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ALL IN

The bridge to possible

Simplifying Federated Machine Learning Jobs With Flame in Kubernetes

Myungjin Lee, Technical Lead
Emerging Technologies and Incubation (ET&I)

BRKETI-2001

Cisco Webex App

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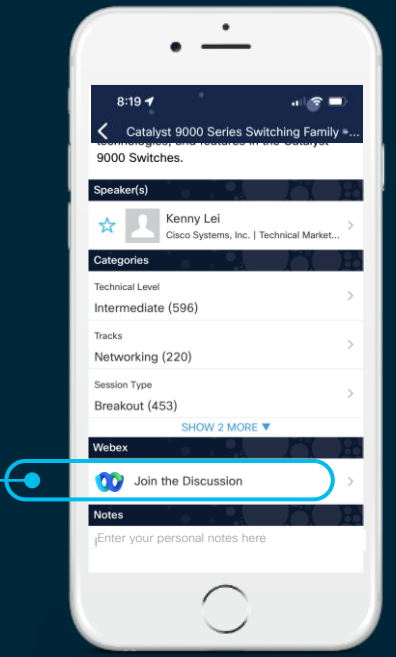

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Webex spaces will be moderated by the speaker until June 17, 2022.

Agenda

- Cisco Research Overview
- Machine Learning at the Edge
- Flame
  Federated Learning, AI/ML, at the Edge
- Demo
- Summary
- Call to Action

Cisco Research Overview

Goal: To conduct and foster research in technology areas of strategic interest to Cisco and generate business, technology and societal impact

Ramana Kompella
Head of Cisco Research

Research Team






Ops Team



Research Areas

Ethical AI

Bias detection/mitigation, ethical design, privacy-preserving AI/ML, AI for ethics

Edge Computing

Infrastructure, federated/distributed ML, CAVs, MLOps, serverless, 5G

Future of Work

Productivity, worker wellness, smart home

Future Directions

Data Management,
Data Processing,
Sustainability,
Distributed Systems,
Metaverse,
Blockchain,
Networking,
Cloud

Security

Malware, pen-testing, privacy-preserving computation, SW supply chain, biometrics

Healthcare

AI/ML for diseases, federated learning, mental healthcare, radiology, remote health monitoring

Supply Chain

Anomaly prediction, supply-demand planning, RFID-based tracking, security

NLP

NL understanding, language models, text summarization

AI/ML/CV

Scene prediction, multimodal sensing, image reconstruction, AIOps

Quantum

Quantum networking & cryptography
Quantum computing & datacenter

Machine Learning at the Edge

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AI/ML Use Cases

Cybersecurity

- Anomaly detection
- Breach risk prediction
- ⋮

Manufacturing

- Predictable maintenance
- Product defect detection
- ⋮

Agriculture

- Yield prediction
- Livestock health monitoring
- ⋮

Finance

- Fraud detection
- Risk management
- ⋮

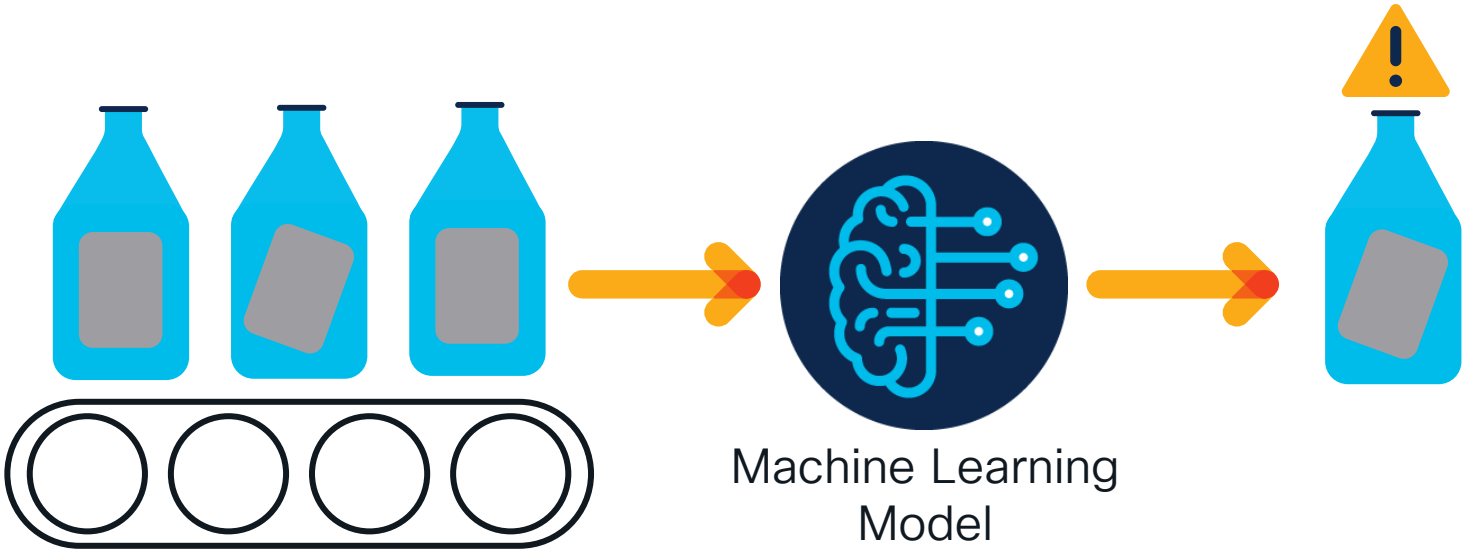
Connected Cars

- Road hazard avoidance
- Driver monitoring
- Driver risk assessment
- ⋮

Healthcare

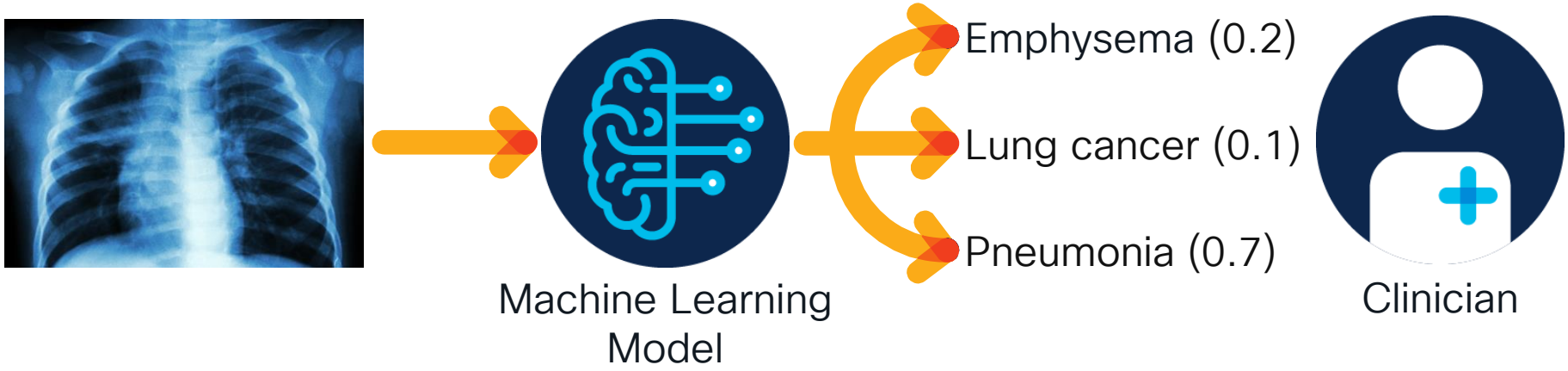
- Precision medicine
- Disease diagnosis
- Drug discovery
- ⋮

Data-driven Quality Control



How to train a model?

