DISTRIBUTED ML Training: A SERVERLESS ARCHITECTURAL APPROACH

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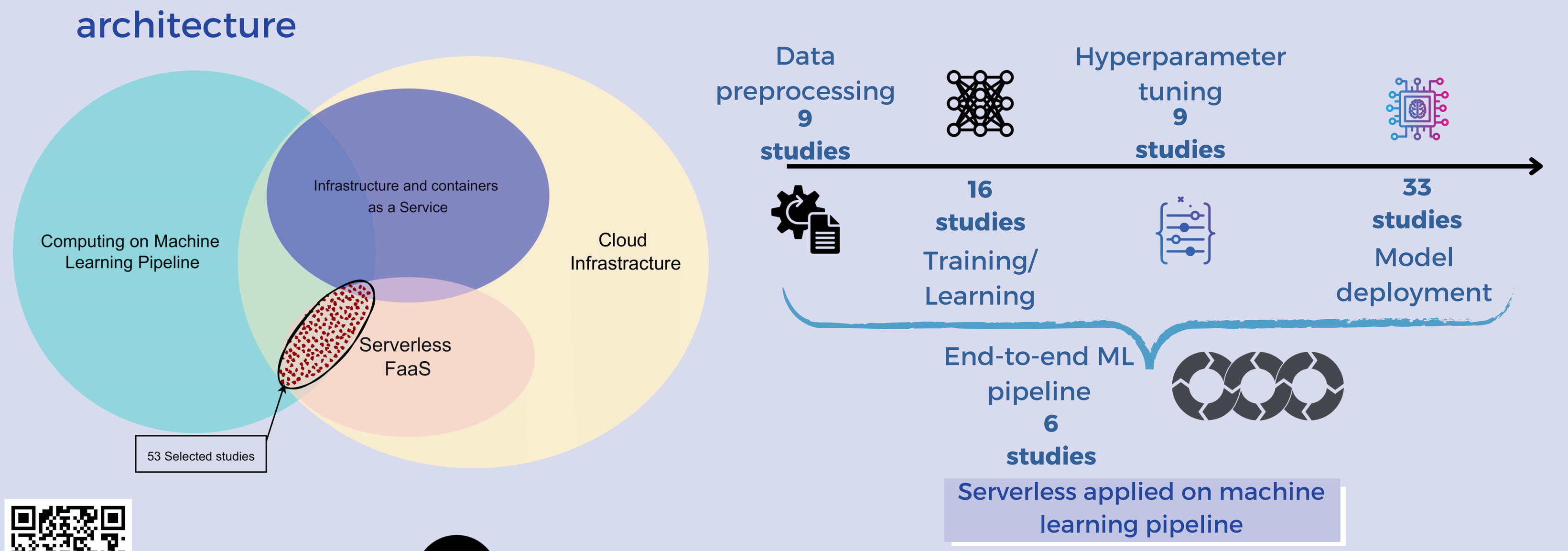
Serverless Functions & Distributed ML: Challenges, Opportunities, Best Practices

- How have serverless functions been utilized in ML pipelines ?
- How can serverless functions be used to speed up ML training?
- How can communication overhead be mitigated in serverless distributed training?
- How can we secure and ensure fault tolerance in serverless training?
- How do we propose a fully serverless ML training architecture?
- What did we learn from comparing serverless ML frameworks?

Serverless Functionsutilization in Machine Learning Pipelines

Conducting a systematic mapping study on ML systems applied on serverless architecture



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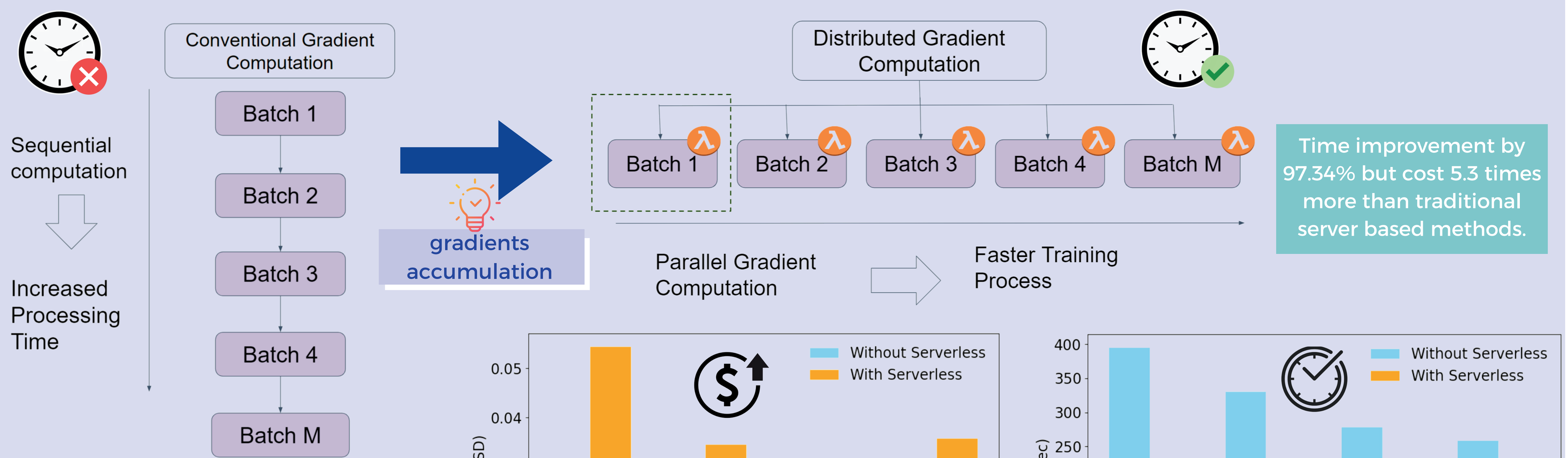
Accelerating ML training with serverless functions



