Aristos: Pipelining One-sided Communication in Distributed Mixture of Experts (MoE)

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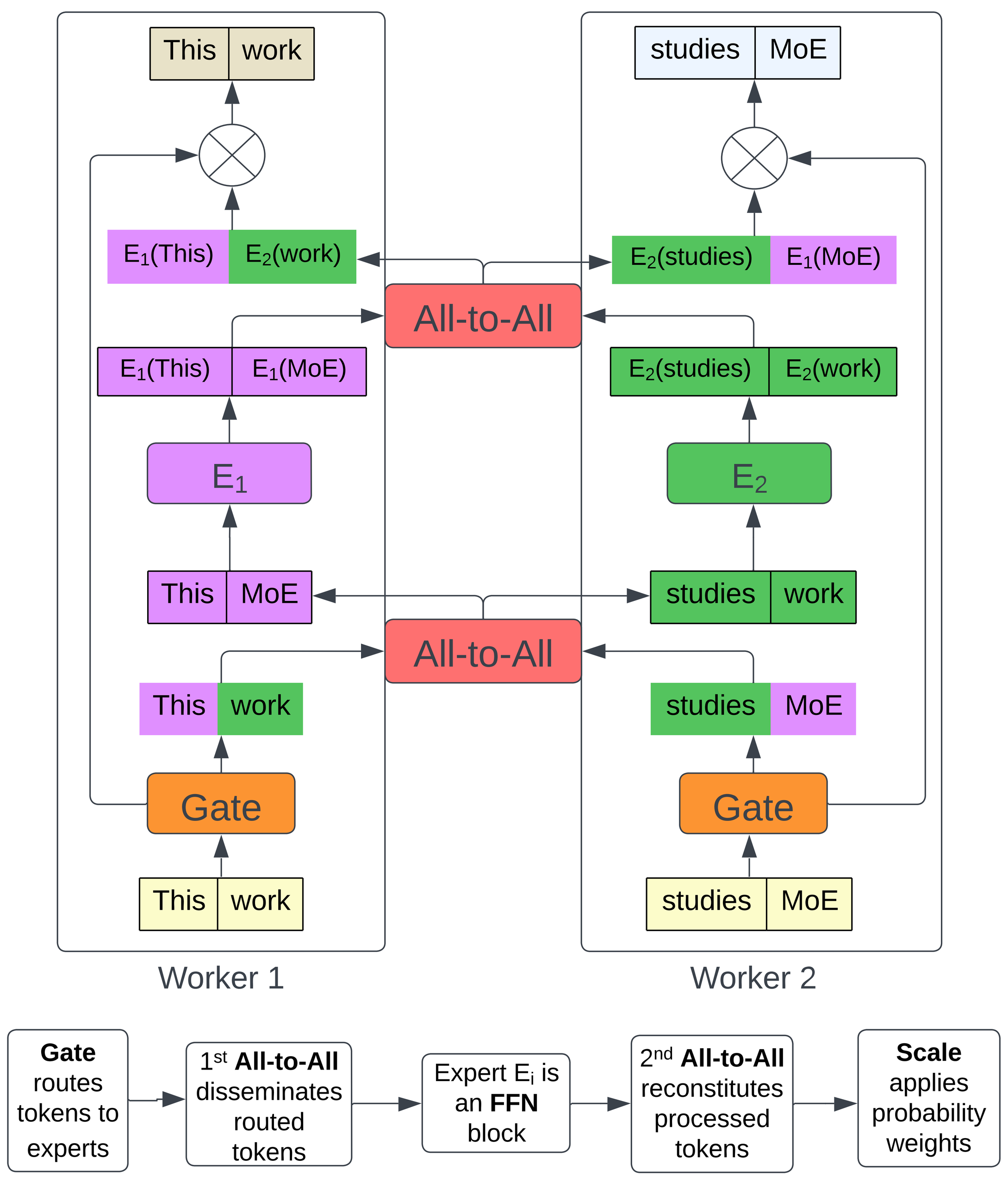
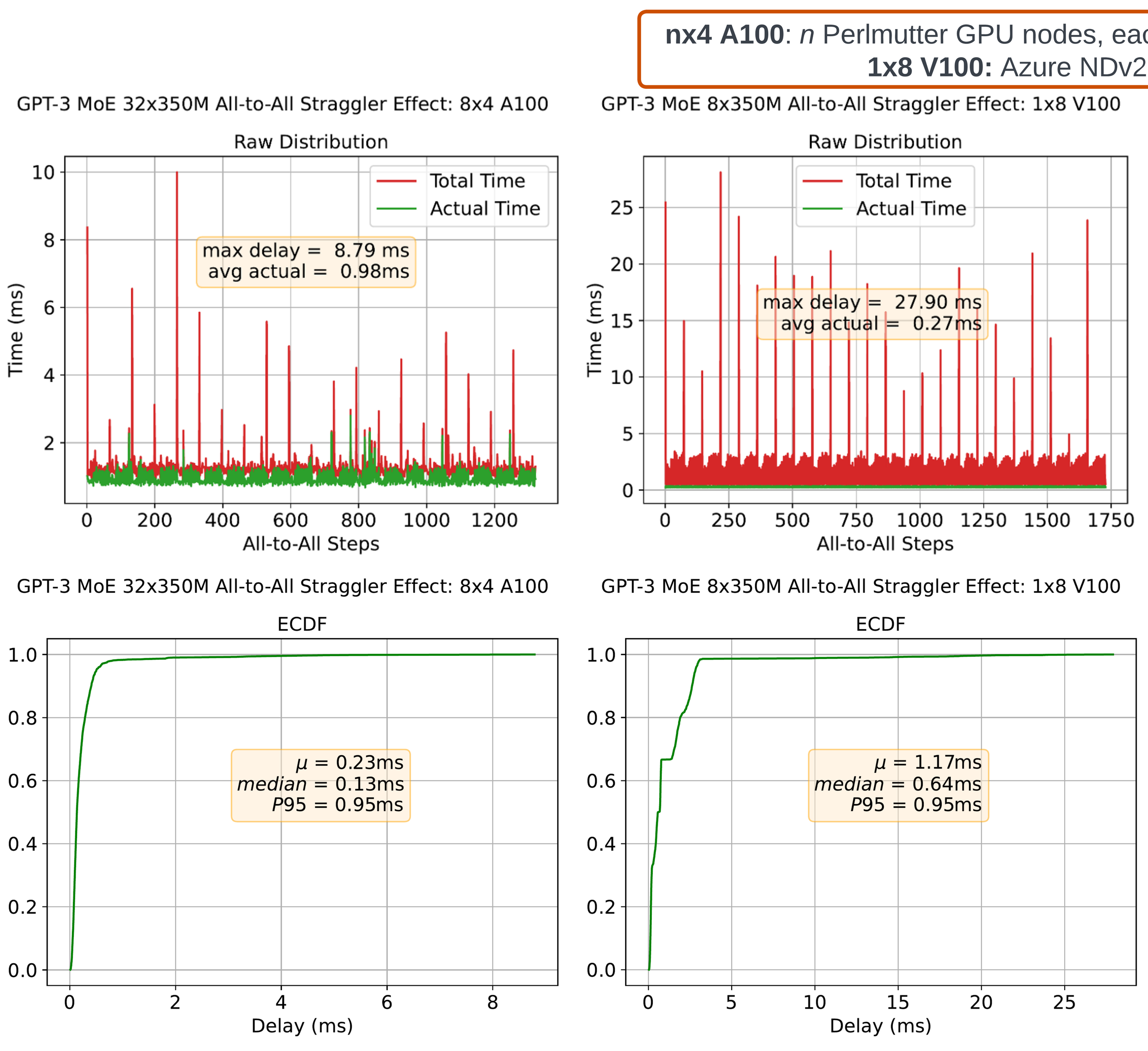
Background

