# Semantic-aware LLM-Application Scheduling

Otto White

December 10, 2025

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Hard to productionize

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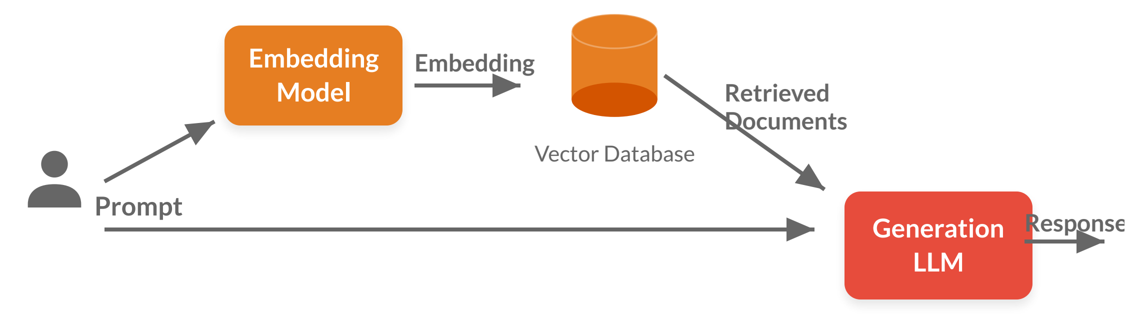
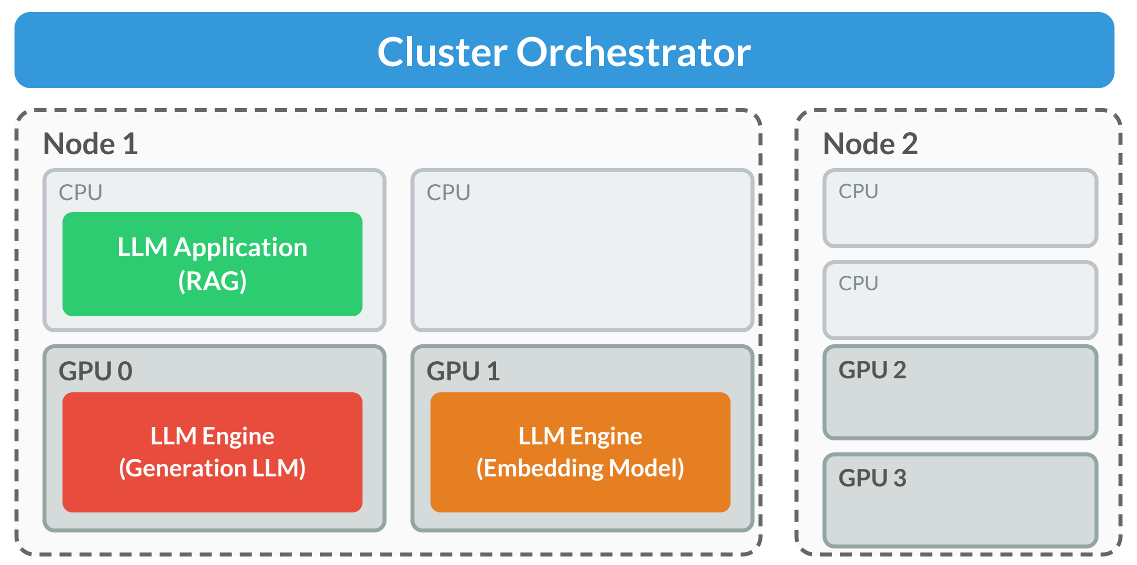
Infeasible for companies at smaller scale to achieve efficient deployments applications. They need automated solutions.

# LLMs → LLM Applications

- LLM Invocations -> Graphs
- Can't optimise for end-to-end performance
- Lack of Critical Path Awareness
- Unfairness





## Related Work

| System | Level | Multi-Engine | Application-Aware | Scheduling Granularity /Co-location |
|---|---|---|---|---|
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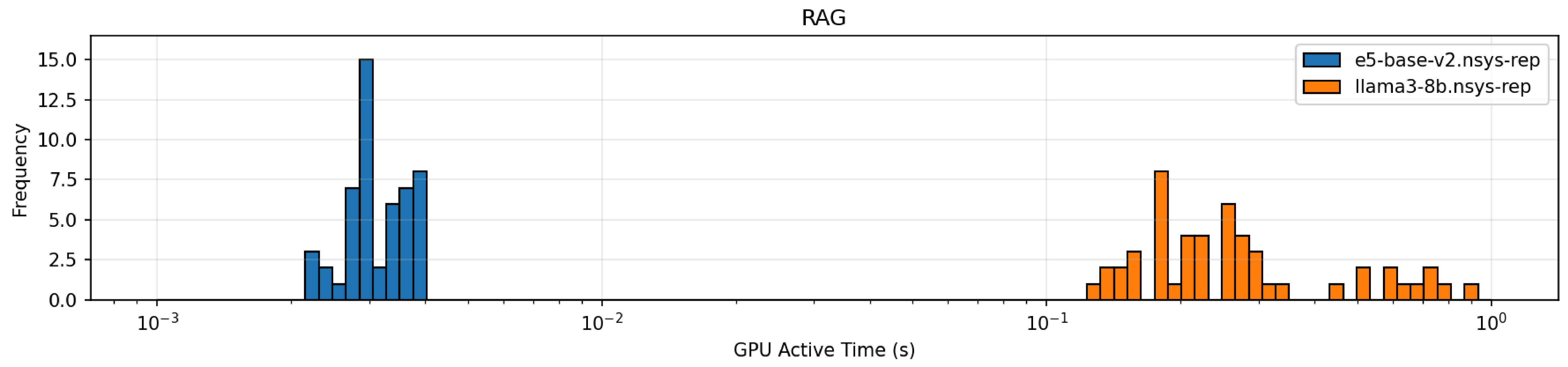

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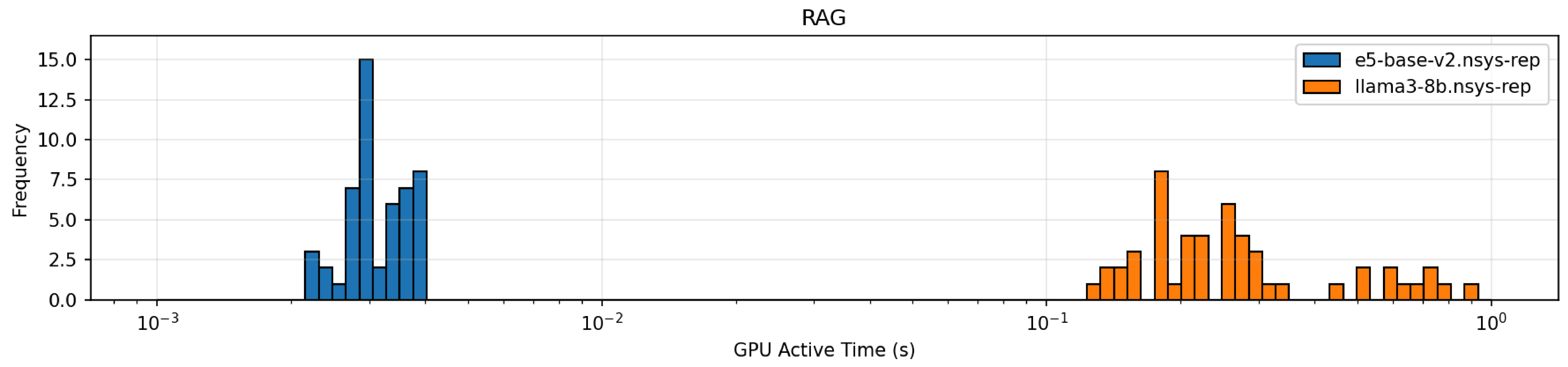

