

# Towards Federated Learning Using FaaS Fabric



6<sup>th</sup> International Workshop on Serverless Computing (WoSC6)

In conjunction with, ACM/IFIP Middleware 2020

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<https://www.serverlesscomputing.org/wosc6/#p9>



# Outline

- ❑ Motivation
- ❑ Background
- ❑ Goals
- ❑ System Design
- ❑ Experimental Setup
- ❑ Results
- ❑ Conclusion and Future Work

# Outline

❑ Motivation



❑ Background

❑ Goals

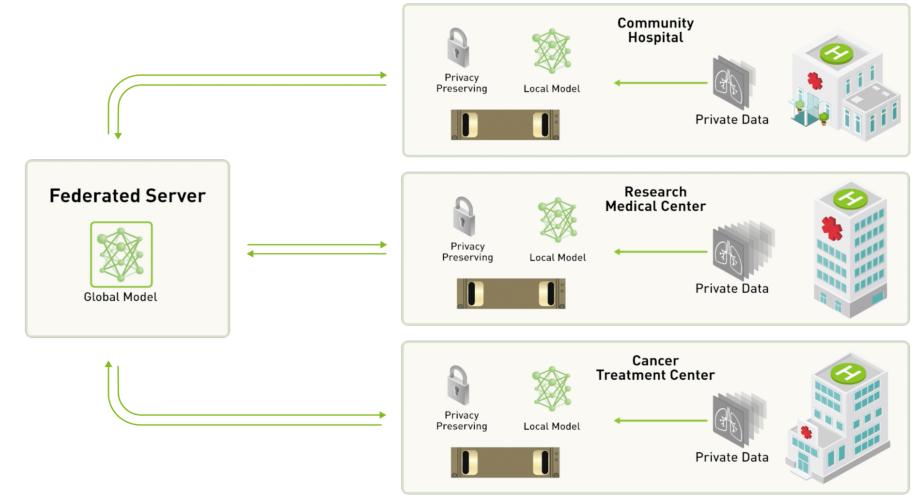
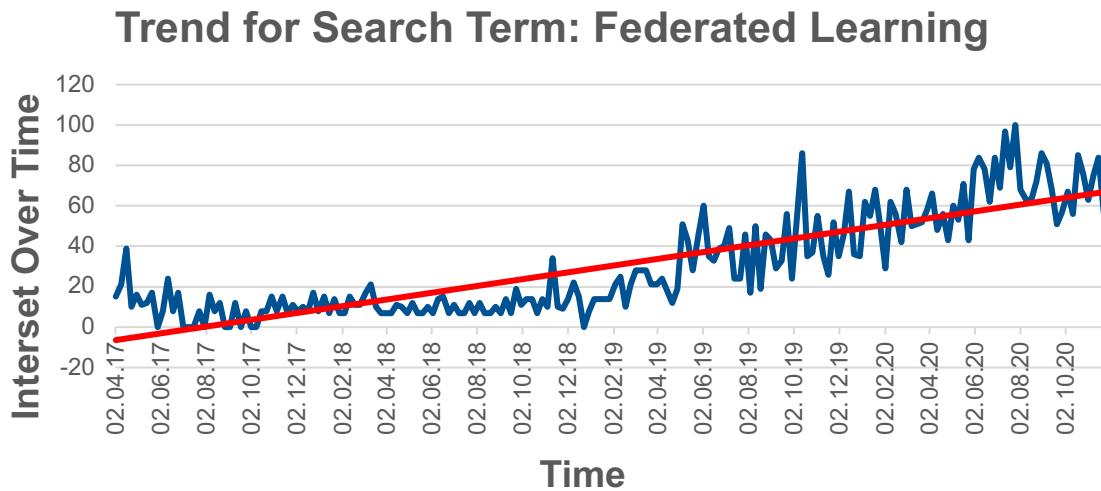
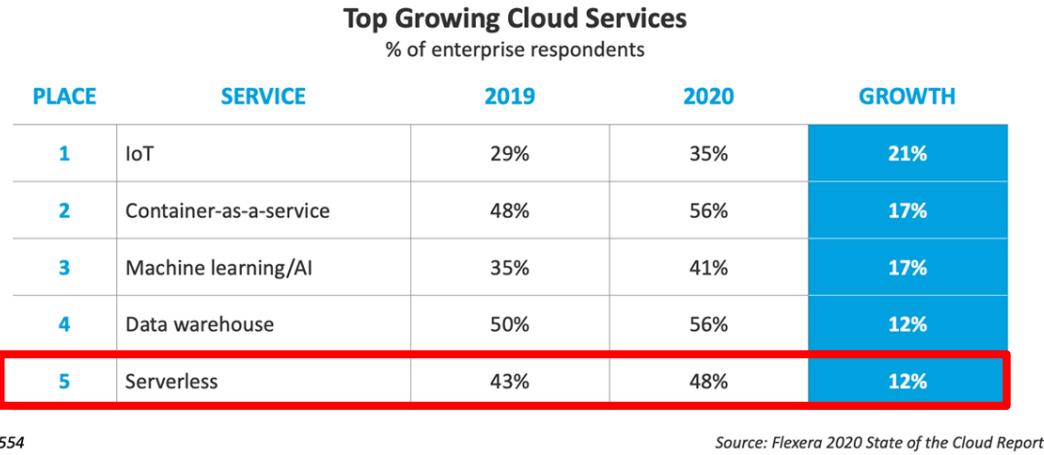
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# Motivation