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Reduce communication overhead: Perform ML operations within the database

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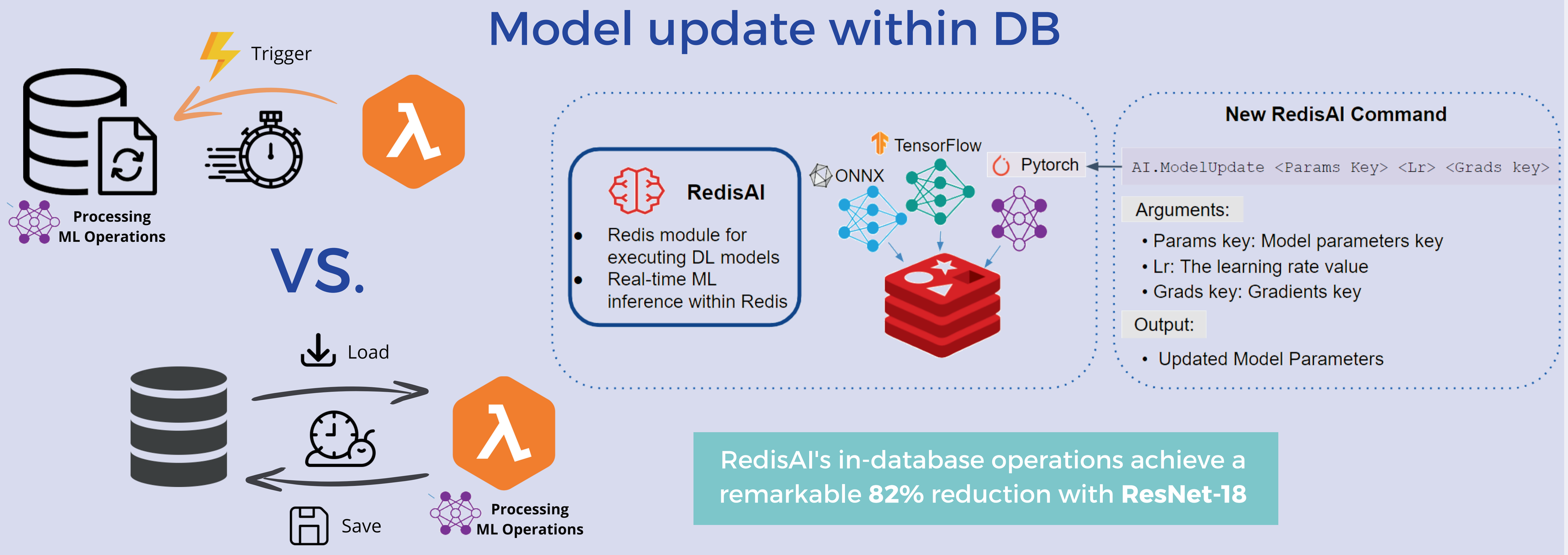
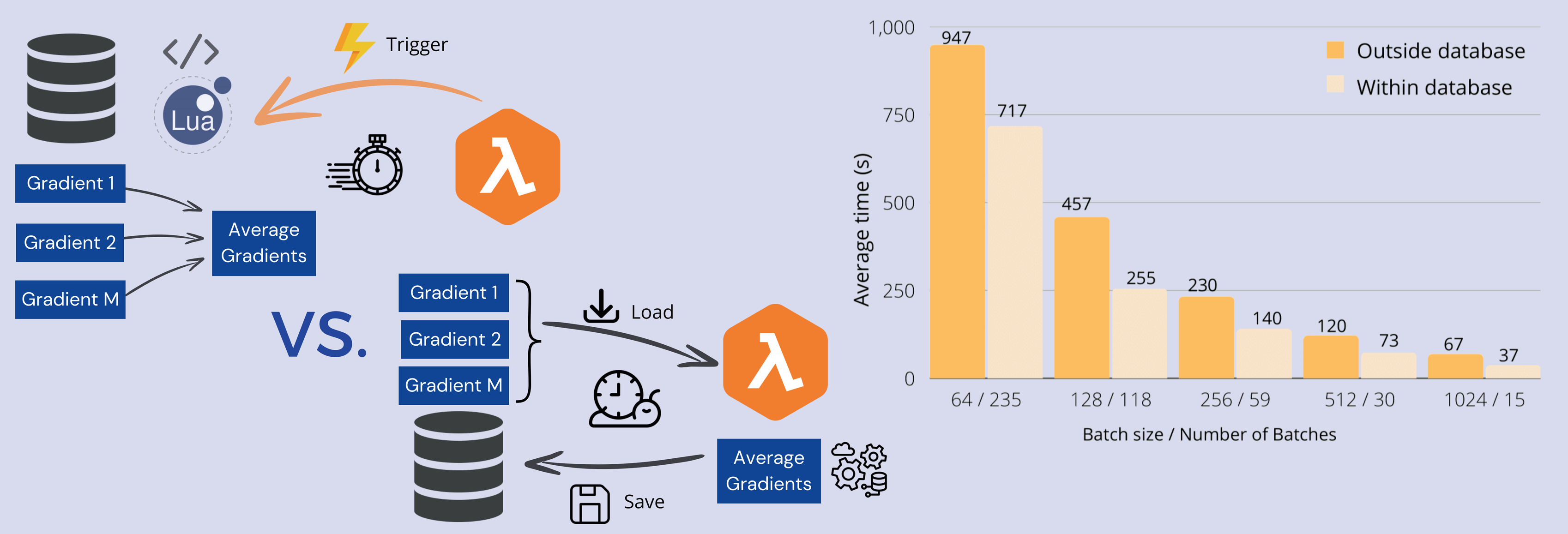
Model update within DB