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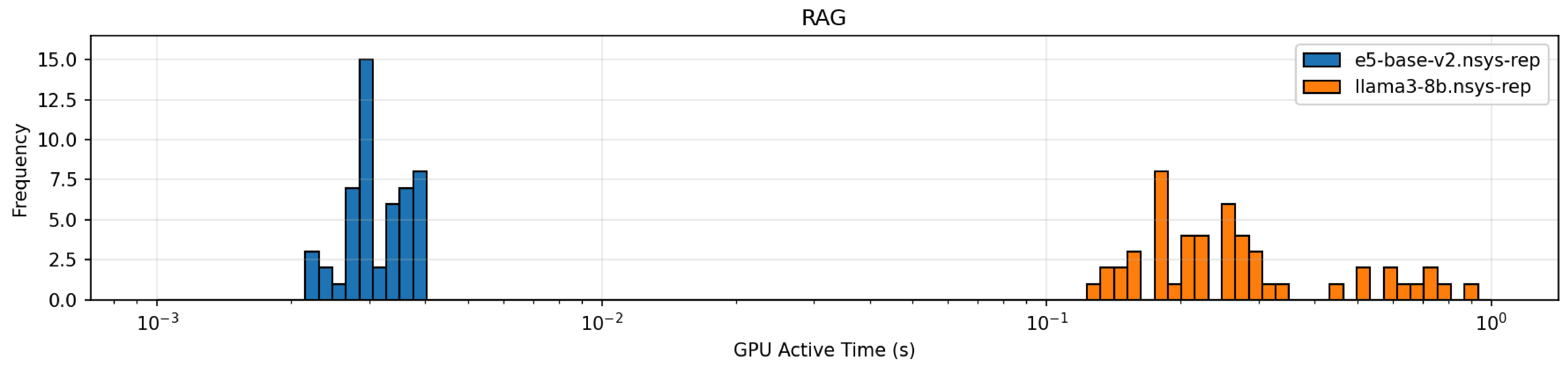

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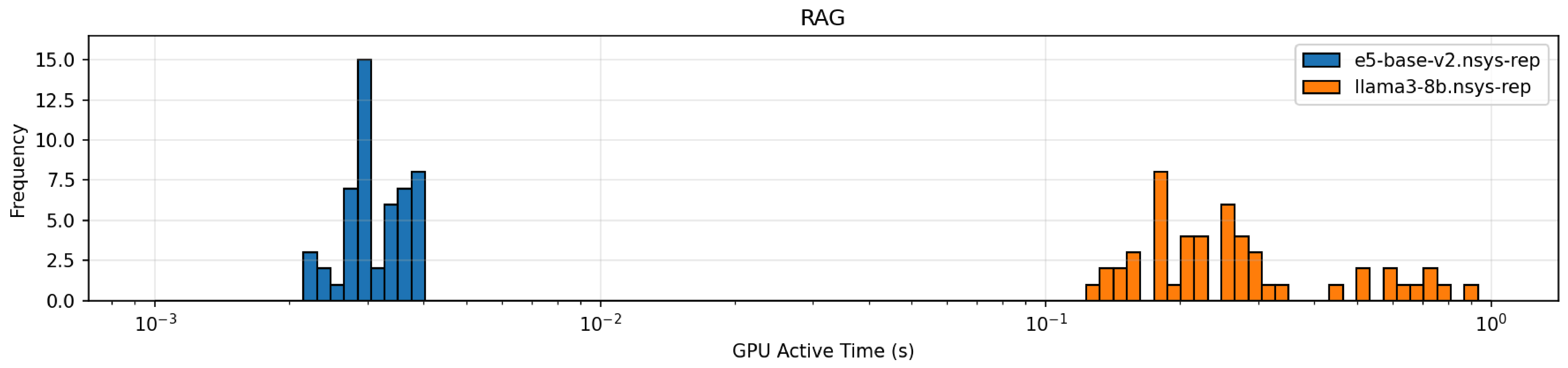

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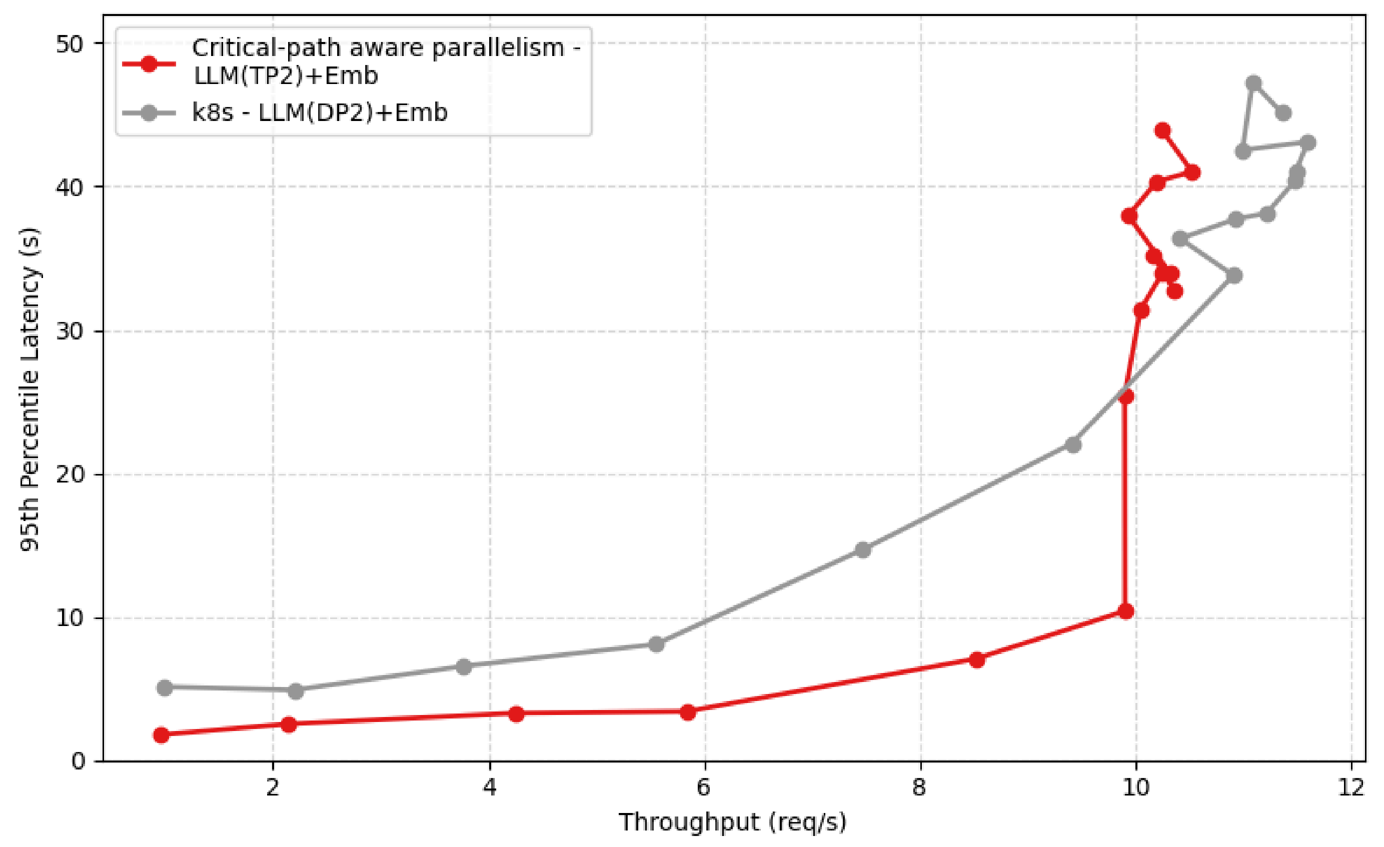
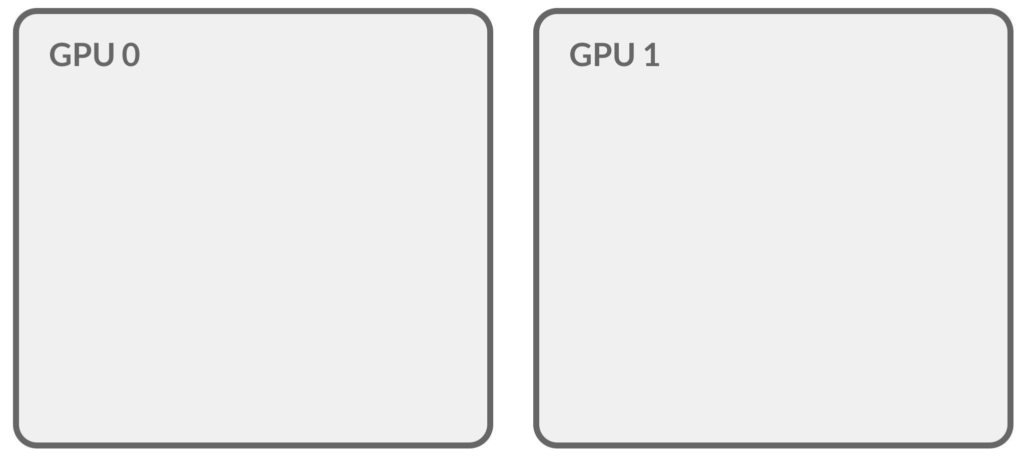
- LLM is the critical path
- TP2 halves RAG application latency