Source: <https://blogs.nvidia.com/blog/2019/10/13/what-is-federated-learning/>



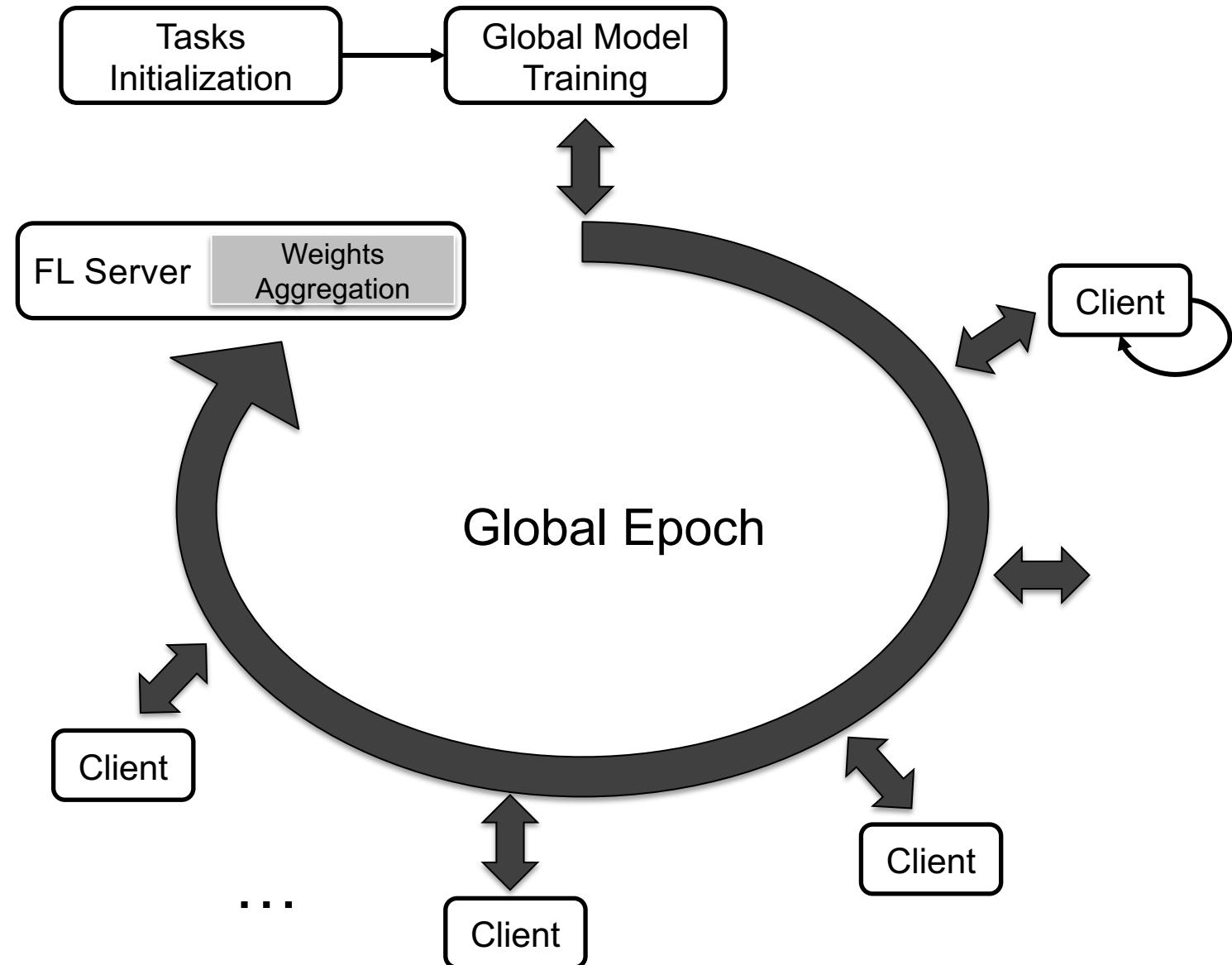
`tff.federated_computation(lambda: 'Hello, World!')()`