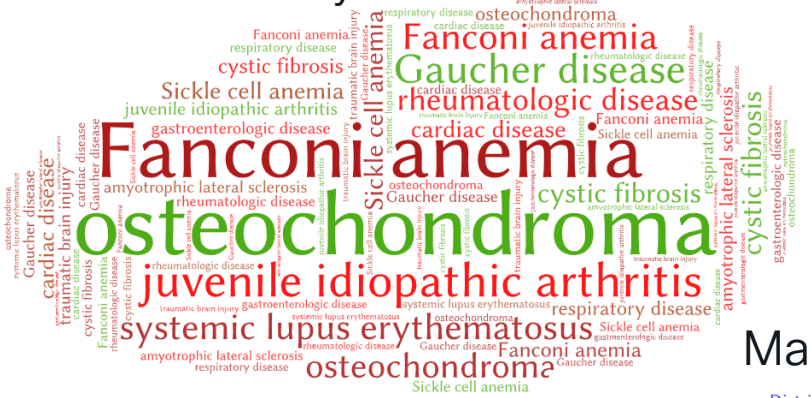
Assisting Clinicians with Data-driven Diagnosis



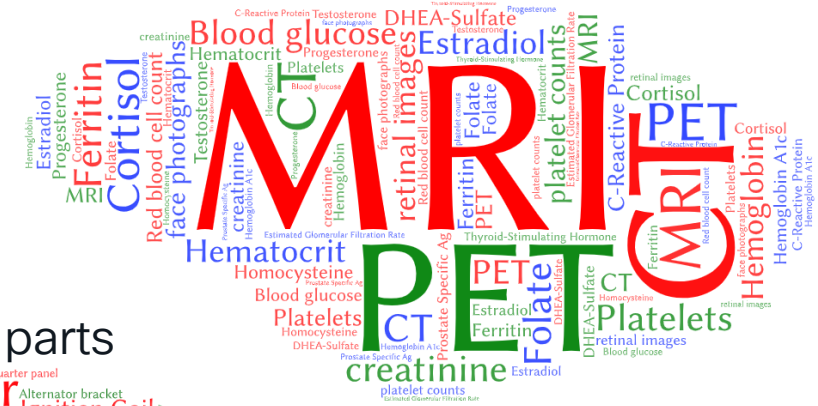
How to train a model?