Distributed MoE Token Flow, where $|W| = EP = 2$

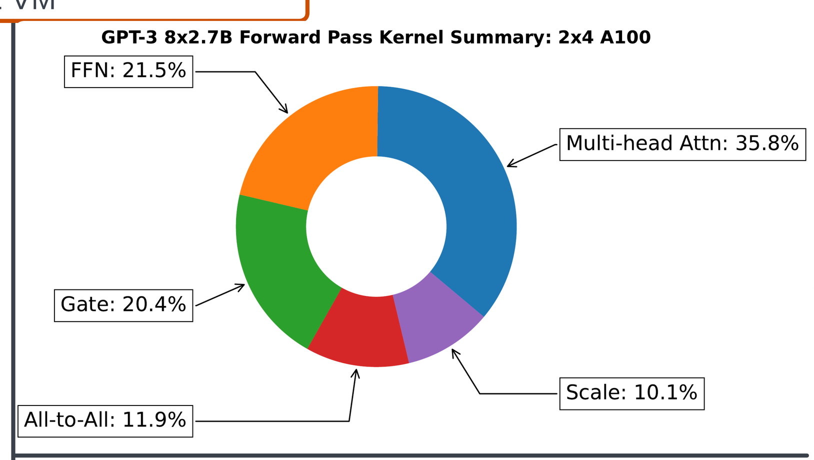


Challenges

The widely-adopted [2, 3, 4] MoE architecture, promising **5x** faster training and **9x** reduced inference costs [6], is currently plagued by three *open* challenges [5, 1] in the distributed setting.



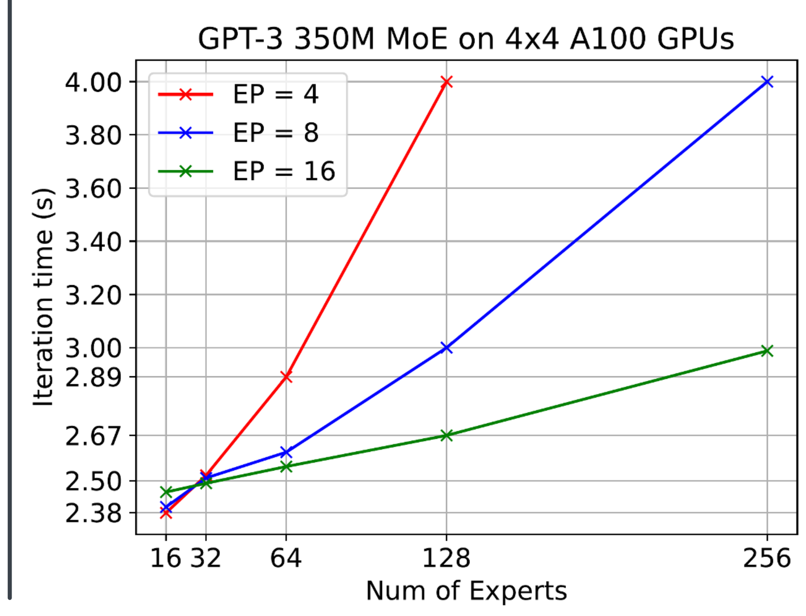
***Challenge* #1** Straggler Effect



***Challenge* #2**
No overlap of communication and computation.

NB: All-to-All is the *second* most time-consuming kernel, only behind the Attn/FFN GEMM.