# Critical-path Aware Parallelism

- **2.4x** improvement in latency
- Minor degradation in throughput



## Critical-path Aware Co-location



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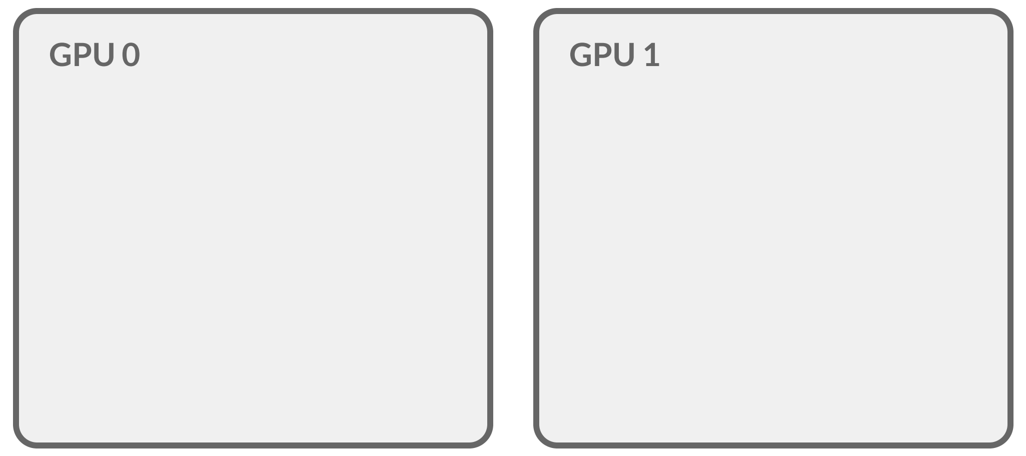

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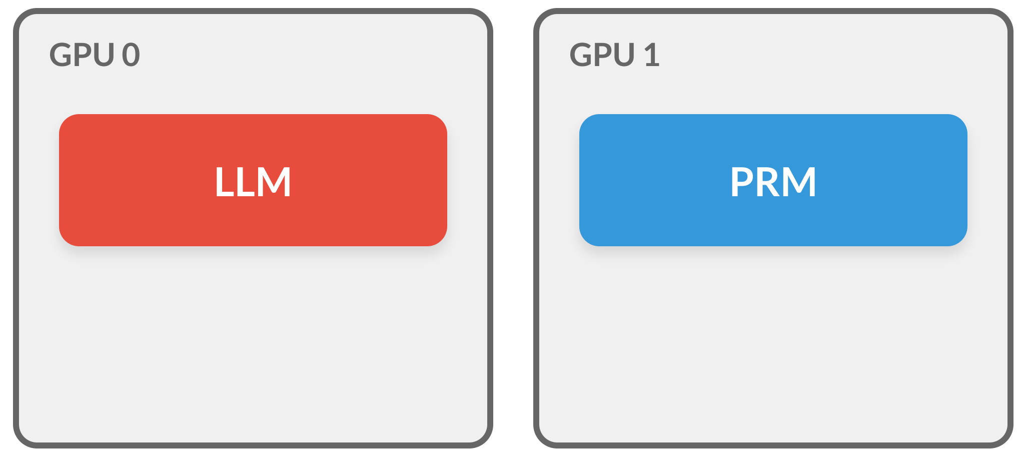

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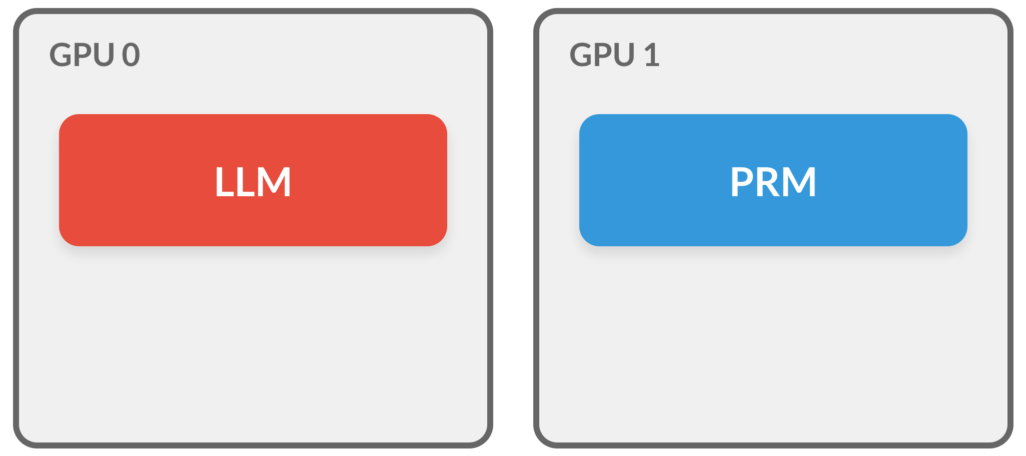
- How should we deploy this application?
- Severe underutilization