Many Models To Be Trained

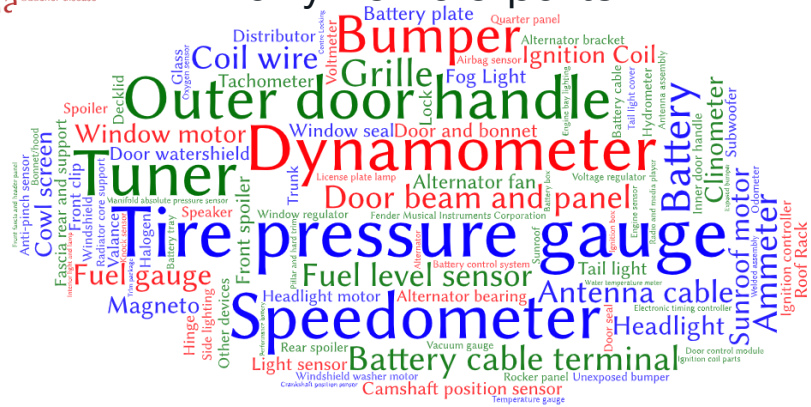
Many diseases



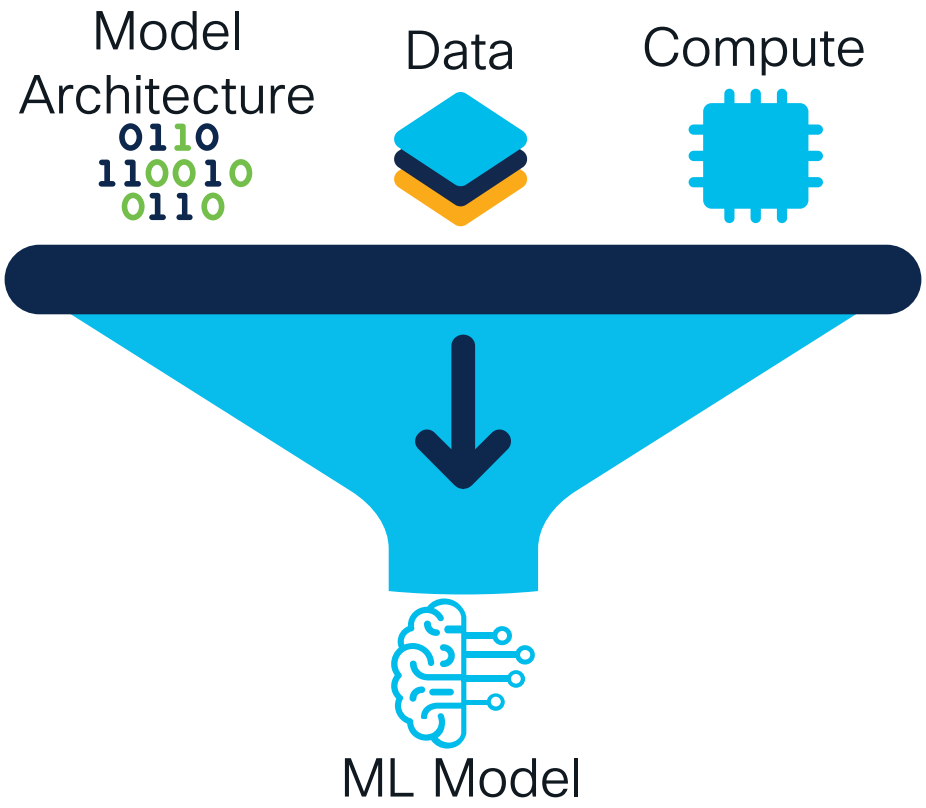
Many medical data types



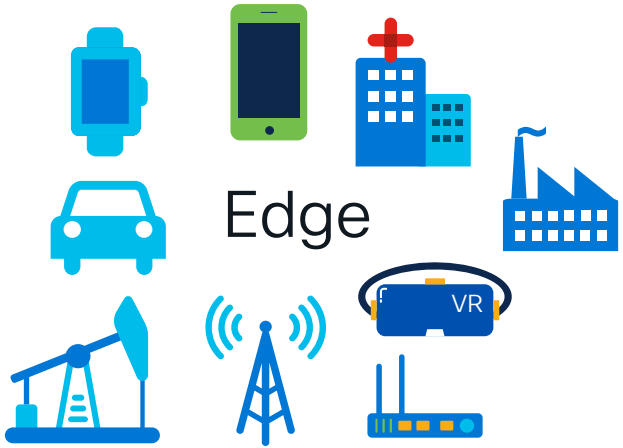
Many vehicle parts

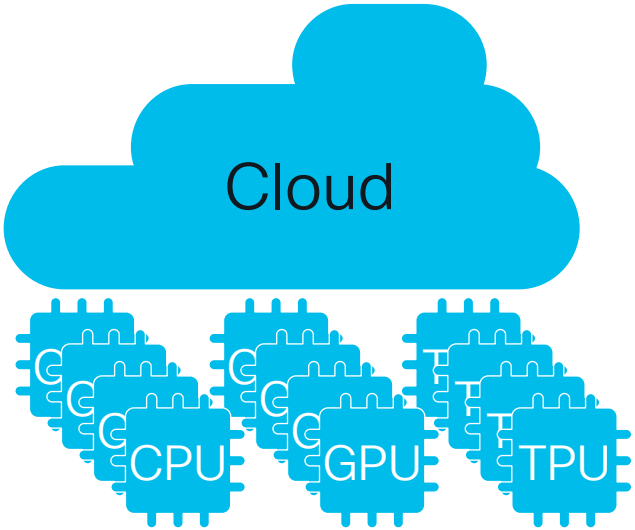


(Simplified) Recipe of Machine Learning



Challenges of ML Training at the Edge

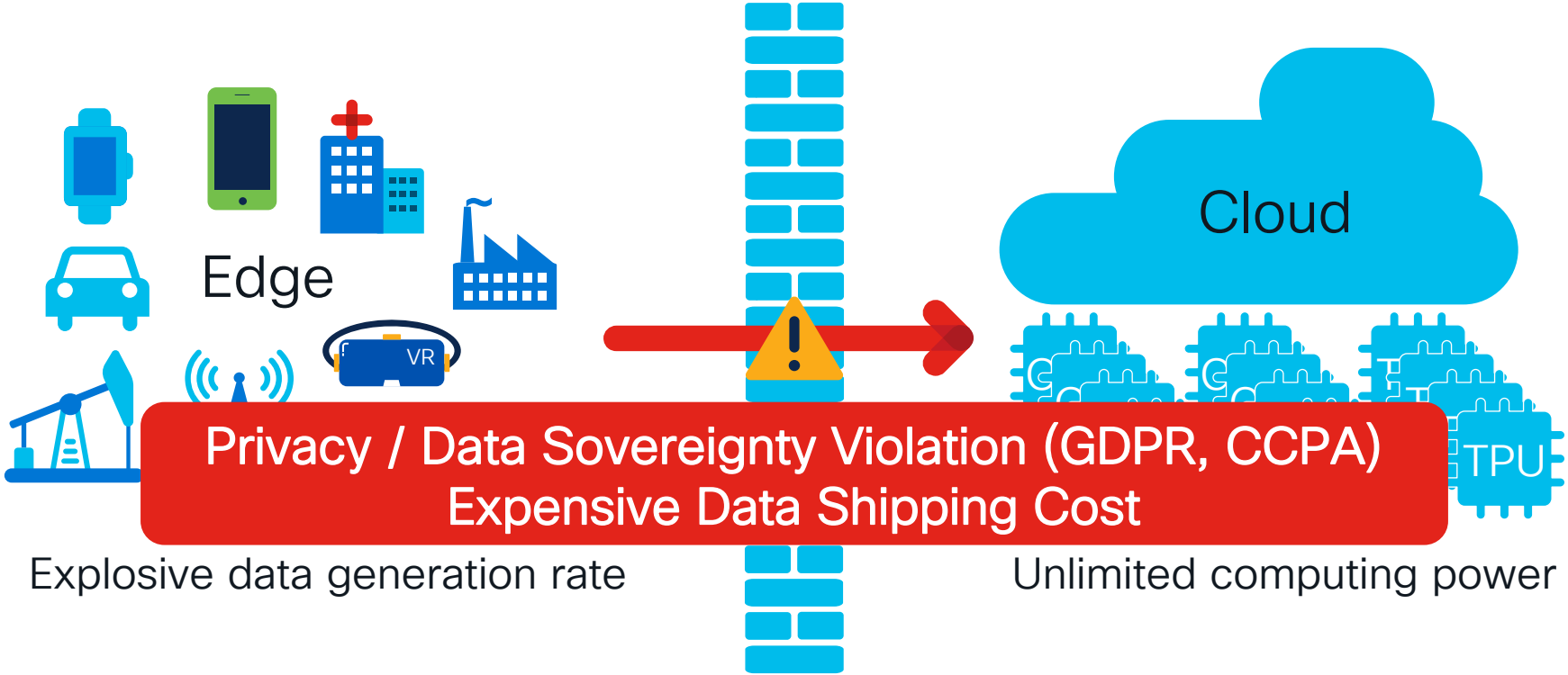




Explosive data generation rate