# Outline

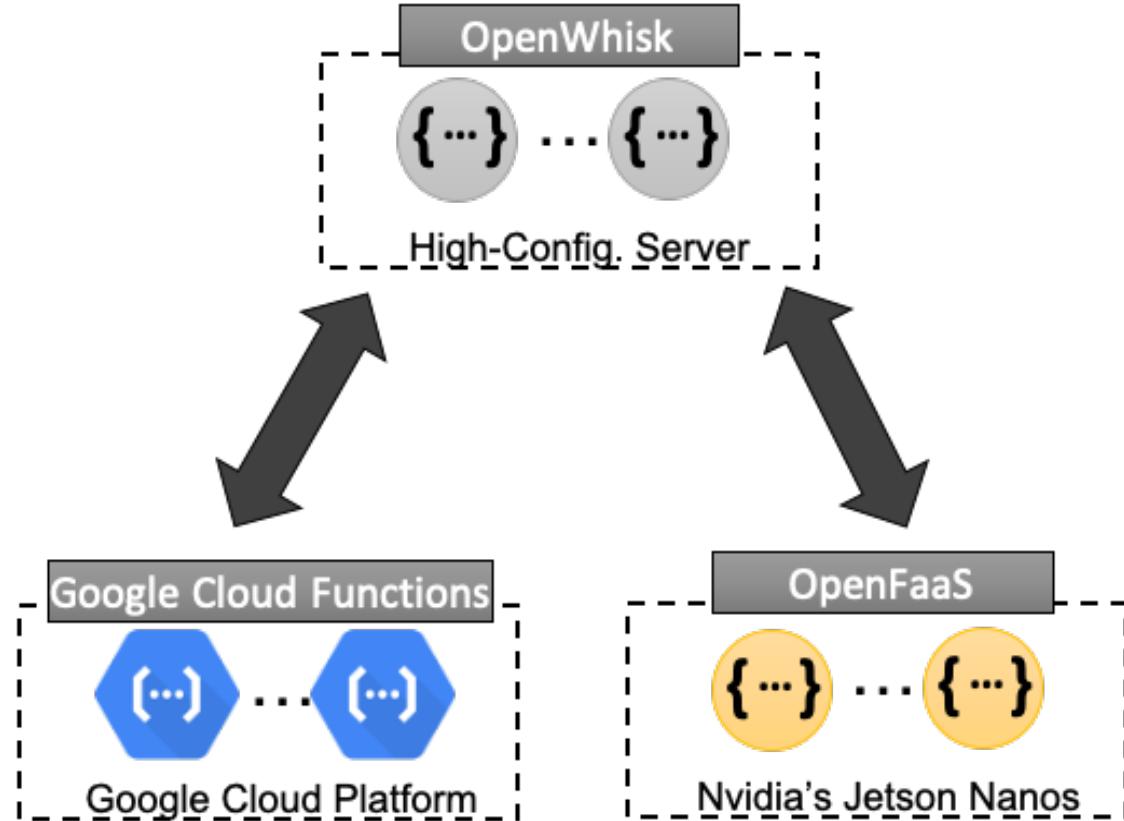
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# Federated Learning