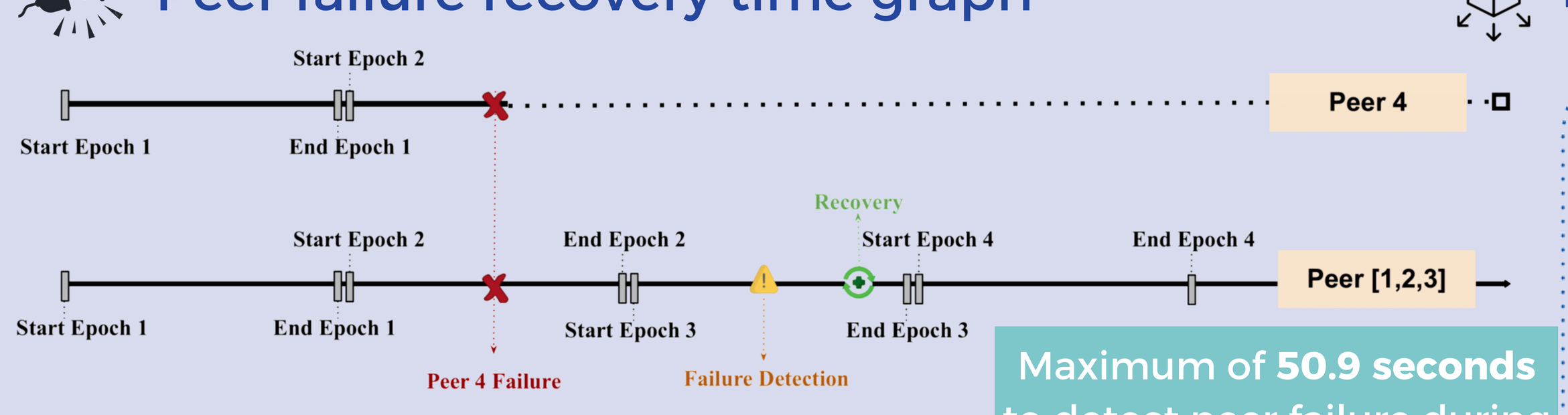


Gradients Averaging within DB

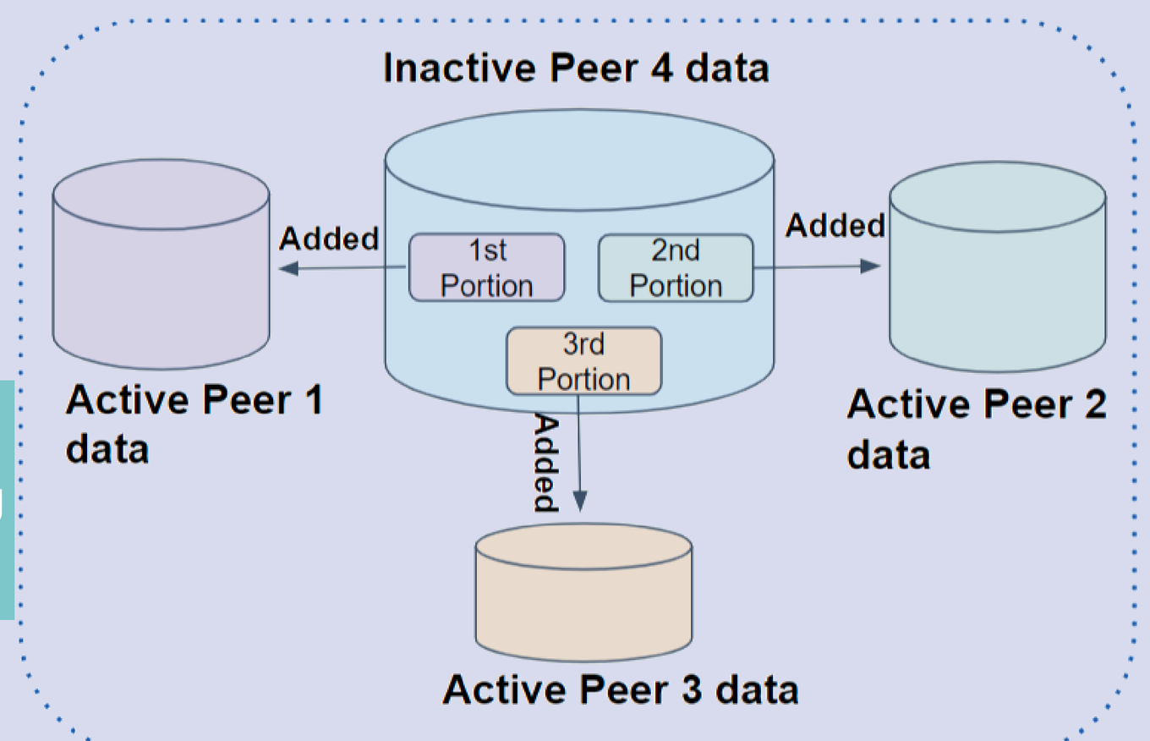


Secure & Fault tolerant communication in serverless distributed training

Peer failure recovery time graph

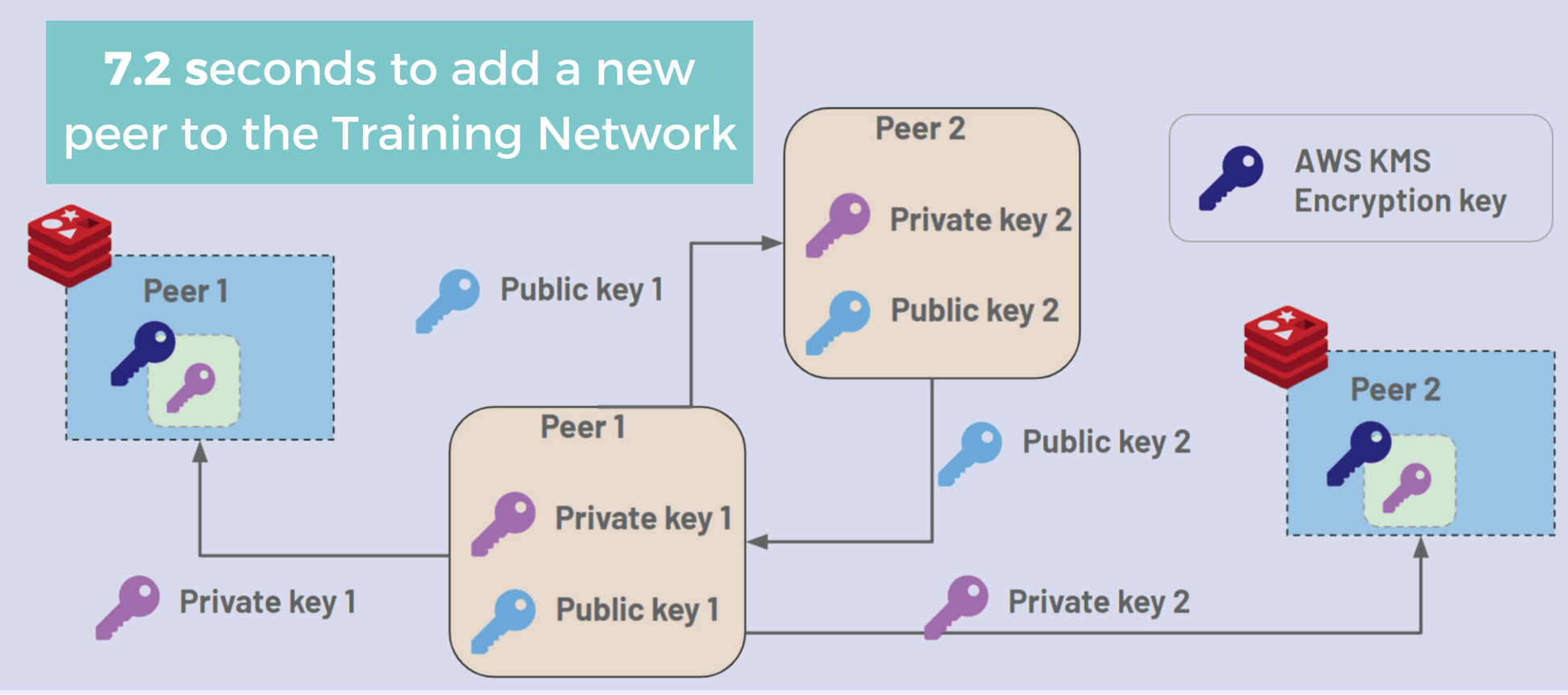


Data redistribution of failed peer