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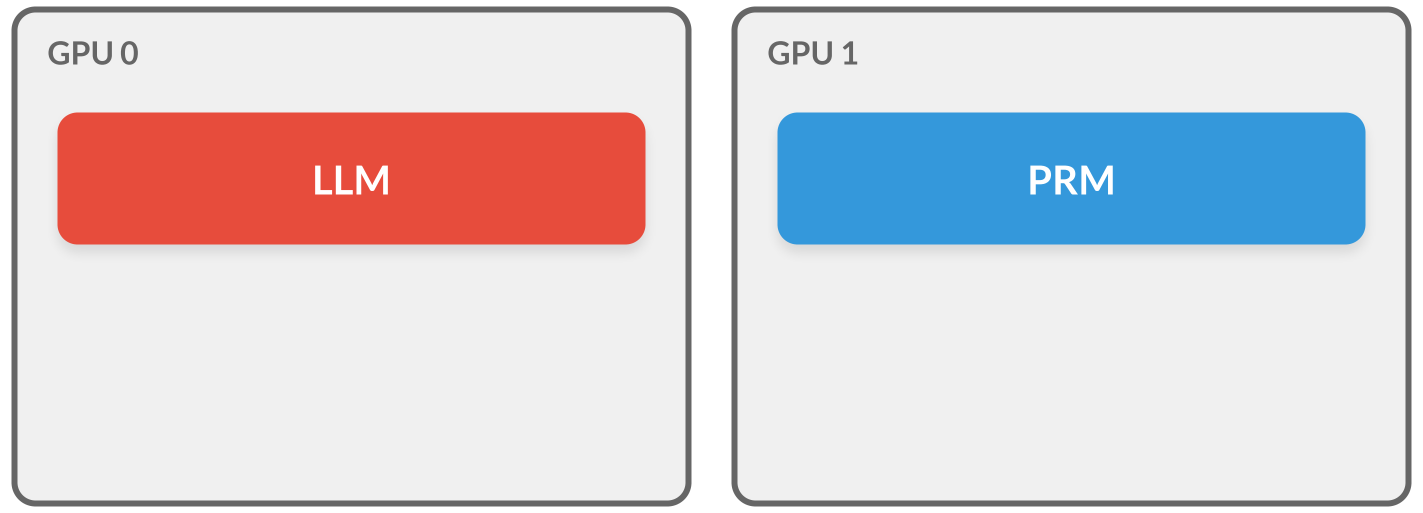

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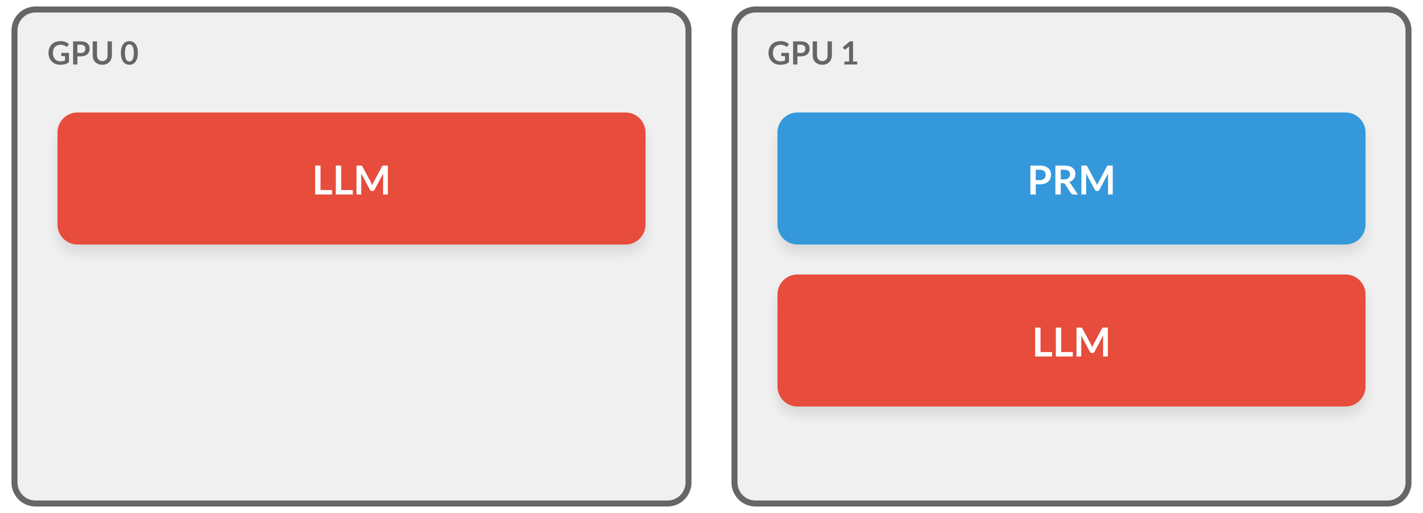
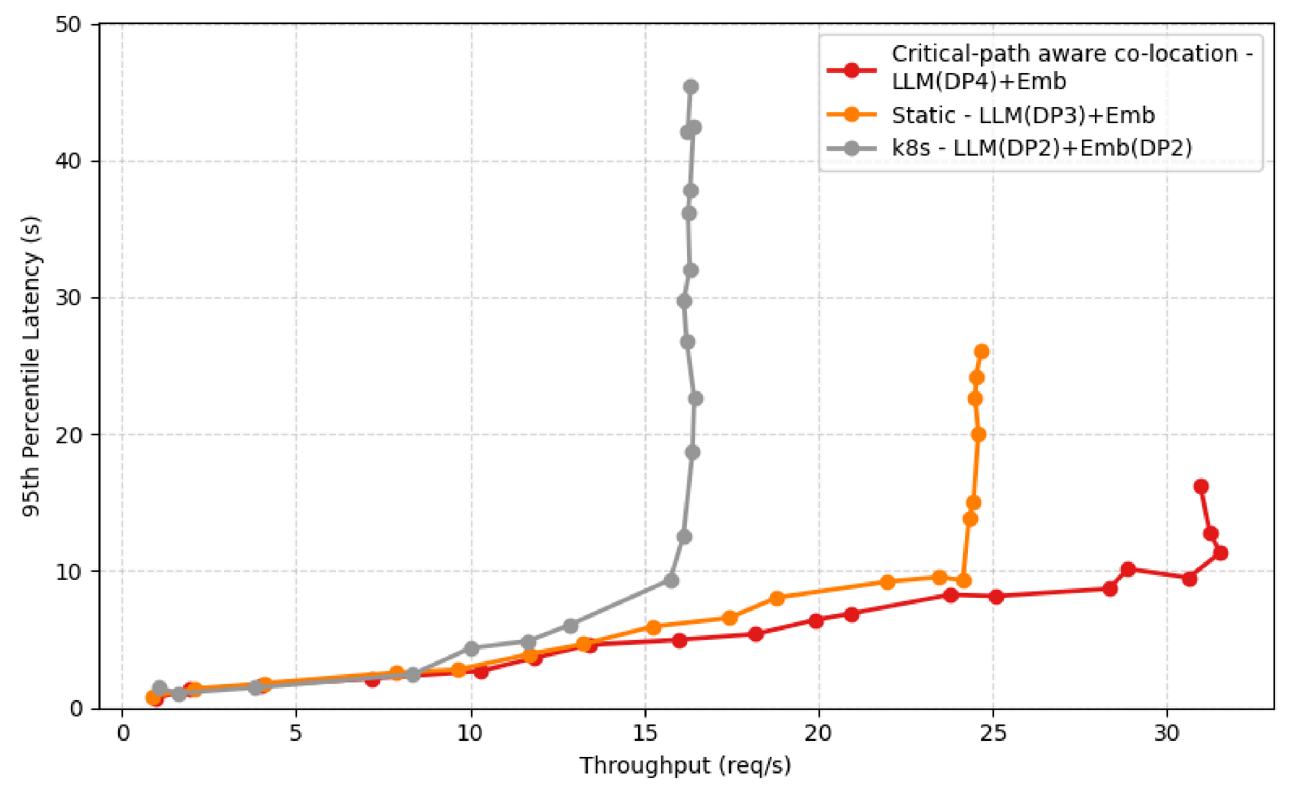
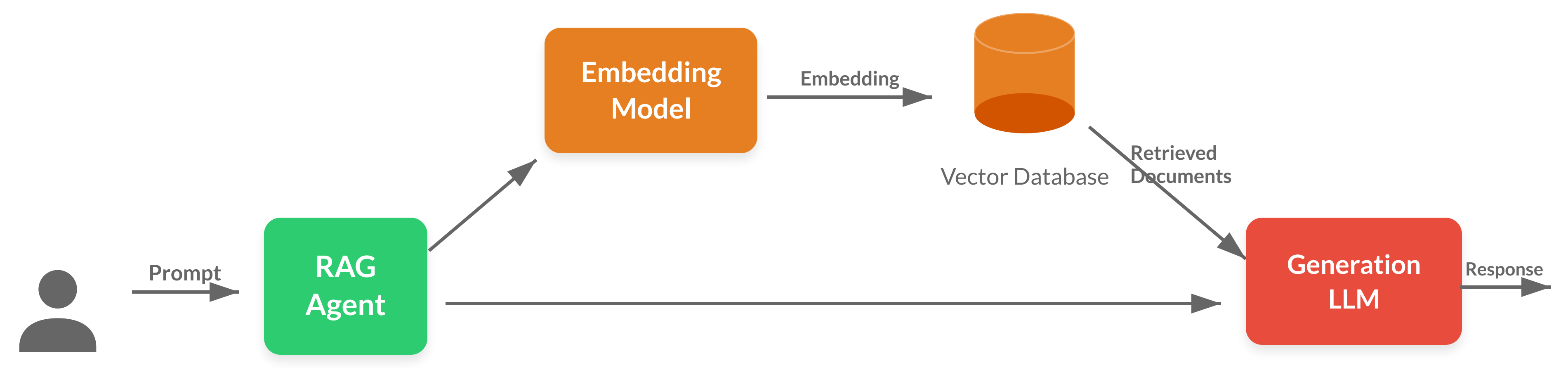


