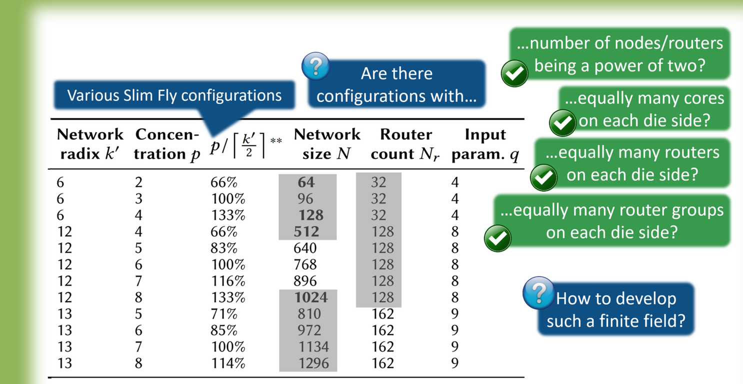



### (4.3) Layout advantages:

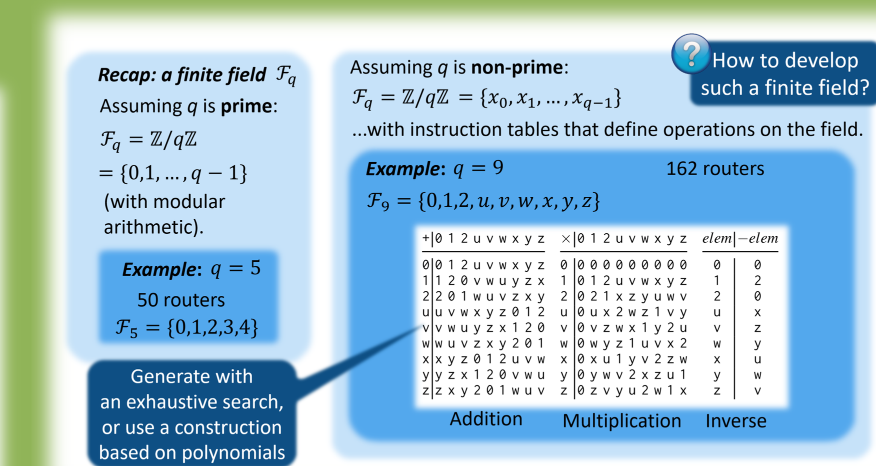


The subgroup layout (sn_subgr) is best for 200 nodes. The group layout reduces wiring complexity for 1296 nodes

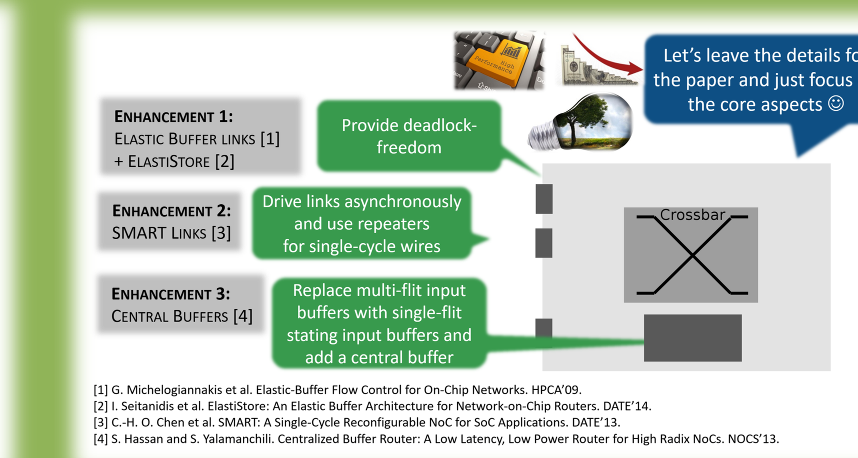
### (4.4) NoC configurations with non-prime finite fields:




| Network radix $k'$ | Concentration $p$ | $p/\lceil k'/2 \rceil$ | Network size $N$ | Router count $N_r$ | Input param. $q$ |
|---|---|---|---|---|---|
| 6 | 2 | 66% | 64 | 32 | 4 |
| 6 | 3 | 100% | 96 | 32 | 4 |
| 6 | 4 | 133% | 128 | 32 | 4 |
| 12 | 4 | 66% | 512 | 128 | 8 |
| 12 | 5 | 83% | 640 | 128 | 8 |
| 12 | 6 | 100% | 768 | 128 | 8 |
| 12 | 7 | 116% | 896 | 128 | 8 |
| 12 | 8 | 133% | 1024 | 128 | 8 |
| 13 | 5 | 71% | 810 | 162 | 9 |
| 13 | 6 | 85% | 972 | 162 | 9 |
| 13 | 7 | 100% | 1134 | 162 | 9 |
| 13 | 8 | 114% | 1296 | 162 | 9 |