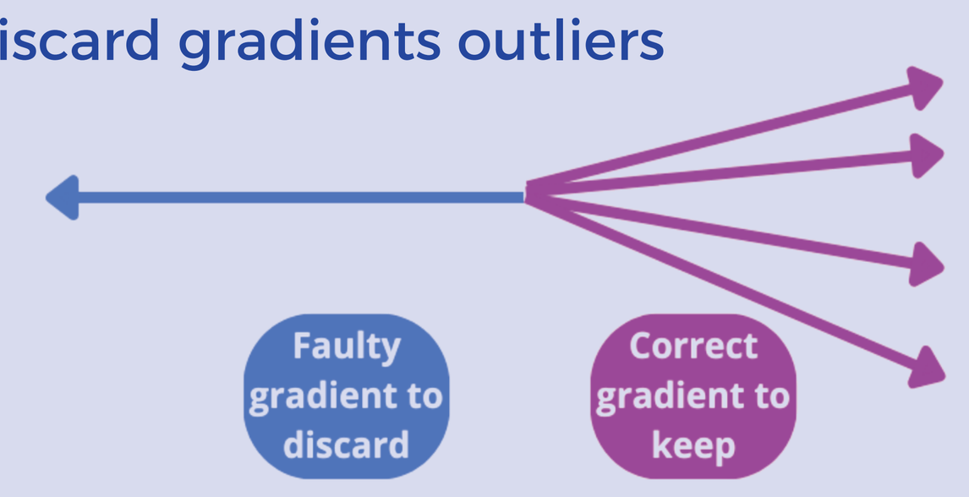
Adding new peers

Peers authentication mechanism / Asymmetric Encryption



Tolerating ML Byzantine attacks

Discard gradients outliers

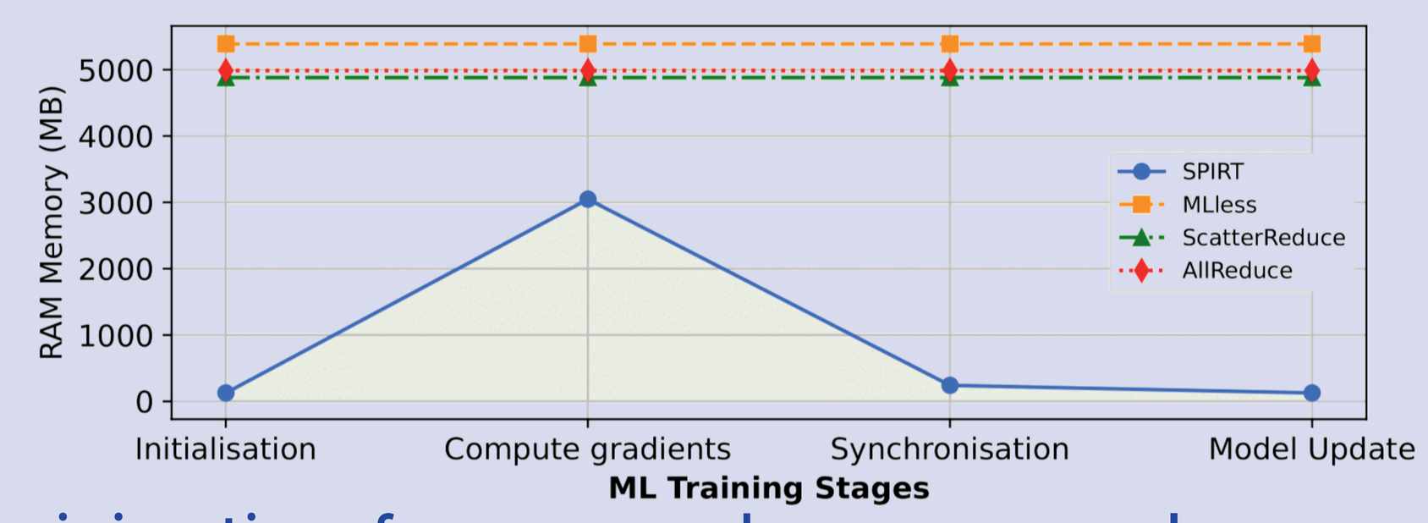


Serverless ML training frameworks comparison