# Critical-path Aware Co-location

- **2x** throughput over K8S
- **50%** over best manual K8S config
- K8S: data parallelism only



# Future Work: Multi-Engine Fairness



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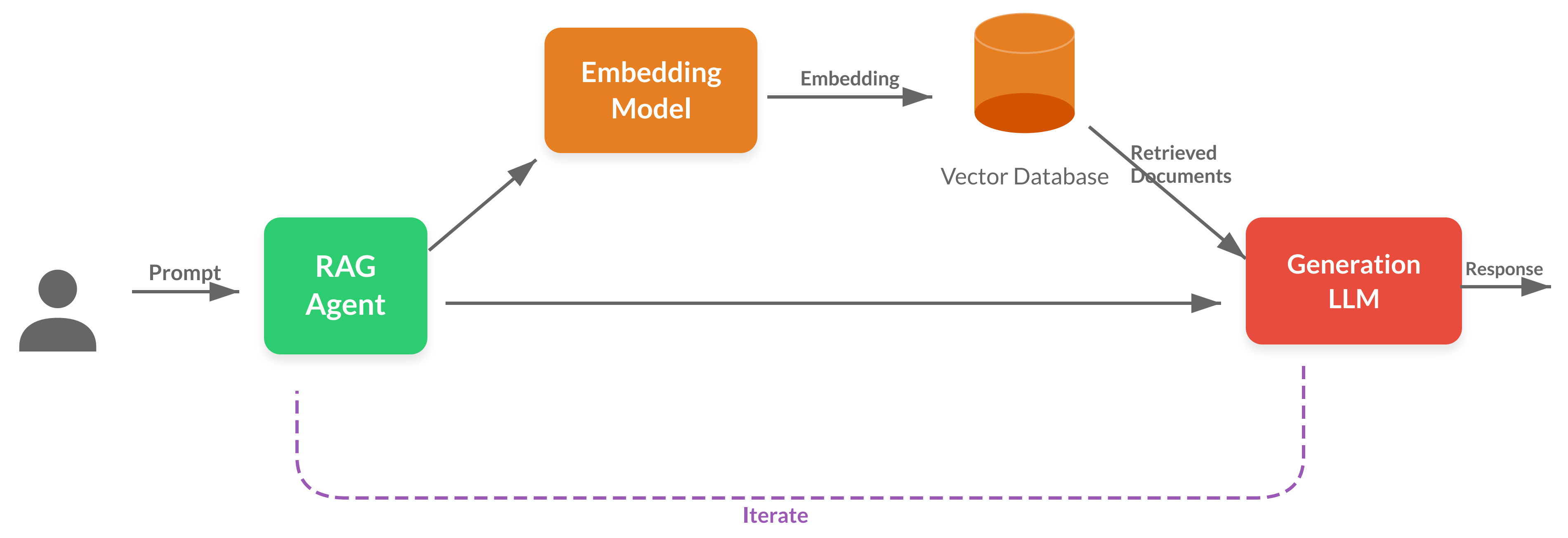