Unlimited computing power

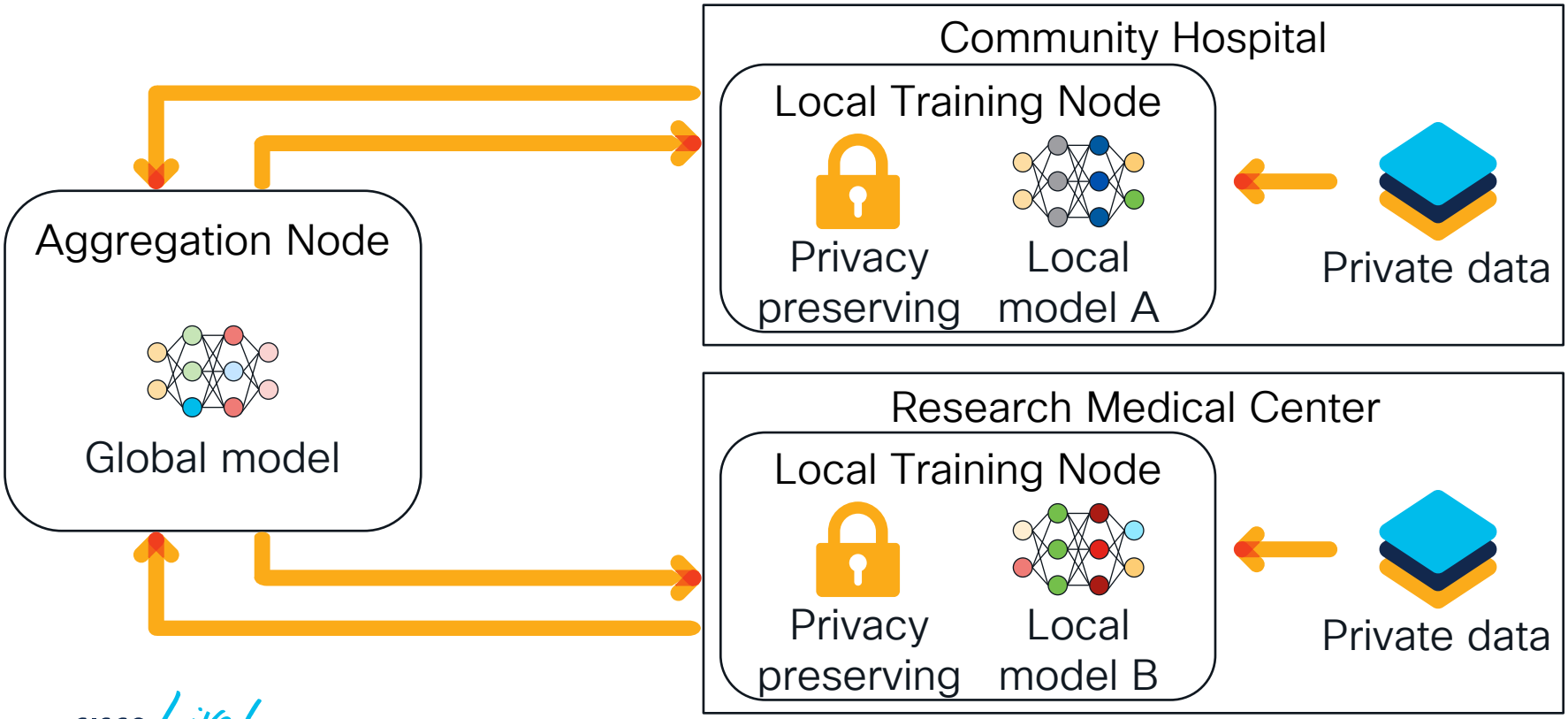
Challenges for ML Training at the Edge



Spectrum of ML Training Approaches

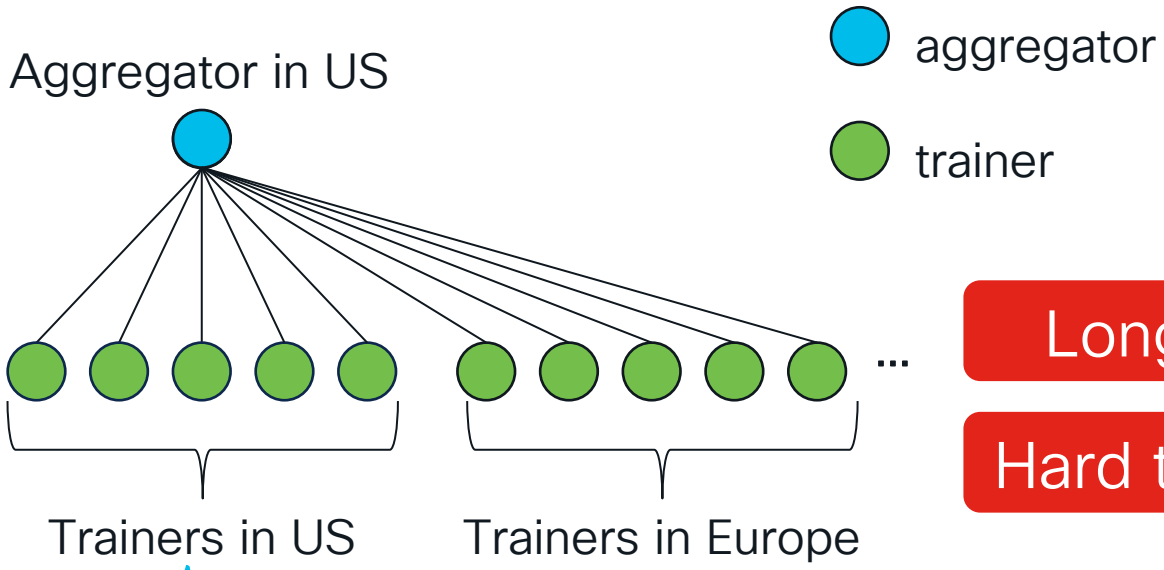
Data Store	Centralized	Geo distributed
Training Location	Cloud, datacenters	Edge, end devices
Resources	Homogenous, unlimited	Heterogenous, scarce
Network	Datacenter Networks	WAN
Data Movement	Yes	No