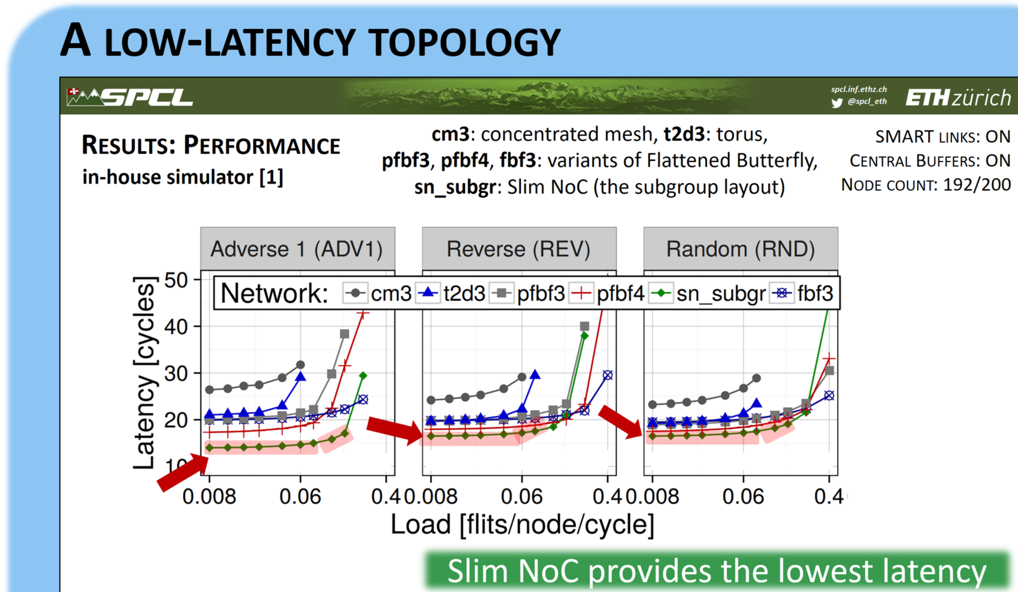



### (4.5) Slim NoC Router microarchitecture:

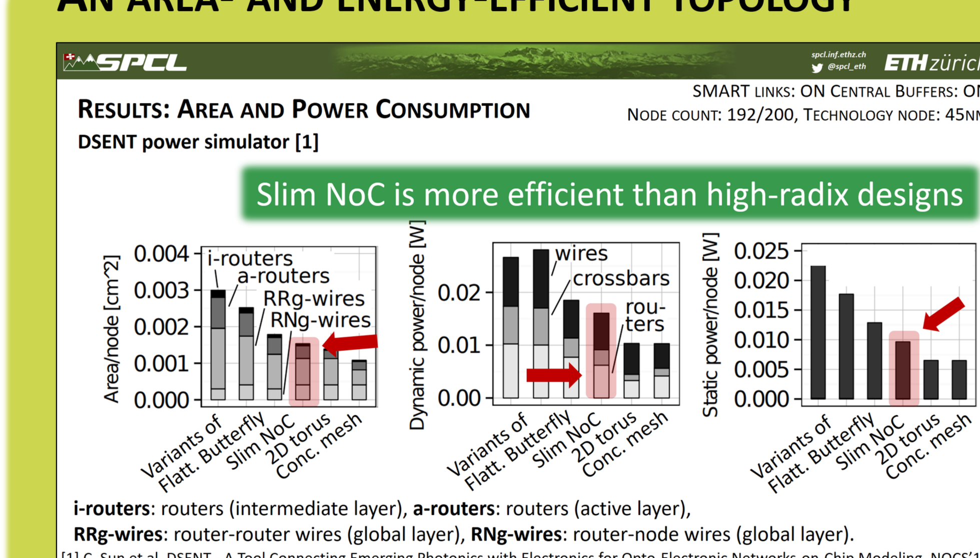



## (5) Key Slim NoC results

### A low-latency topology

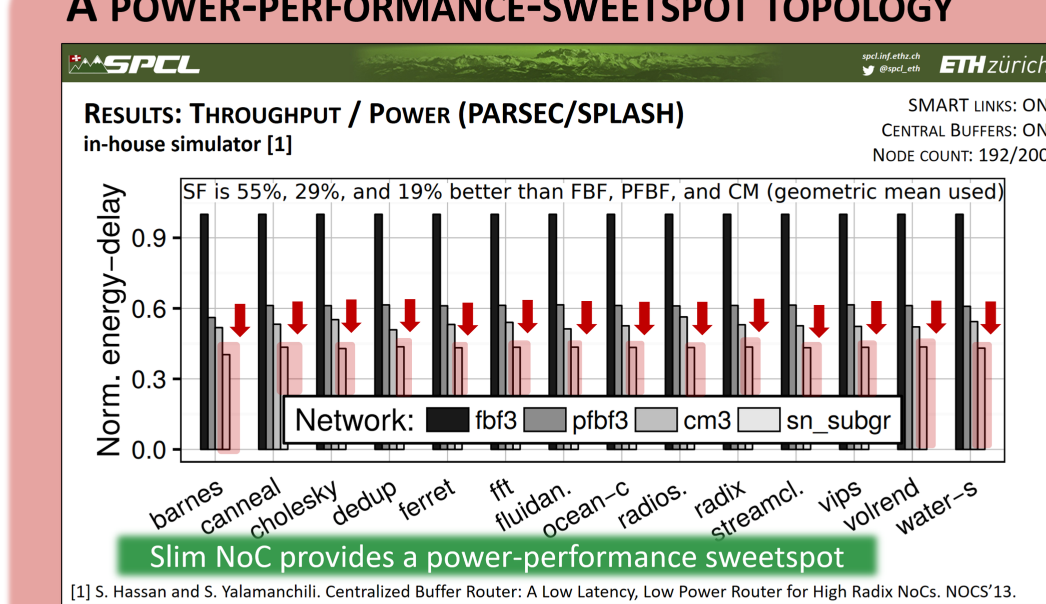