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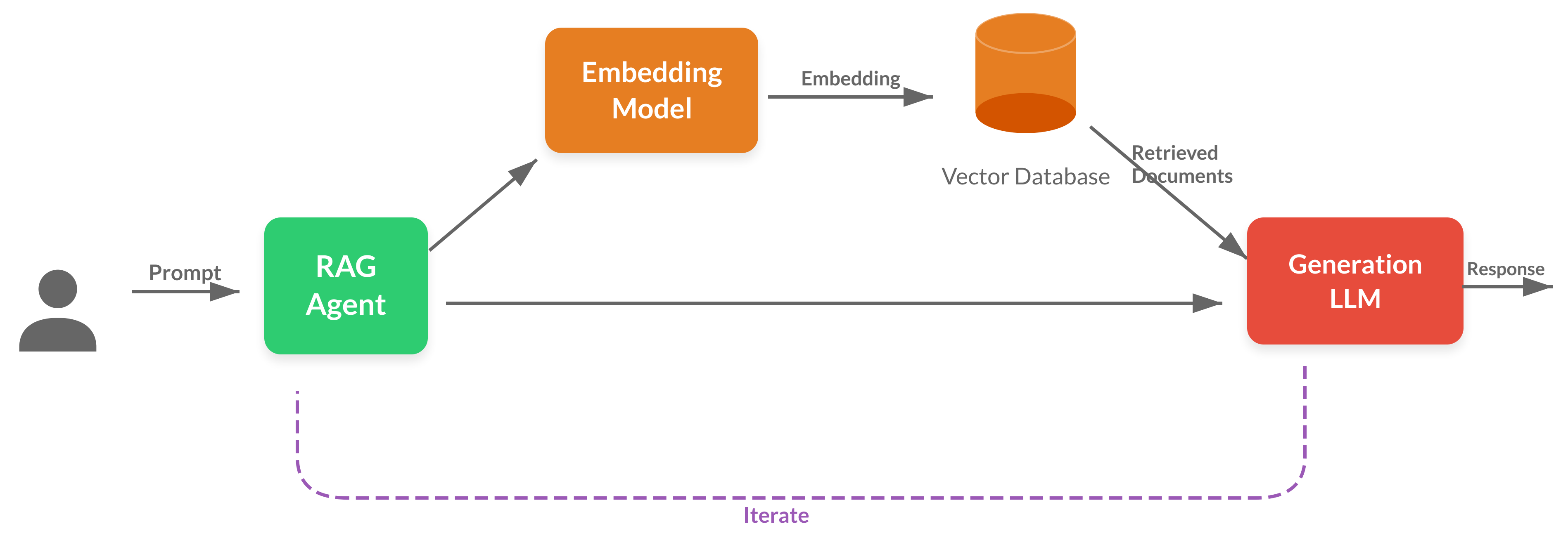

- Common pattern in agentic applications

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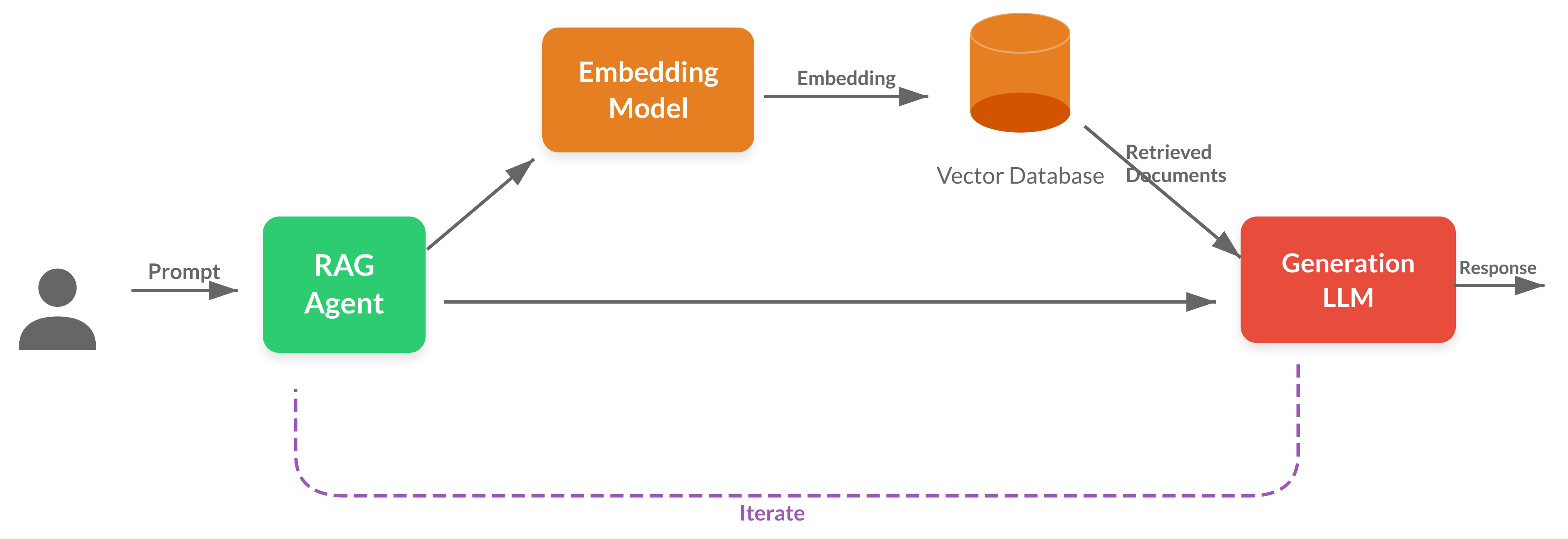

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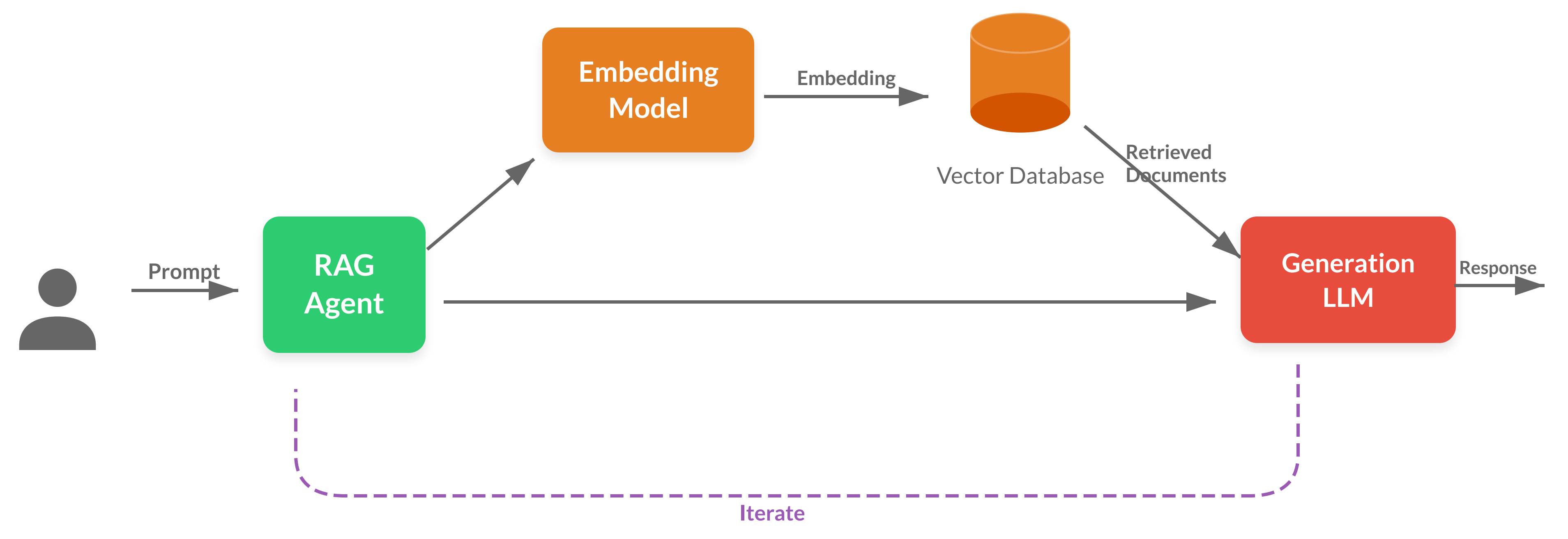