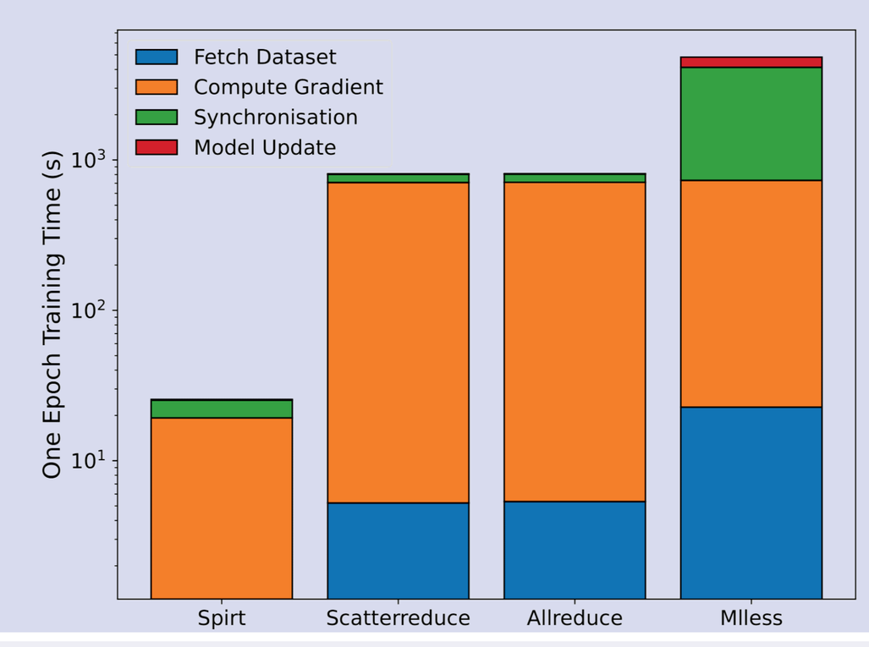
Typical Serverless Training Workflow

- **Fetch dataset** : Each worker fetches its dataset partition
- **Compute gradient** : Independent training of workers on local batches/compute gradients
- **Synchronization** : Gradients upload and aggregation in shared database by workers