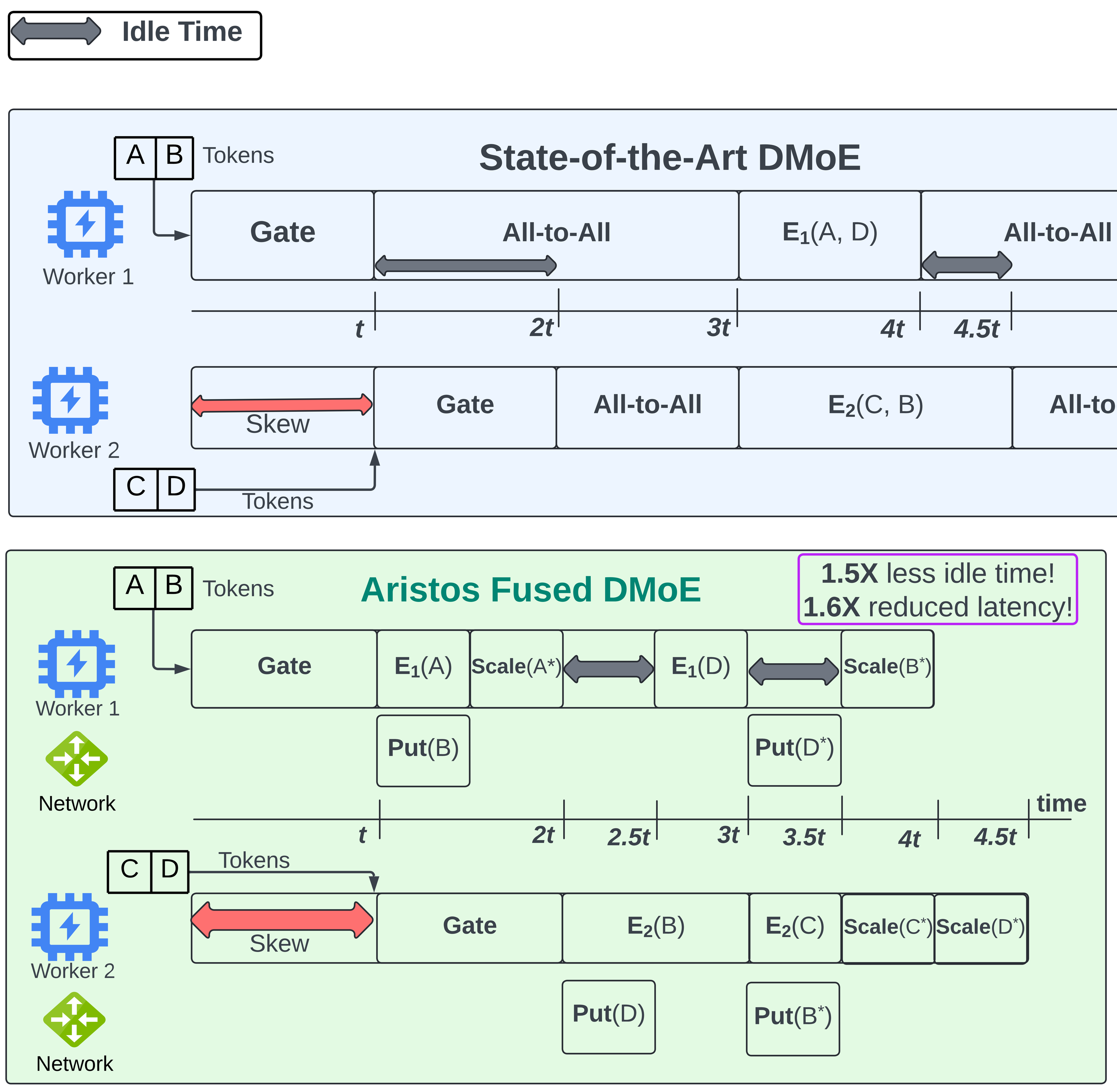
Expert Parallel (EP) vs Iteration Latency (↓ is better)

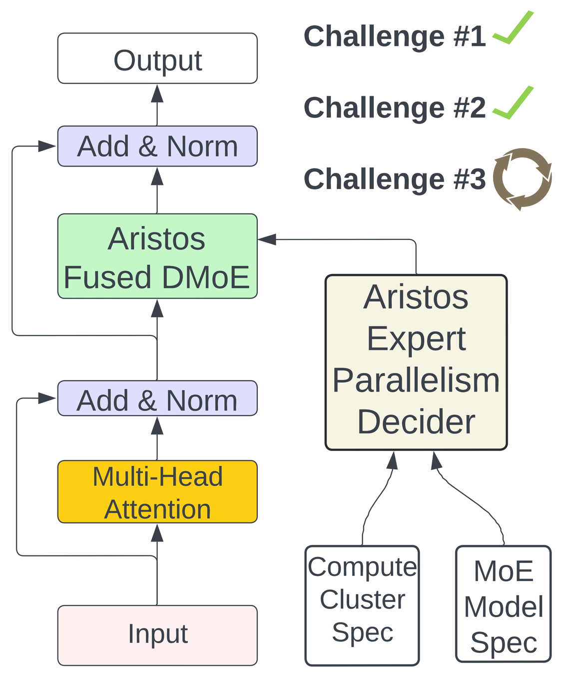


***Challenge* #3**
Deciding an optimal expert parallel strategy.

NB: *EP = 4* yields an OOM error at 256 experts

Method





System architecture of Aristos

Ongoing Work

Define $G = (V, E)$ as the cluster topology, where V denotes devices and E communication links. Equation 1 captures the objective of challenge #3: finding $G^* = \{g = (V_g, E_g) \mid g \subseteq G\}$ the set of optimal expert parallel groups or the *topology-aware sharding specification.*