- Common pattern in agentic applications
- Some requests far more expensive than others
- HoL blocking for the many cheaper requests that iterate fewer times

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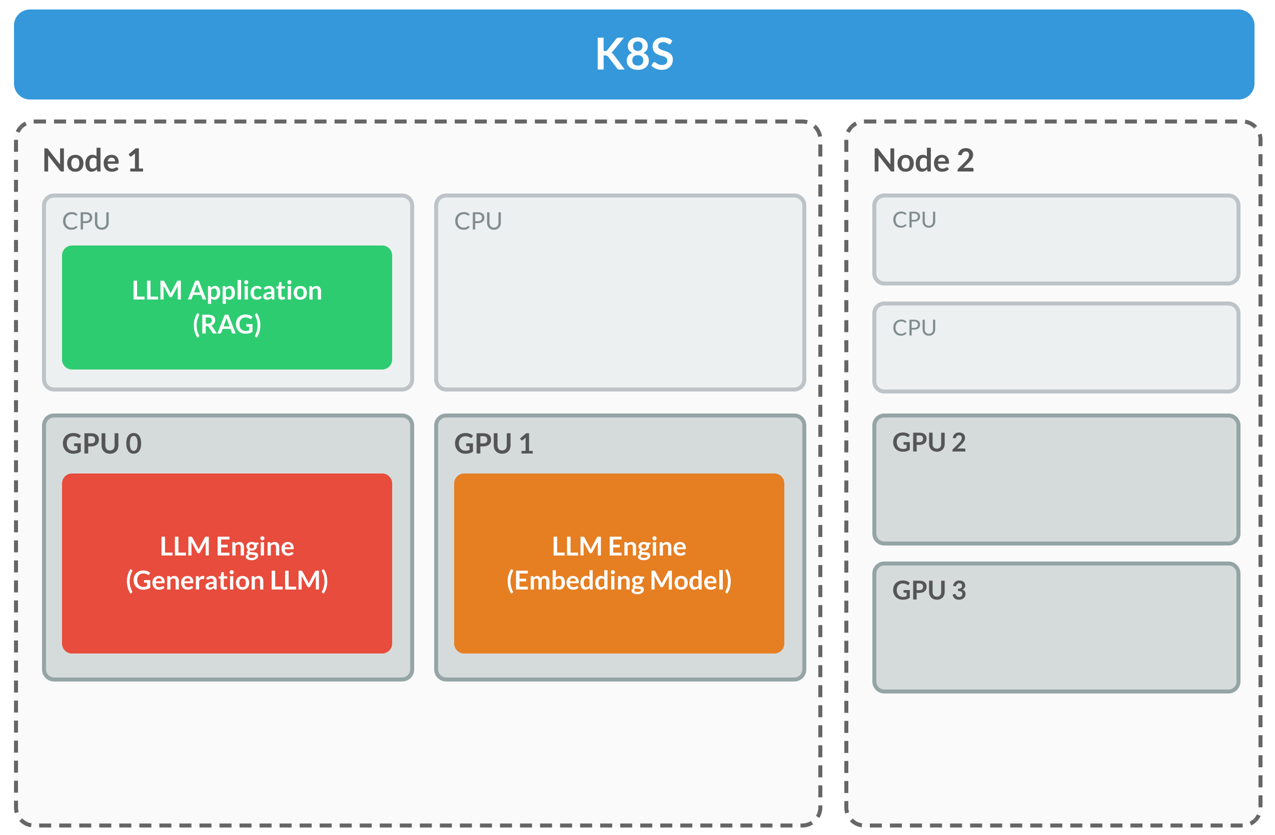

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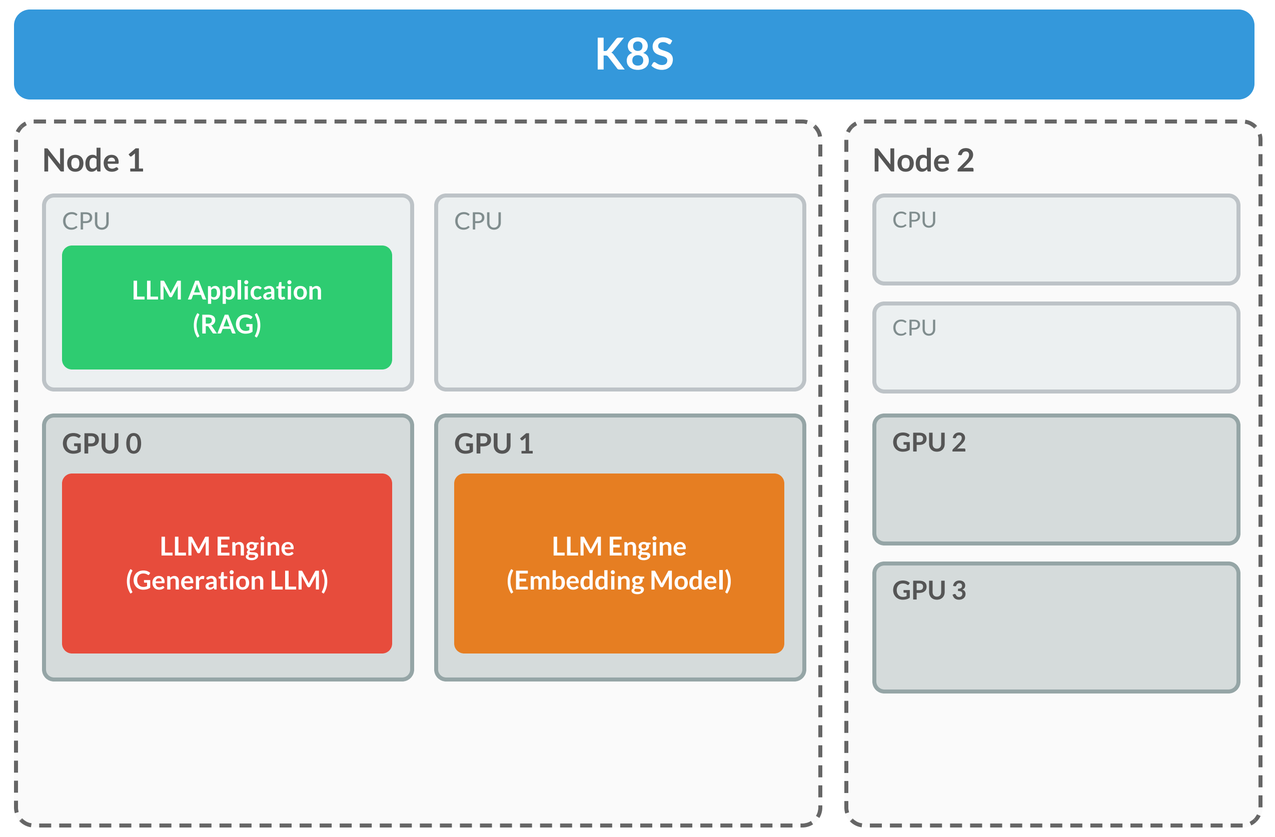