- **Model Update** : Update each local model with the aggregated gradients

Split the training workflow into separate serverless functions: Optimisation in RAM usage



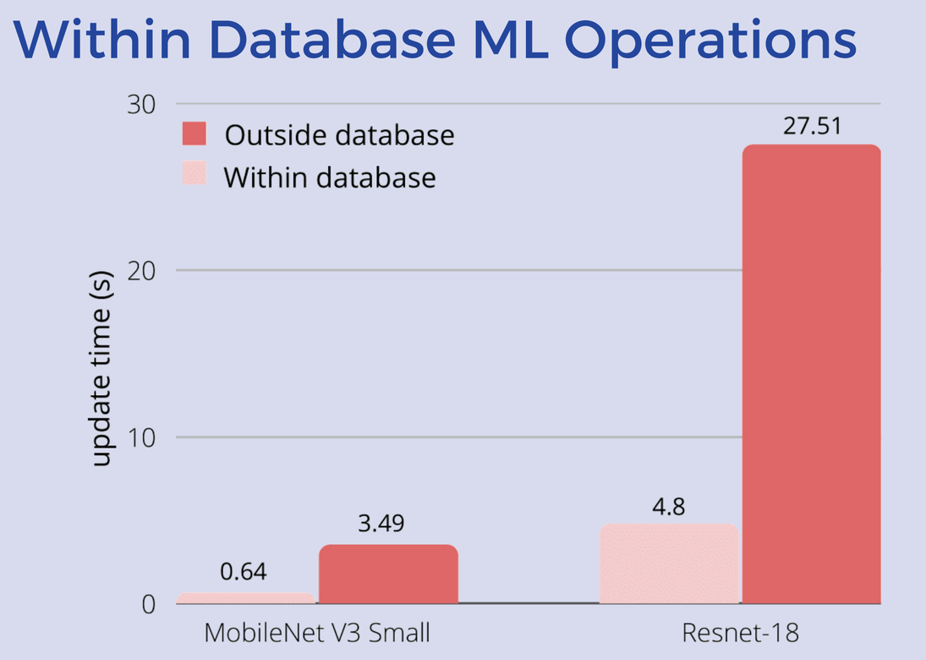
Training time for one epoch across serverless frameworks