ML Training at the Edge: Federated Learning



Today's Conventional FL

Problem: one-size-fits-all approach doesn't work

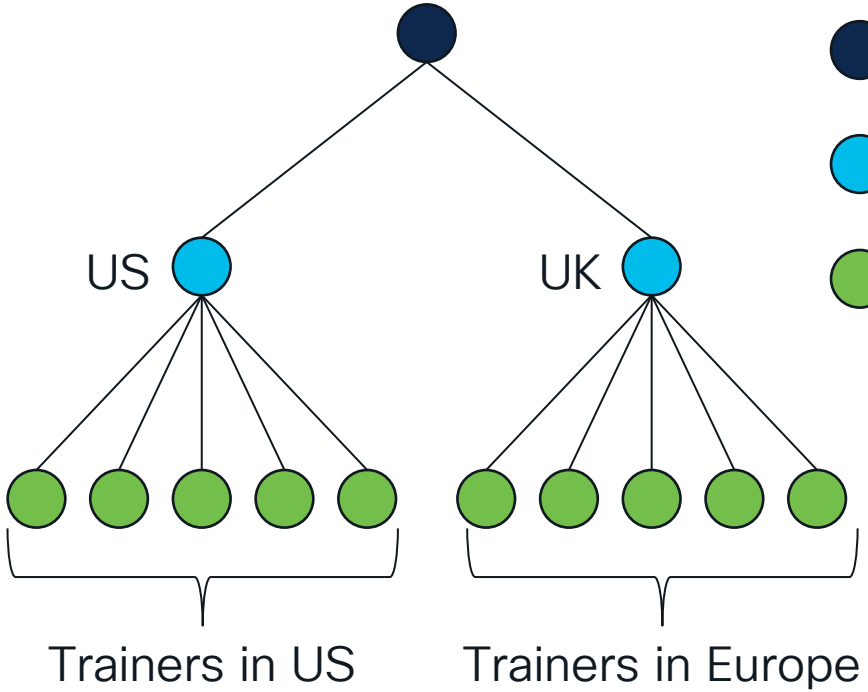


Longer time to converge

Hard to personalize a model

Today's Conventional FL

Problem: one-size-fits-all approach doesn't work



global aggregator

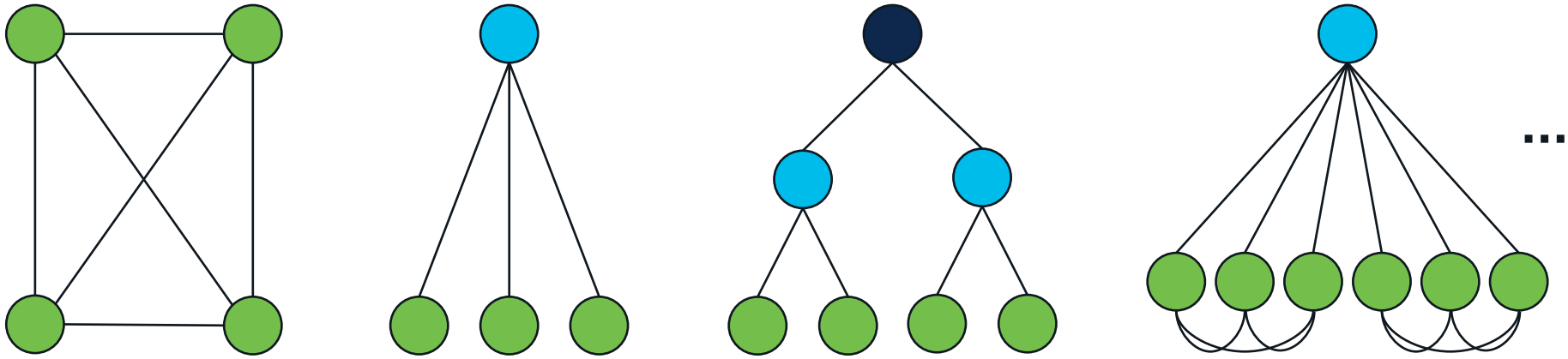
aggregator

trainer

Tedious workload update

Challenges: Fast Evolution, Rigid Framework

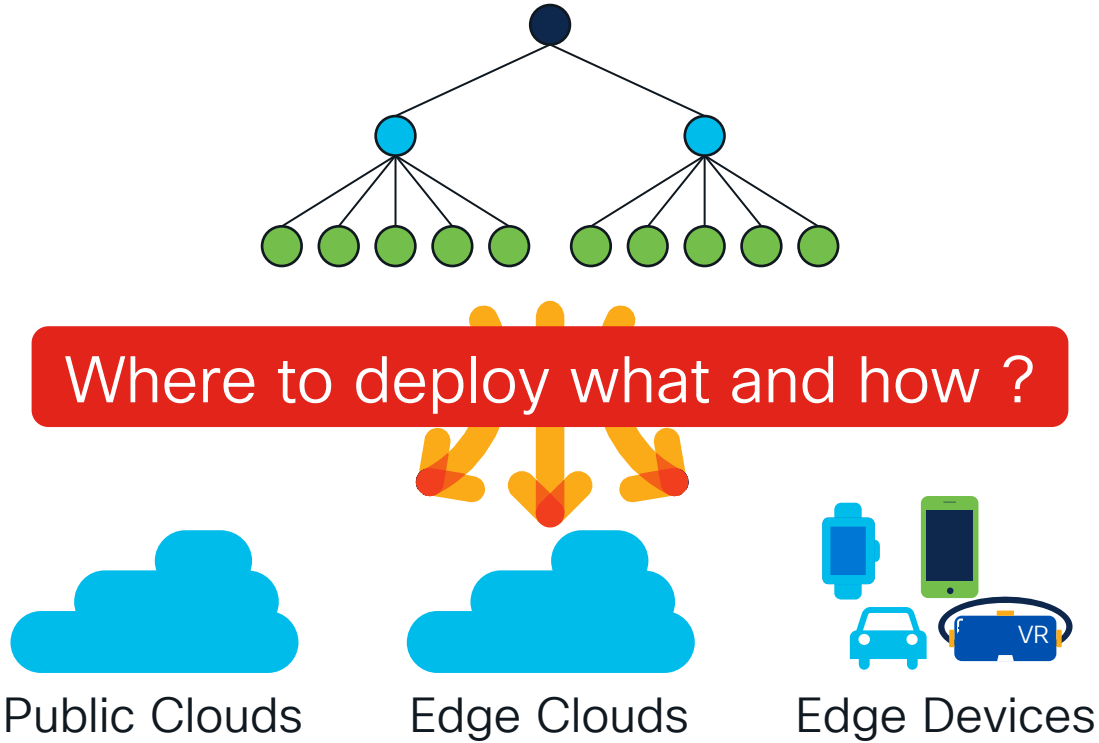
Many potential topologies



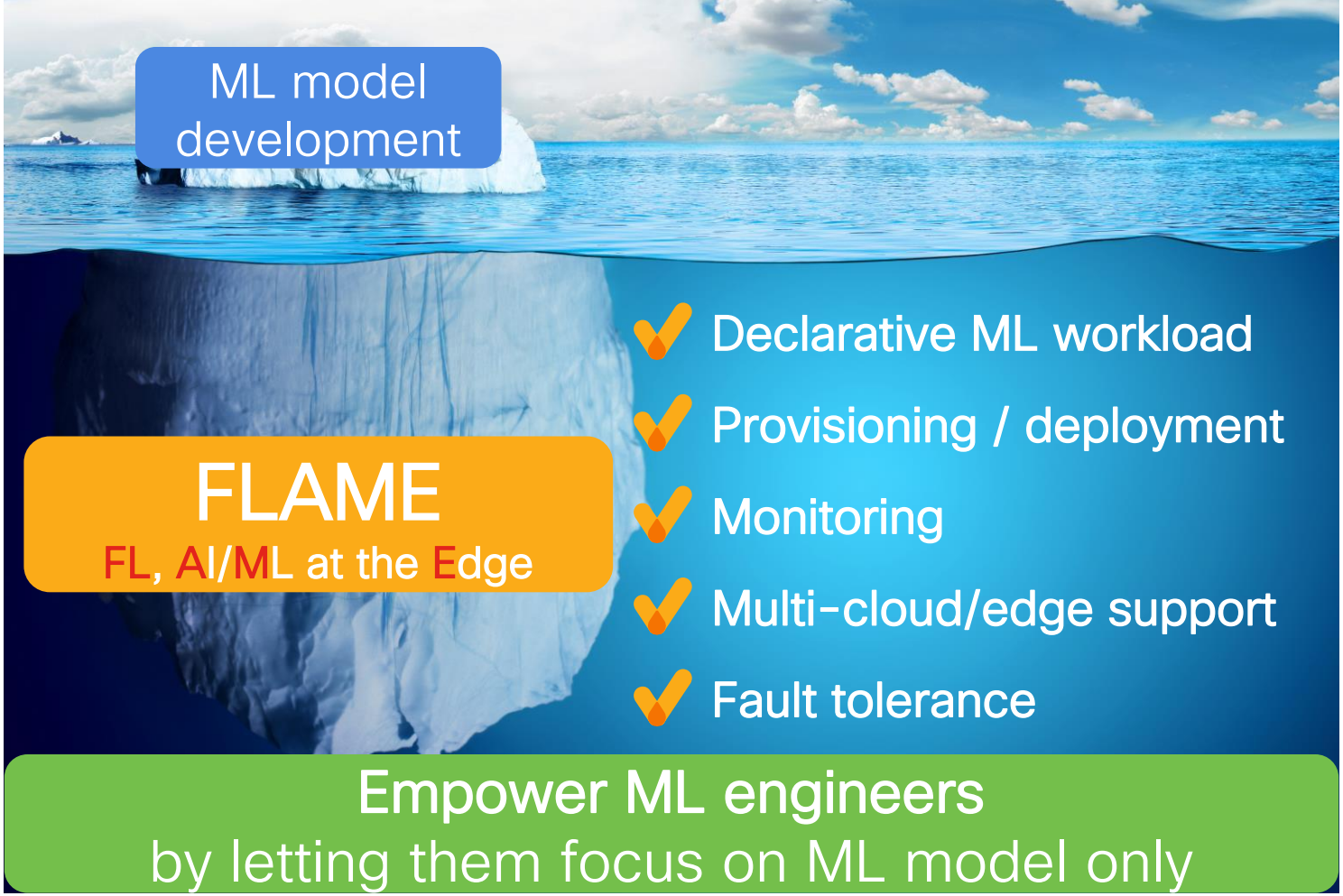
Distributed | Two-tier | Hierarchical | Hybrid ...

Complex, various training approaches

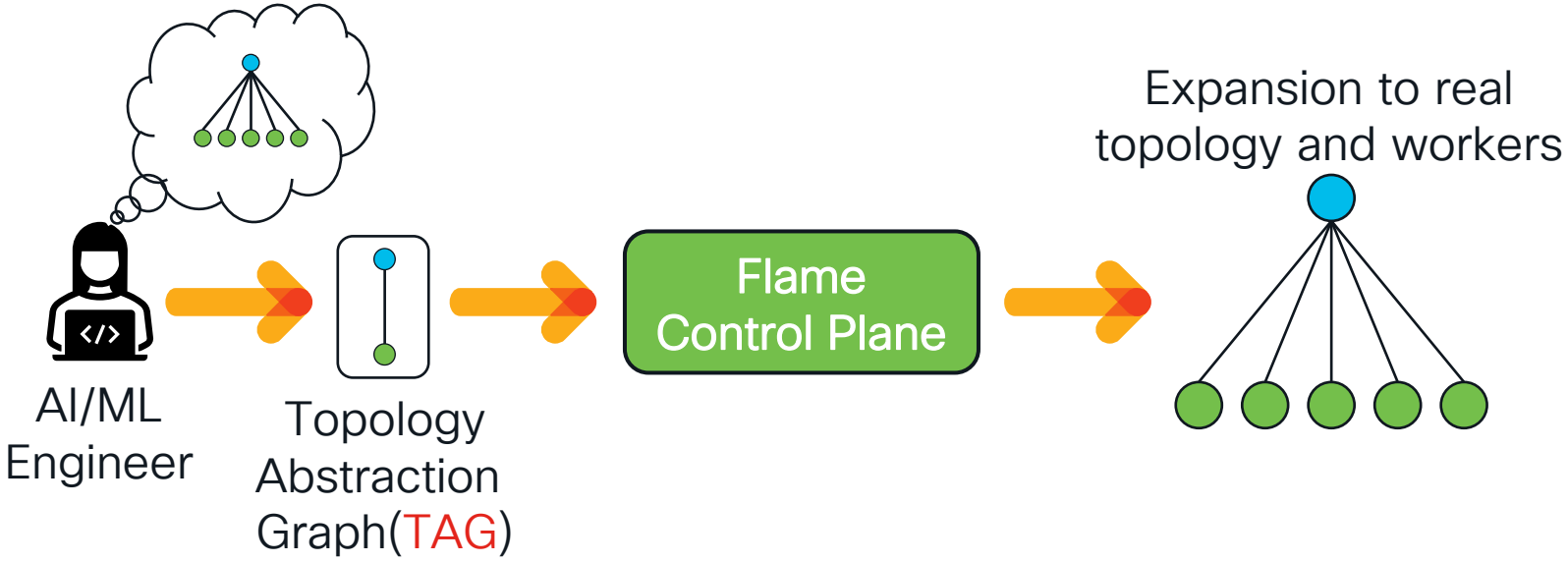
Challenges: Non-Trivial Federated Learning Ops