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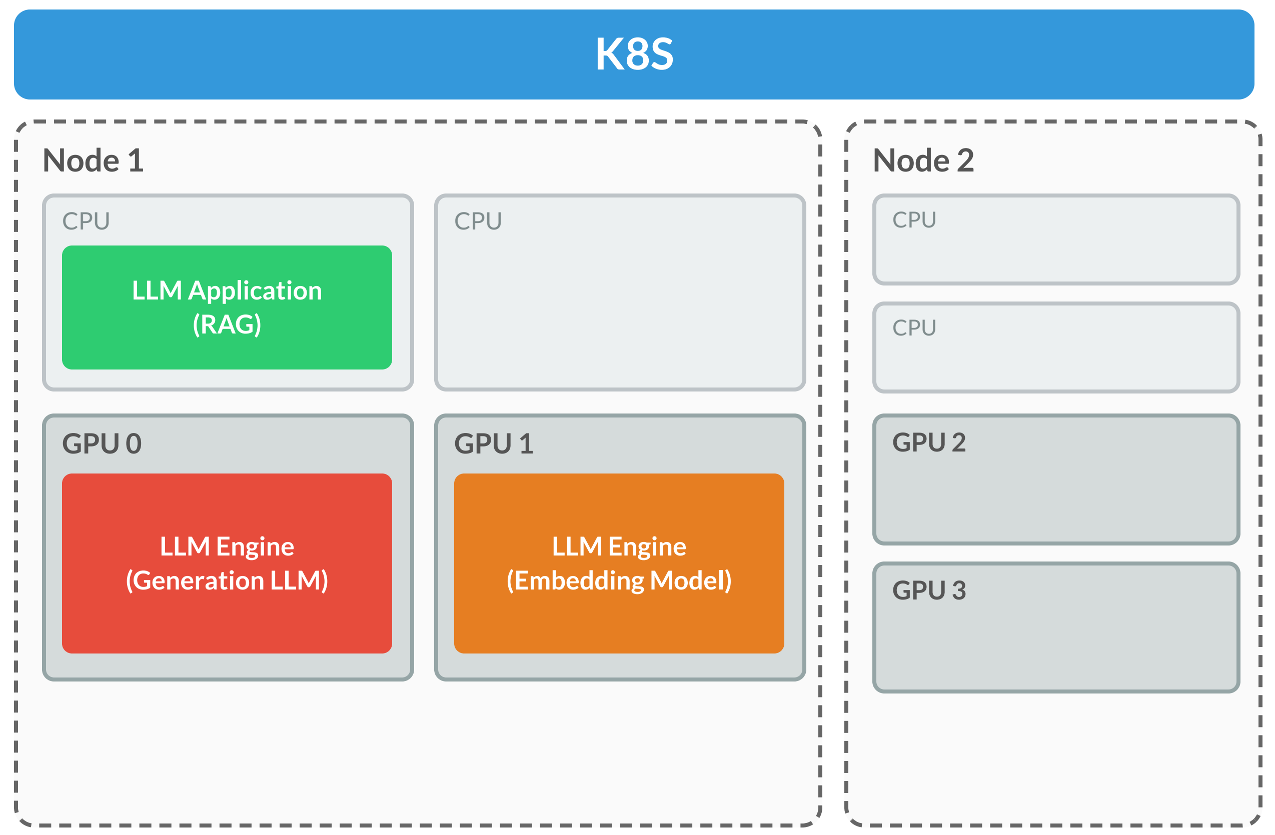

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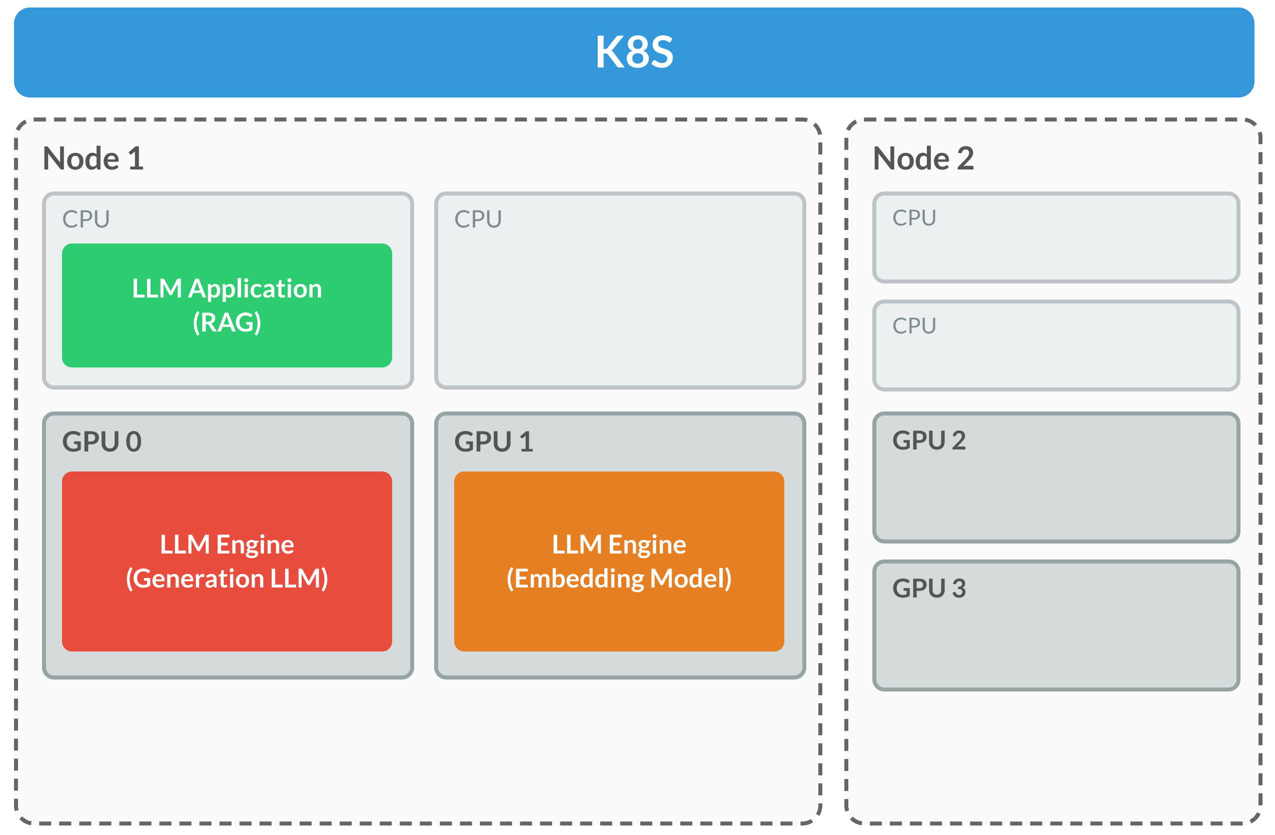
- Can also have HoL blocking between workflows


K8S
Node 1
CPU
LLM Application (RAG)
CPU
GPU 0
LLM Engine (Generation LLM)
GPU 1
LLM Engine (Embedding Model)
Node 2
CPU
CPU
GPU 2
GPU 3