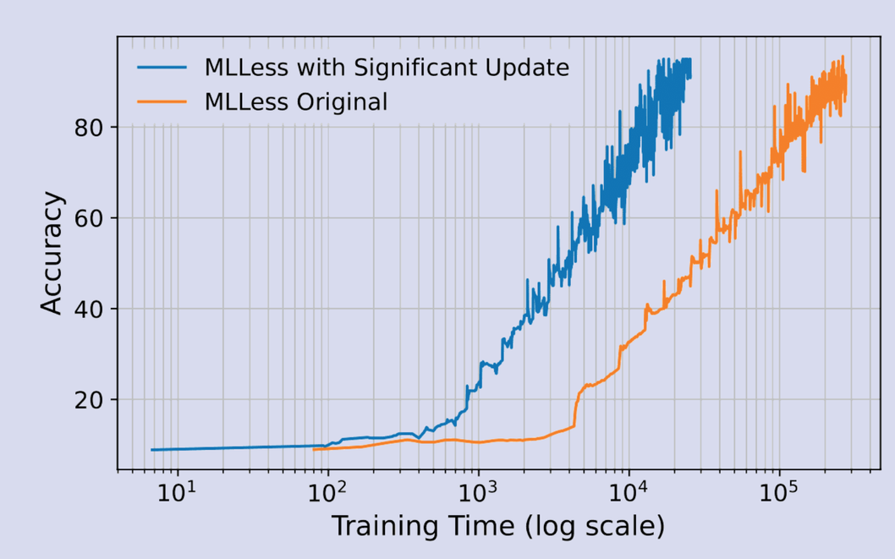
Preprint TPDS 2024

Reduce Communication Overhead

- SPIRT: Within Database ML Operations



- MLLESS: Synchronise only Significant Updates



- LambdaML: ScatterReduce Vs. AllReduce

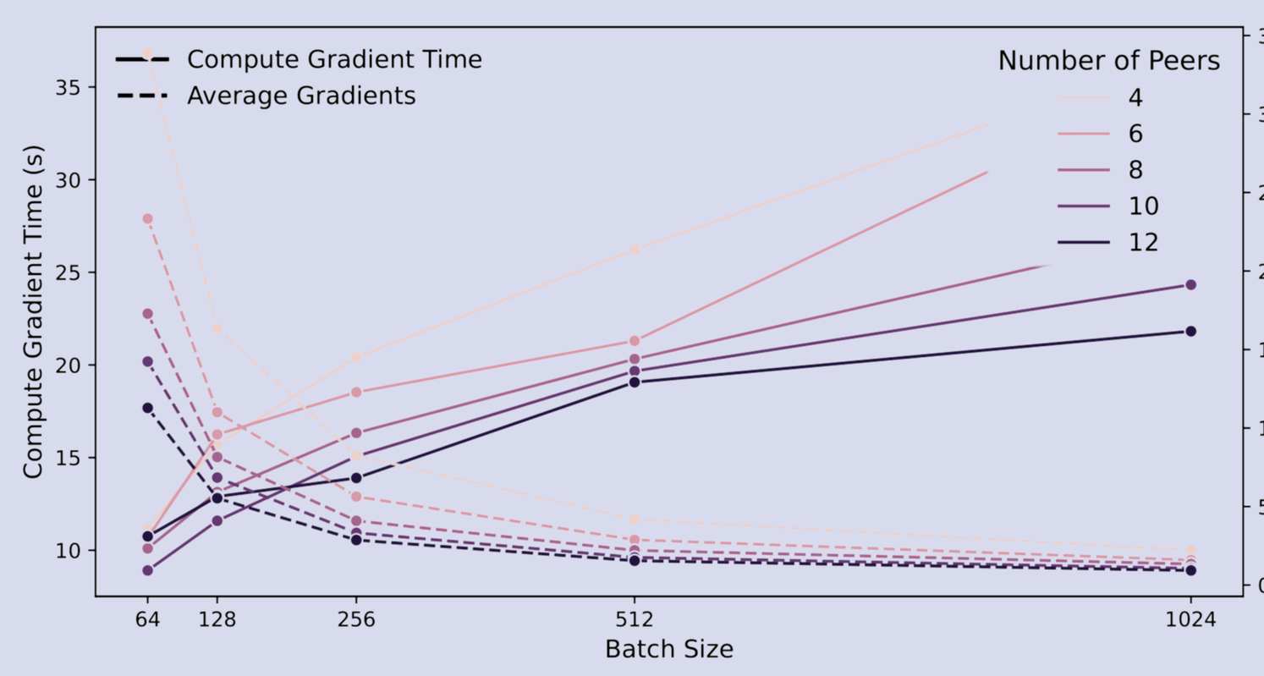
SPIRT : Framework for training ML workflow in serverless environments