Flame:
FL, AI/ML at the Edge

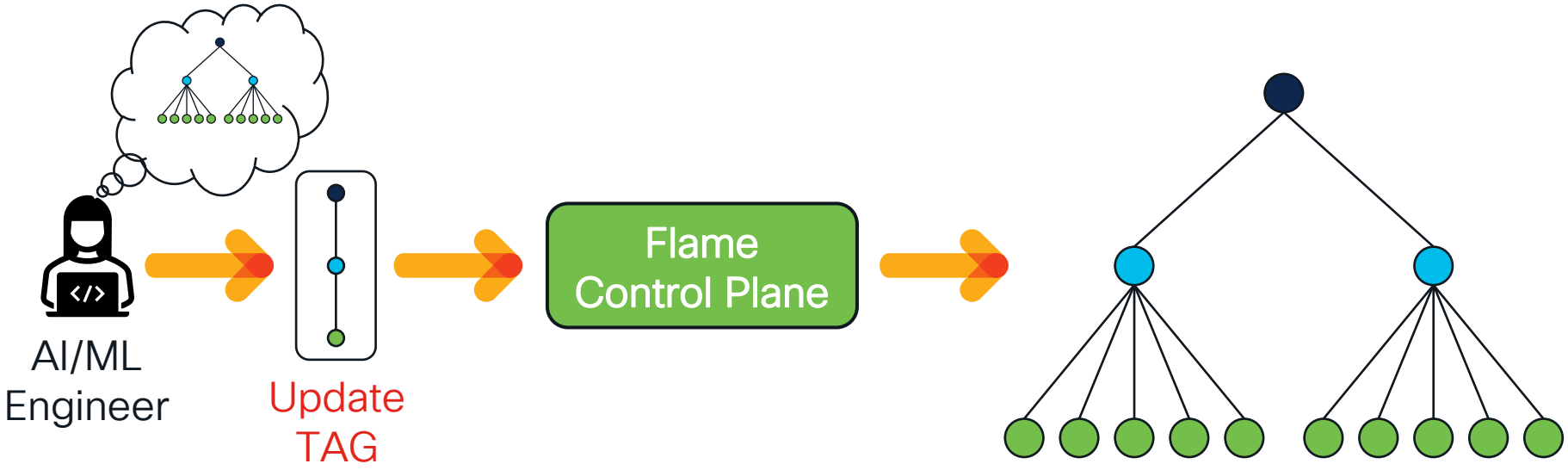


The Flame Way



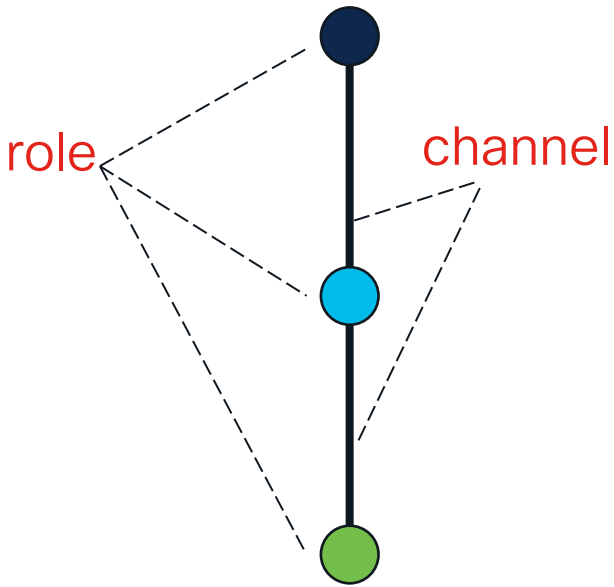
Decoupling ML code from topology simplifies workload specification

The Flame Way



TAG enables online update and fast turnaround

Topology Abstraction Graph (TAG)



Building block: Role and Channel

Role defines ML training behaviors (code)

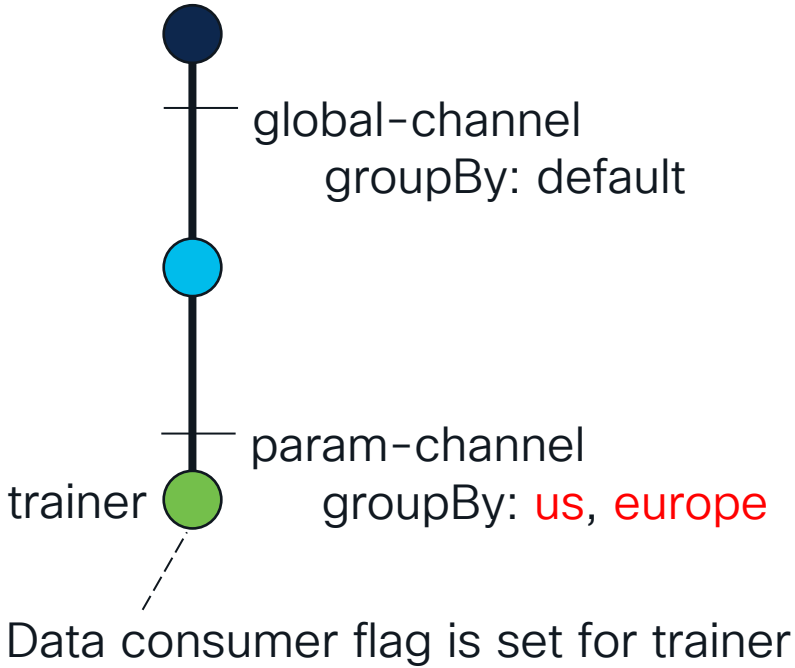
Role's data consumer flag maps role to data

Channel: Abstraction for communication

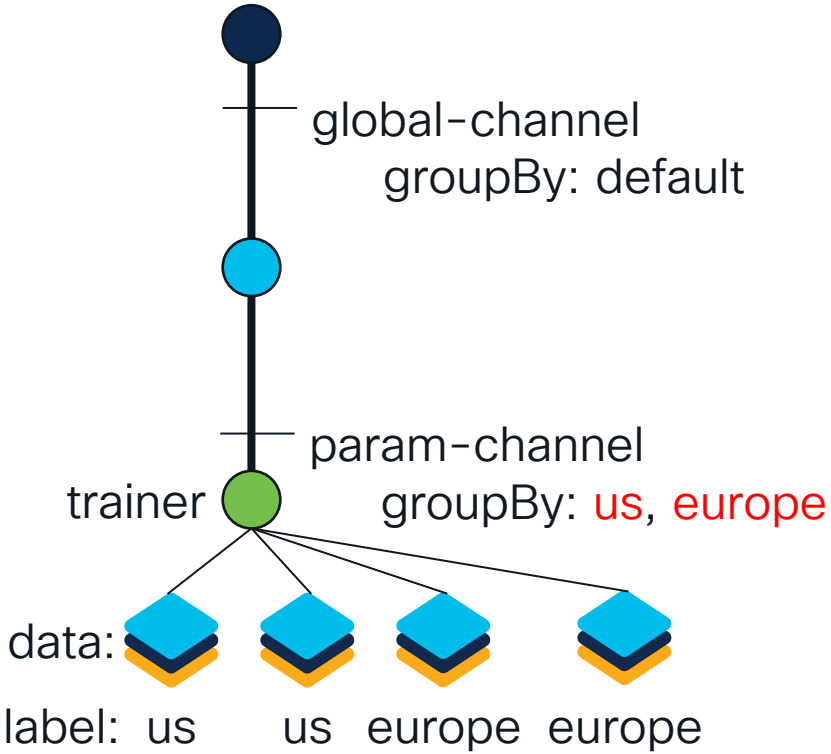
Channel's groupBy feature allows clustering

- Label-based
- Extensible for other metrics (e.g., data similarity, etc.)