# FaaS Fabric



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# Goals

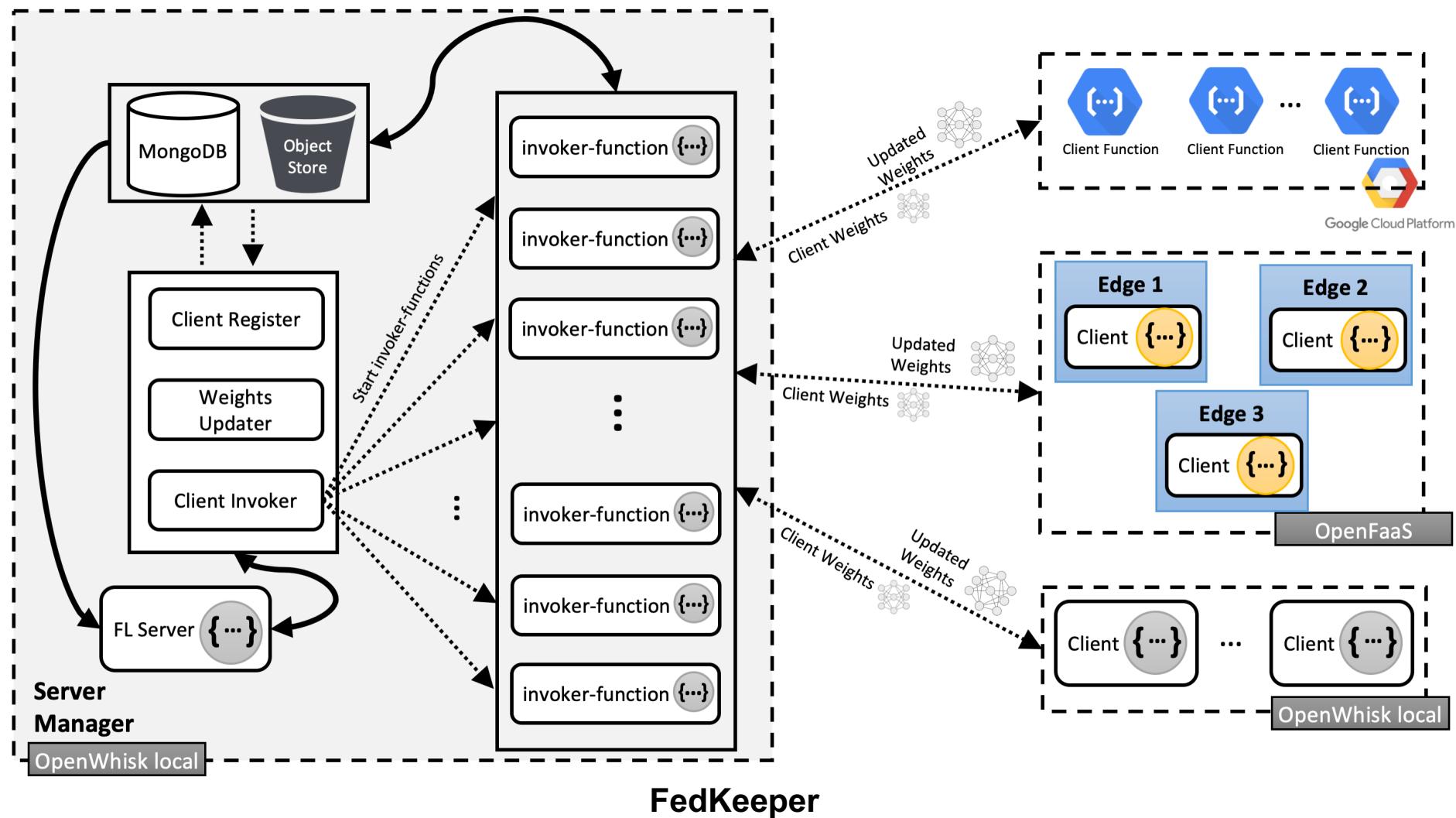
- 
- The diagram illustrates three goals, each represented by a blue circle with a white number and a black arrow pointing to a rectangular box containing a detailed description.
- 1 Extension of FaaS to multiple heterogeneous FaaS platforms.
  - 2 Enabling Federated Learning using Serverless Computing.
  - 3 Ease of use.

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# System Design



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# Experimental Setup

## OpenWhisk (OW)

- Deployed over a single node Kubernetes Cluster (On-premise)
- Two sockets, Intel Cascade Lake-SP, 22 cores each

## OpenFaaS (OF)

- Edge Cluster with 3 Nvidia Jetson Nano Devices (On-premise)
- K3s as the container-orchestration system

## Google Cloud Functions (GCF)

## Each platform runs Tensorflow

## Evaluation on a Image Classification Task

## Two architectures:

- 2-layer Fully connected NN
- CNN

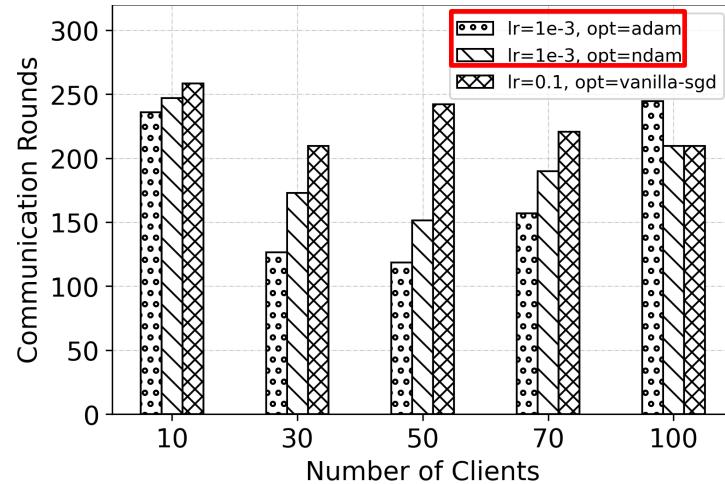
| Configuration | OW    | OF   | GCF   |
|---------------|-------|------|-------|
| Memory        | 2 GiB | 2GiB | 2 GiB |
| FL-Clients    | 7     | 3    | 93    |