- Intra-peer Scalability: parallel gradients computation
- Inter-peer Scalability: Changing number of peers

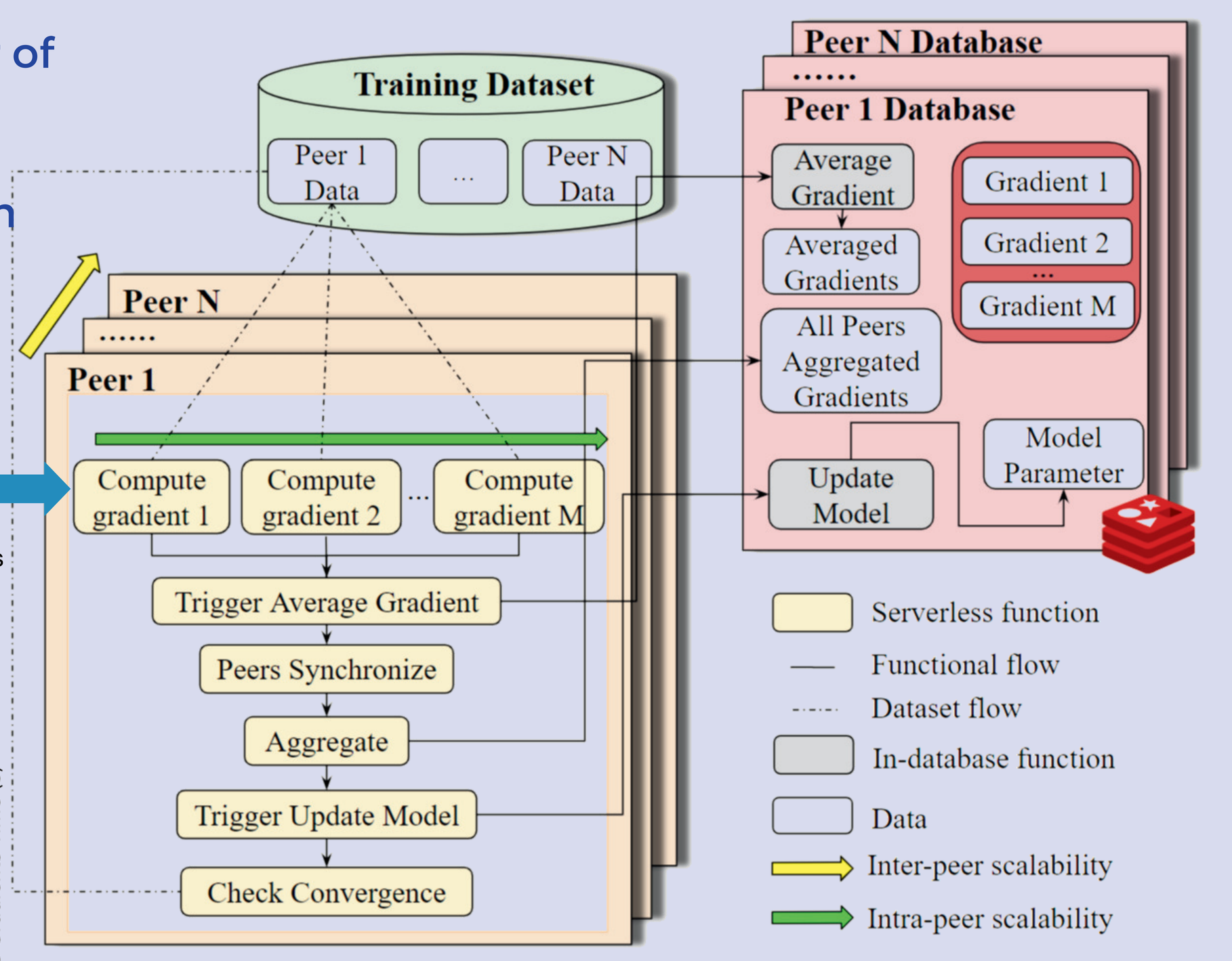
AWS step function for epoch orchestration

No single point of failure: robust peer-to-peer (P2P) architecture

Varying Batch Sizes for Different Number of Peers with DenseNet-121 Model



SPIRT Framework



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IPDPS 2024 • San Francisco, California USA
San Francisco, California • May 27-31, 2024