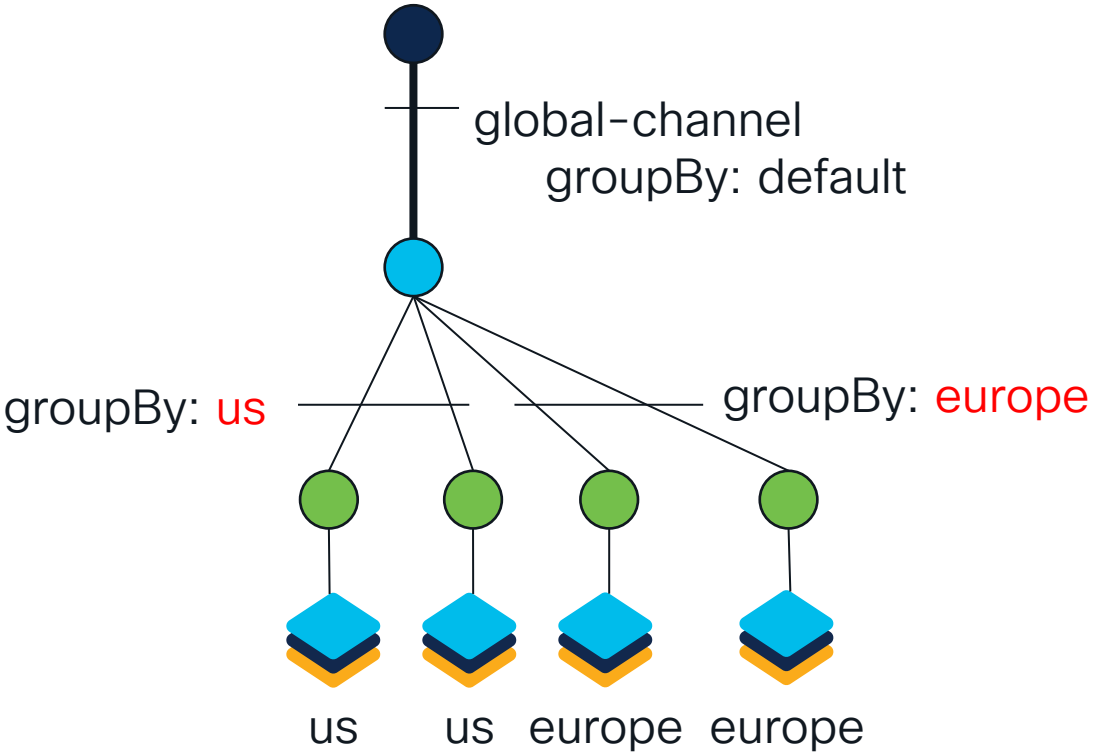
Expansion from TAG



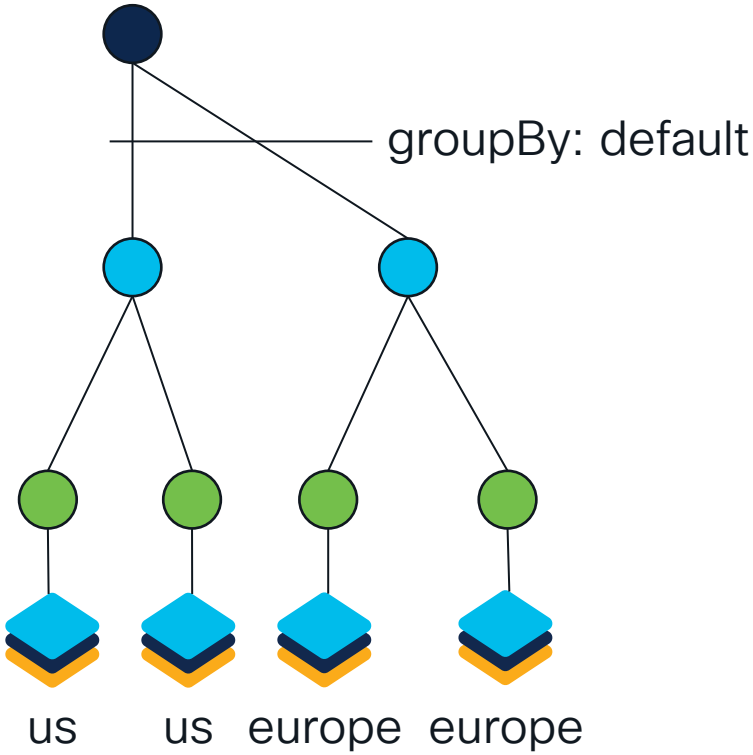
Expansion from TAG



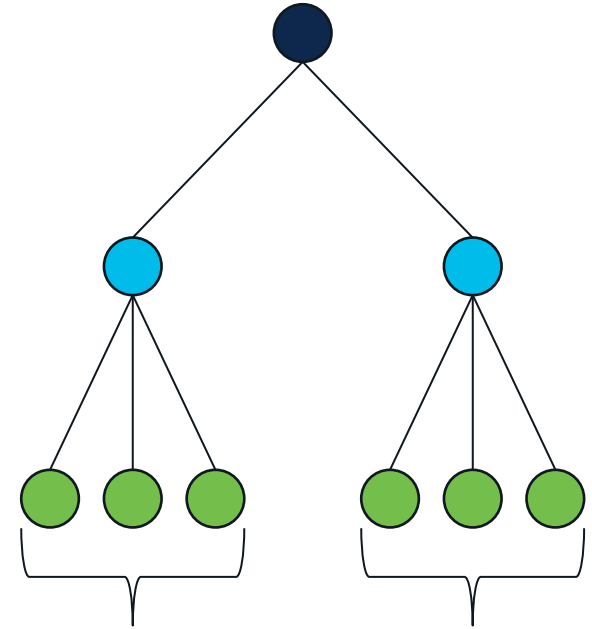
Expansion from TAG



Expansion from TAG



Easy Configuration by TAG



US Trainers Europe Trainers

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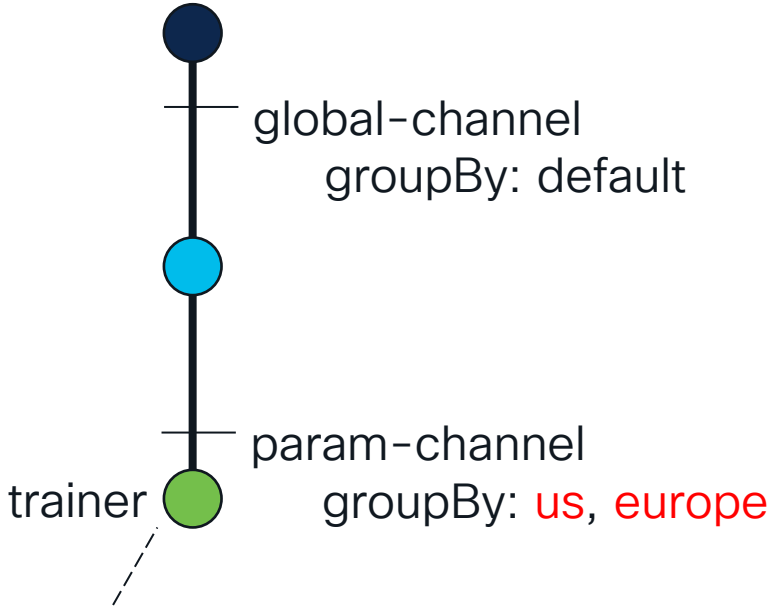
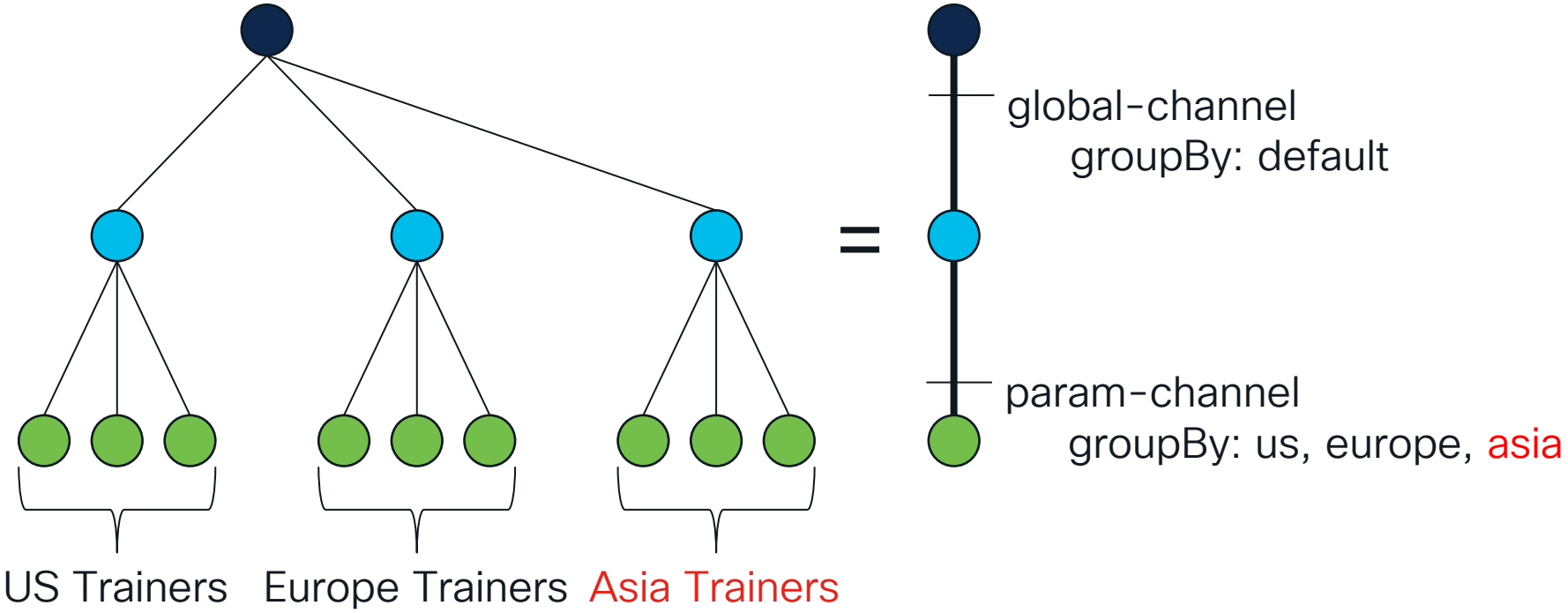
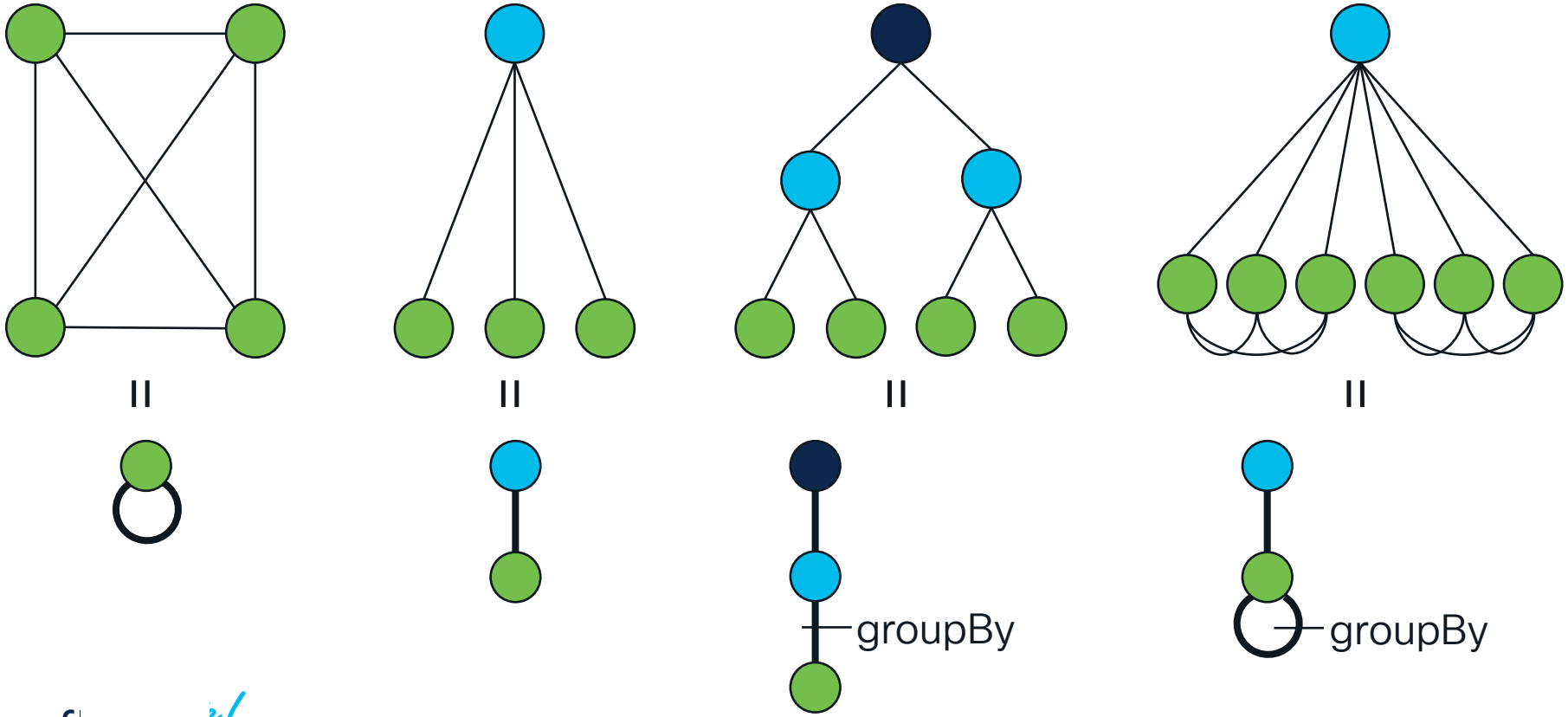