# Outline

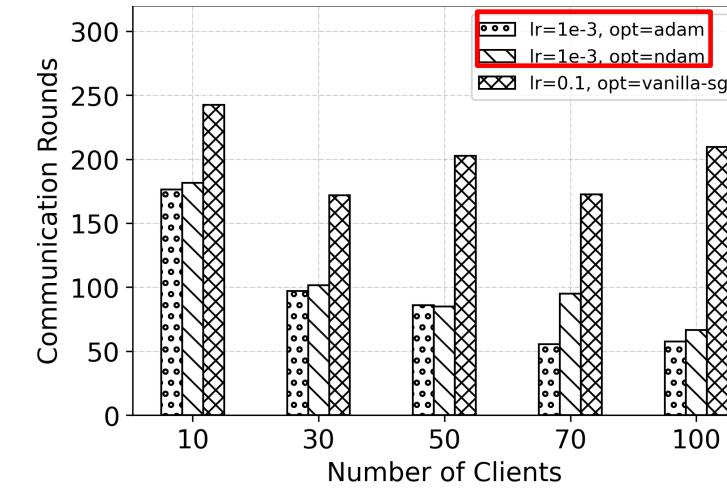
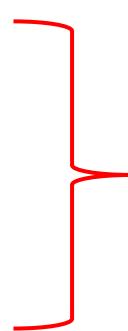
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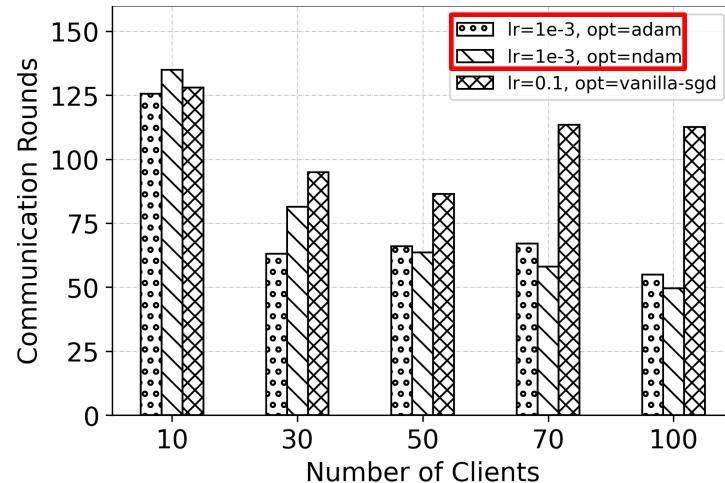
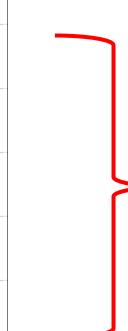
# Increasing Parallelism and local computation



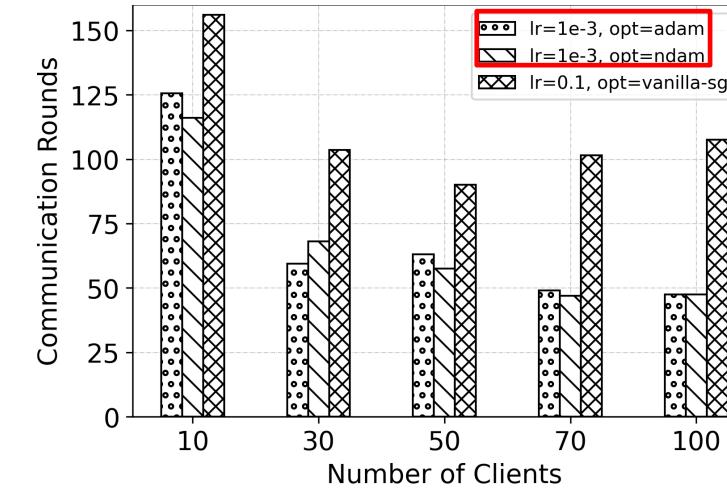
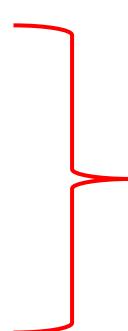
NN, 5 local epochs