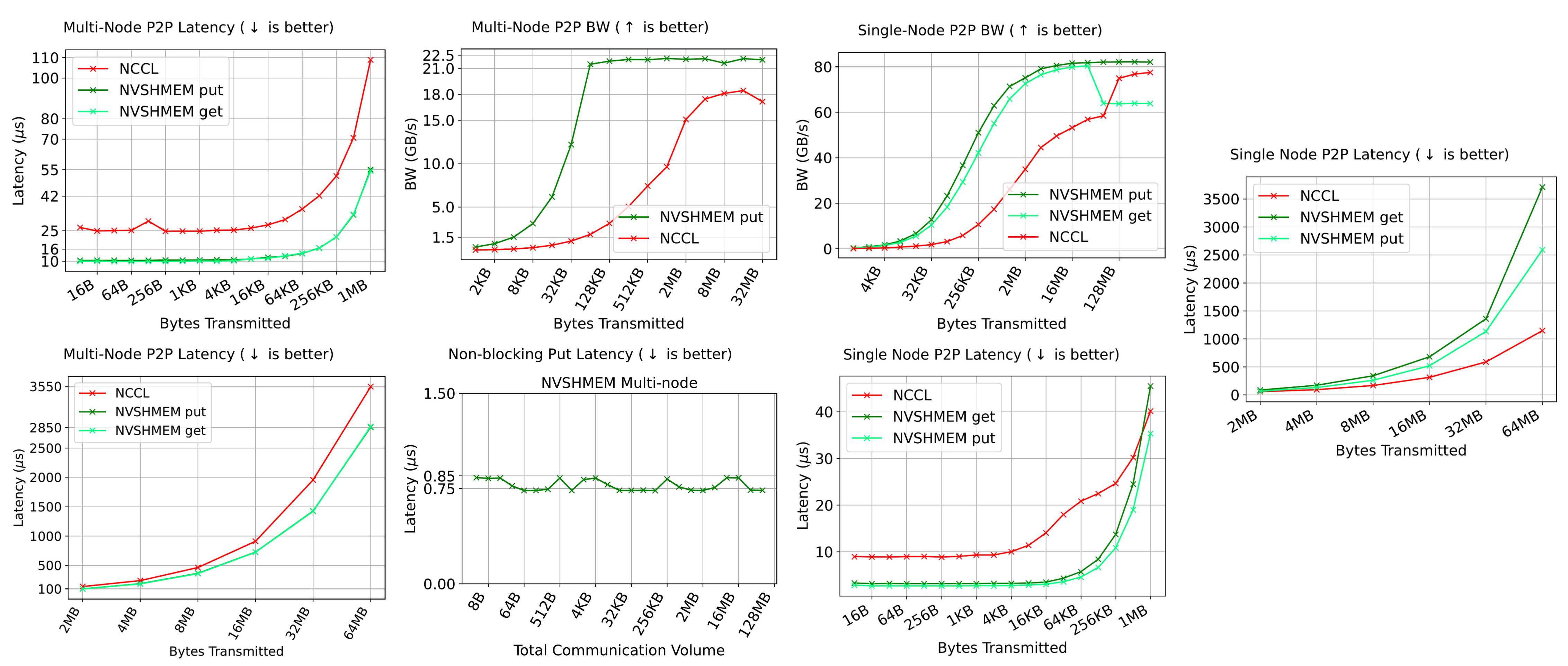
$$\min \max_{g \in G^*} \kappa \left(\pi(g) + \max_{i \in V_g} \mathcal{C}_i \right) + T_\rho(|G^*|) \quad (1)$$

subject to,

$$\sum_{j \in V_g} m_j \geq |\mathcal{X}| \qquad \forall g \in G^* \quad (2)$$

where, $\mathcal{X}$ is the set of all experts and m_j is expert memory capacity for device j. Also, κ identifies the frequency of MoE computation, $\pi(g)$ is the compute cost of g, C_i denotes the communication cost of device i and $T_\rho(|G^*|)$ is the cost of inter-group all-reduce on MoE parameters due to data parallelism. We also note that CUDA development for Aristos Fused is underway.

Microbenchmarks



Acknowledgements

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References

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