### An area- and energy-efficient topology



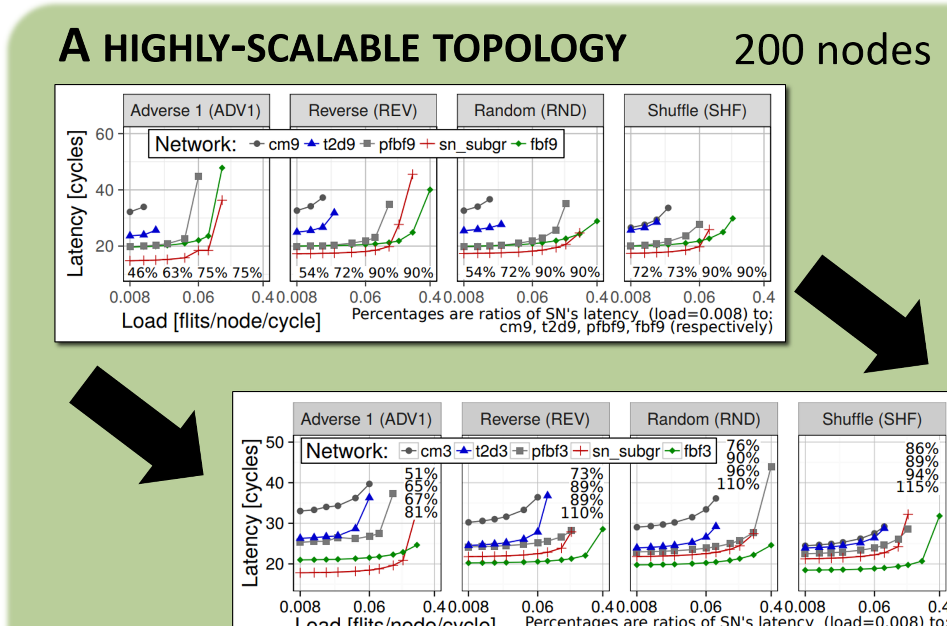

# Slim NoC advantages

### A power-performance-sweetspot topology




### A highly-scalable topology

200 nodes




1296 nodes