NN, 10 local epochs



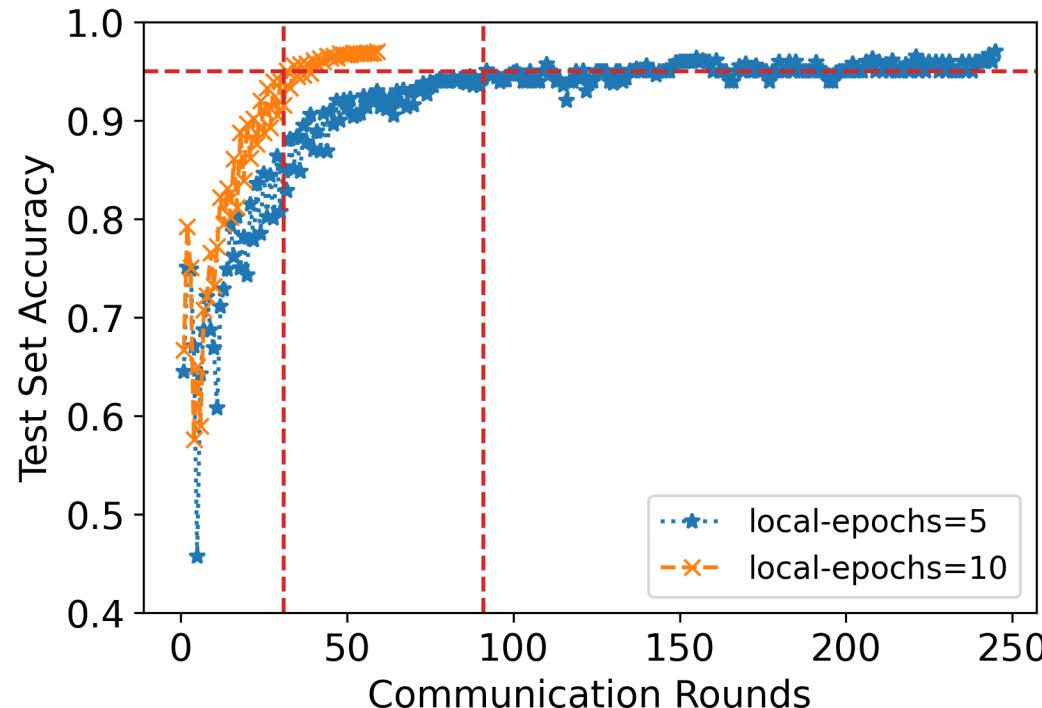
CNN, 5 local epochs



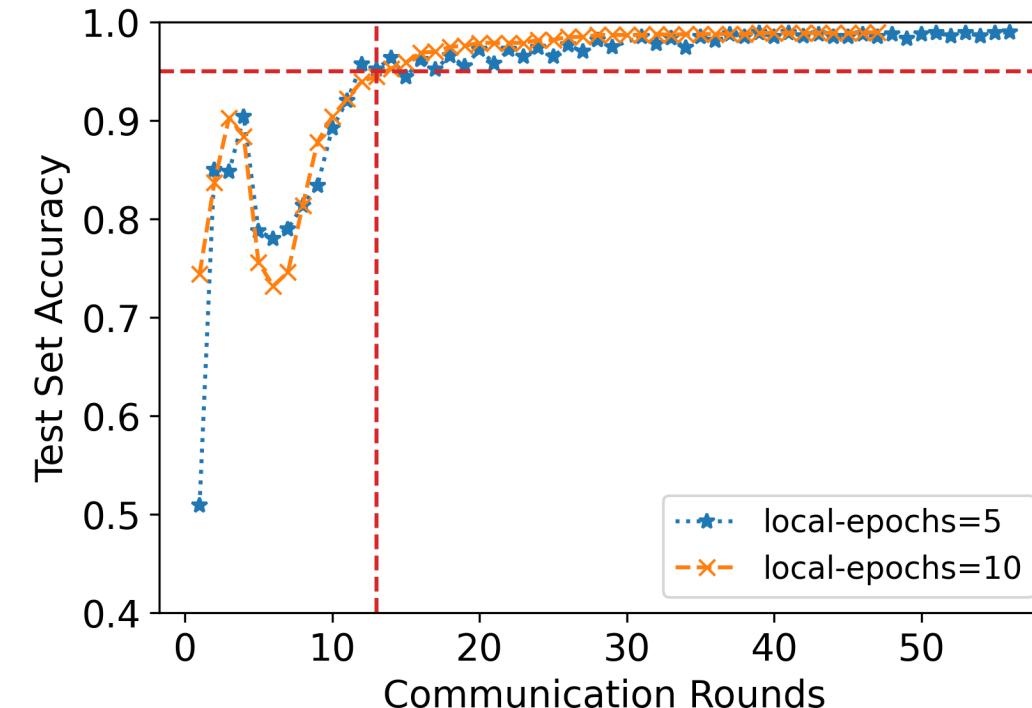
CNN, 10 local epochs



# Accuracy Across Communication Rounds

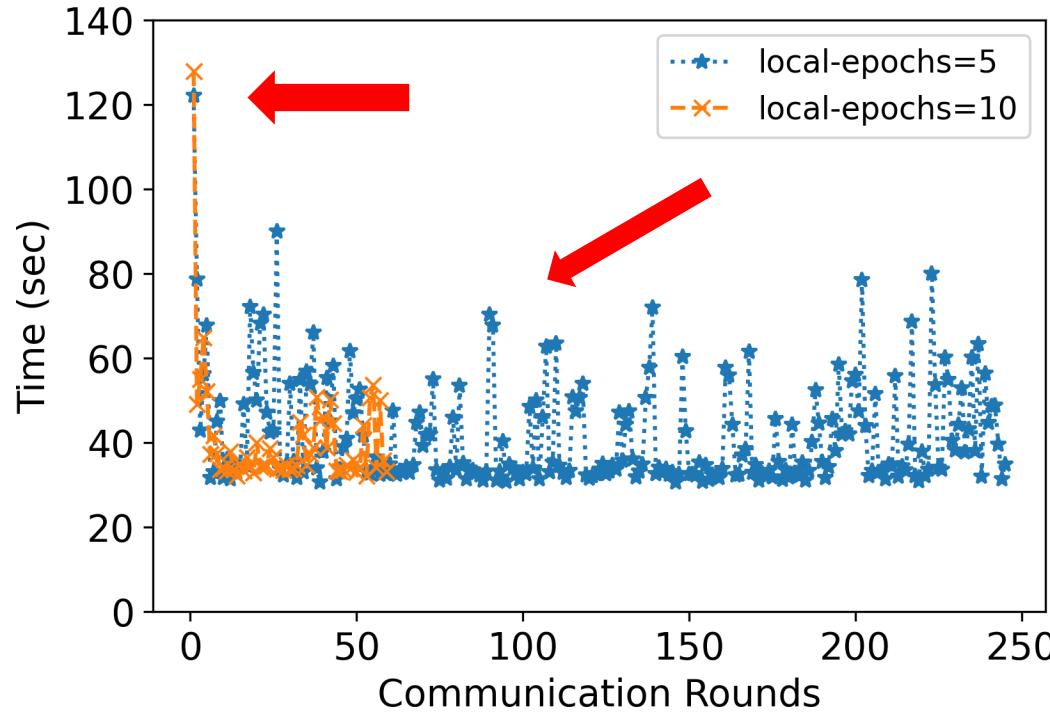


NN

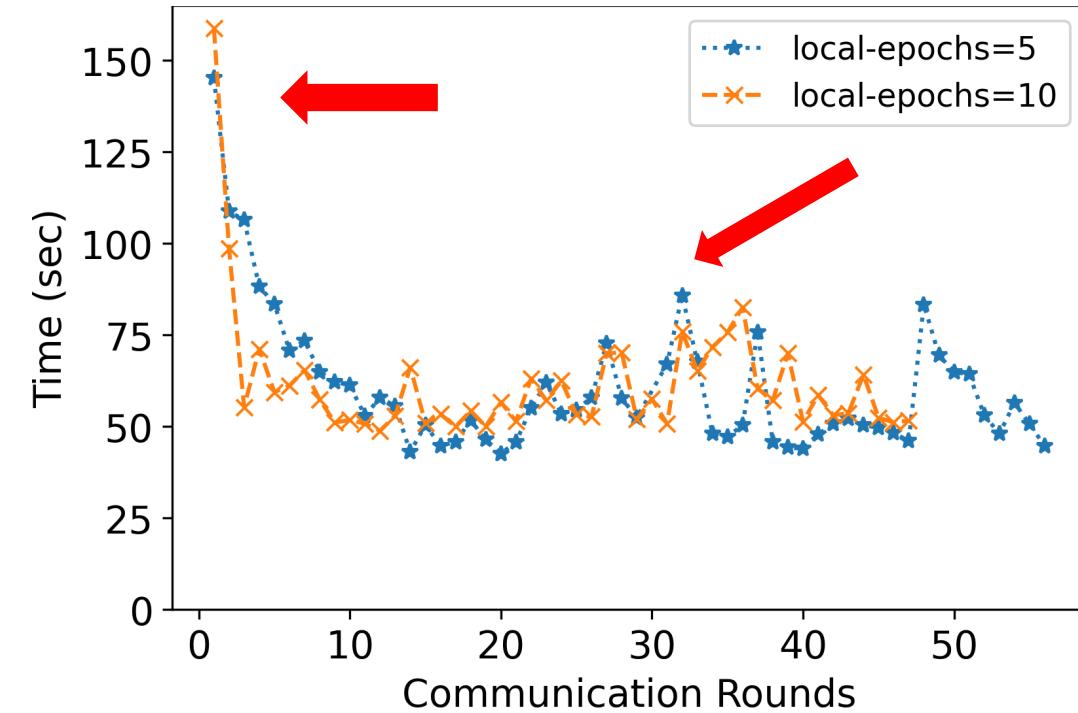


CNN

# Performance Across Communication Rounds

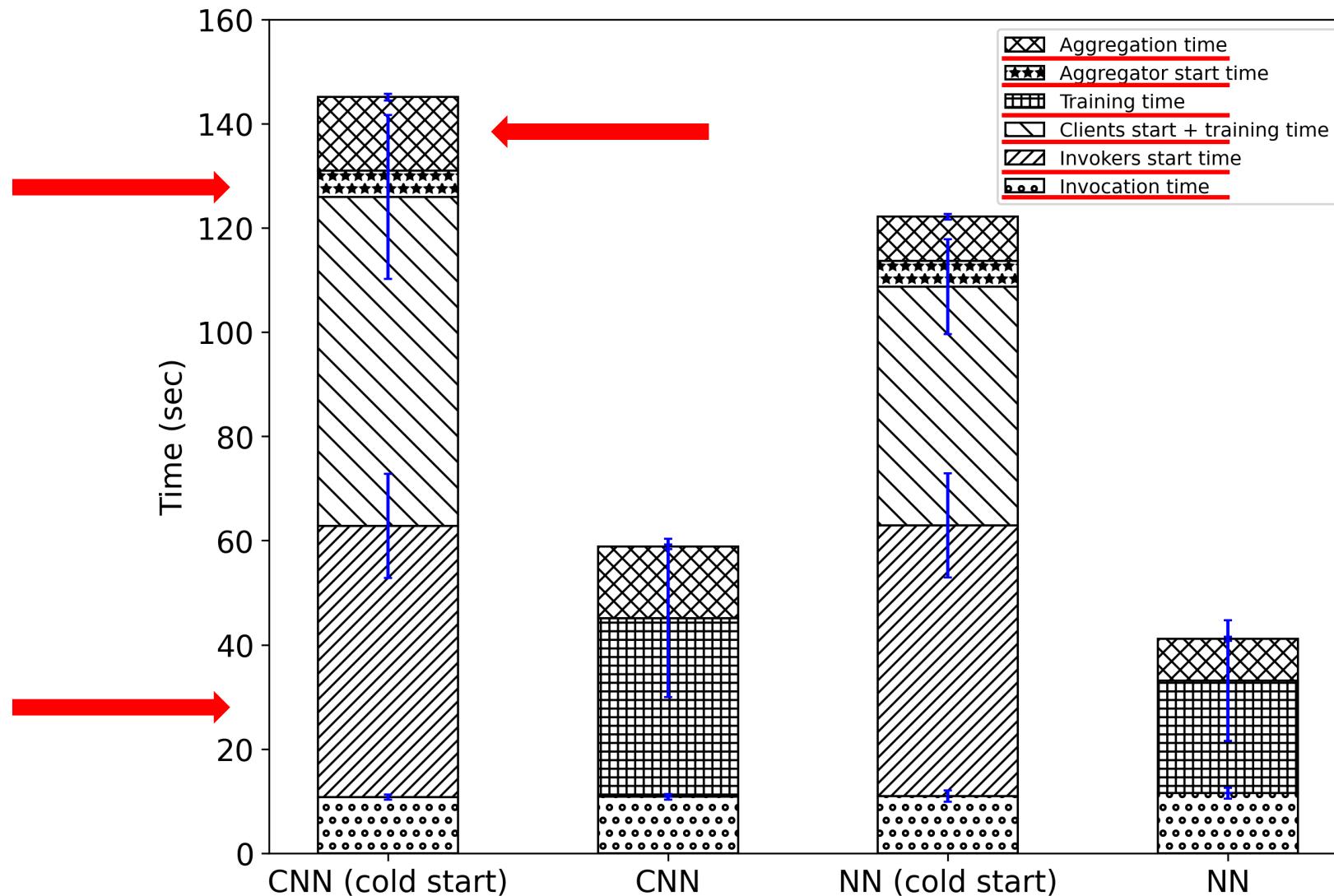


NN



CNN

# Time Distribution



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# Conclusion and Future Work

- ❑ Manageability
- ❑ Simplicity
- ❑ Scalability

## Future Work

- ❑ Optimizing FedKeeper's Performance
- ❑ Compute-aware scheduling of Clients on heterogeneous devices
- ❑ Dynamic addition/removal of clients
- ❑ Integration of privacy solutions

# We are..

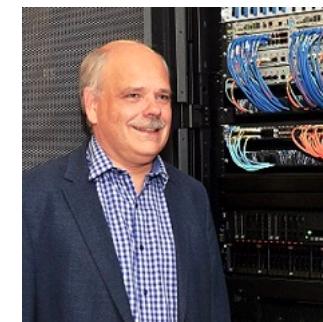
## Edge-Cloud, IoT, HPC RG @ Chair of Computer Architecture and Parallel Systems Technical University of Munich



P.hD. Student  
Mohak Chadha



P.hD. Student  
Anshul Jindal



Prof. Dr. Michael Gerndt

+ Other Students



Visit Us!



### □ Research Areas:

- Dynamic Resource Management HPC/Cloud
- Function scheduling in heterogeneous FaaS platforms
- Modelling of microservices/FaaS applications
- AI for smart Cloud operations (anomaly detection and failure predictions) and many more..

# Contact

Thank you for your attention!

Questions ?



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