Data consumer flag is set for trainer
# of trainers is equal to # of data sets in use

Easy Configuration by TAG



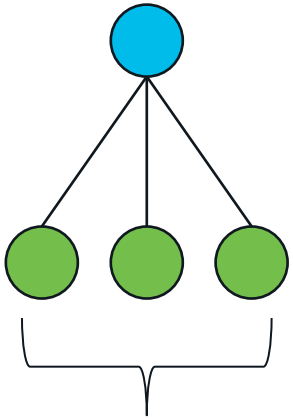
Power of Flame Abstraction



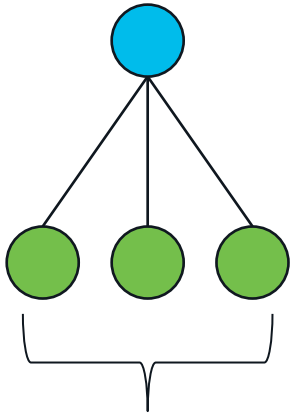
Power of Flame Abstraction

Parallelized Group Training

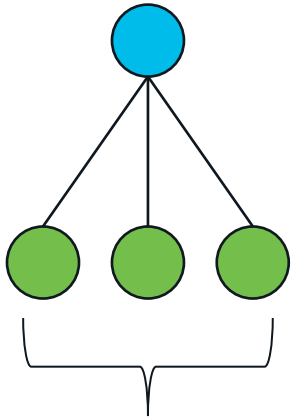
groupBy: us, europe, asia



US Trainers



Europe Trainers



Asia Trainers

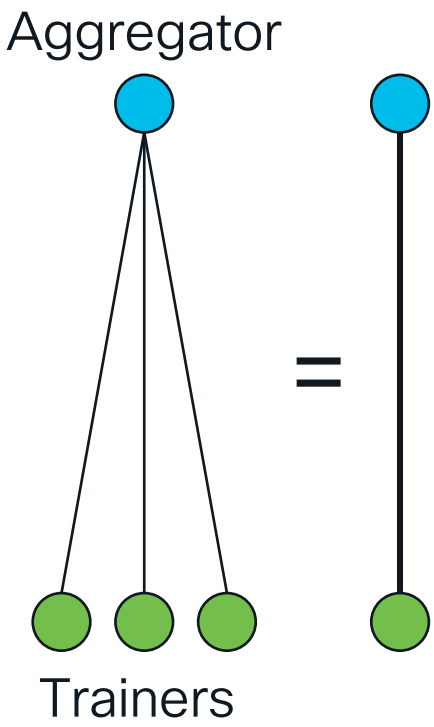
Flame Abstraction Summary

Topology update with small code changes

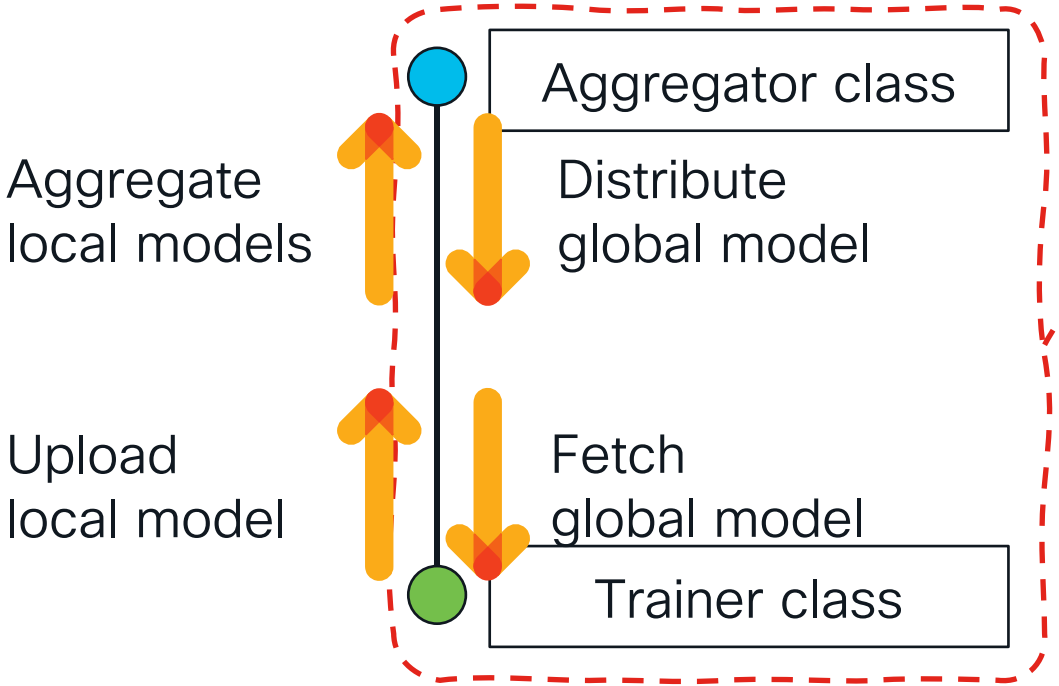
Independent underlying comm mechanisms

Transparent MLOps for federated learning

Preparing Training: User Persona



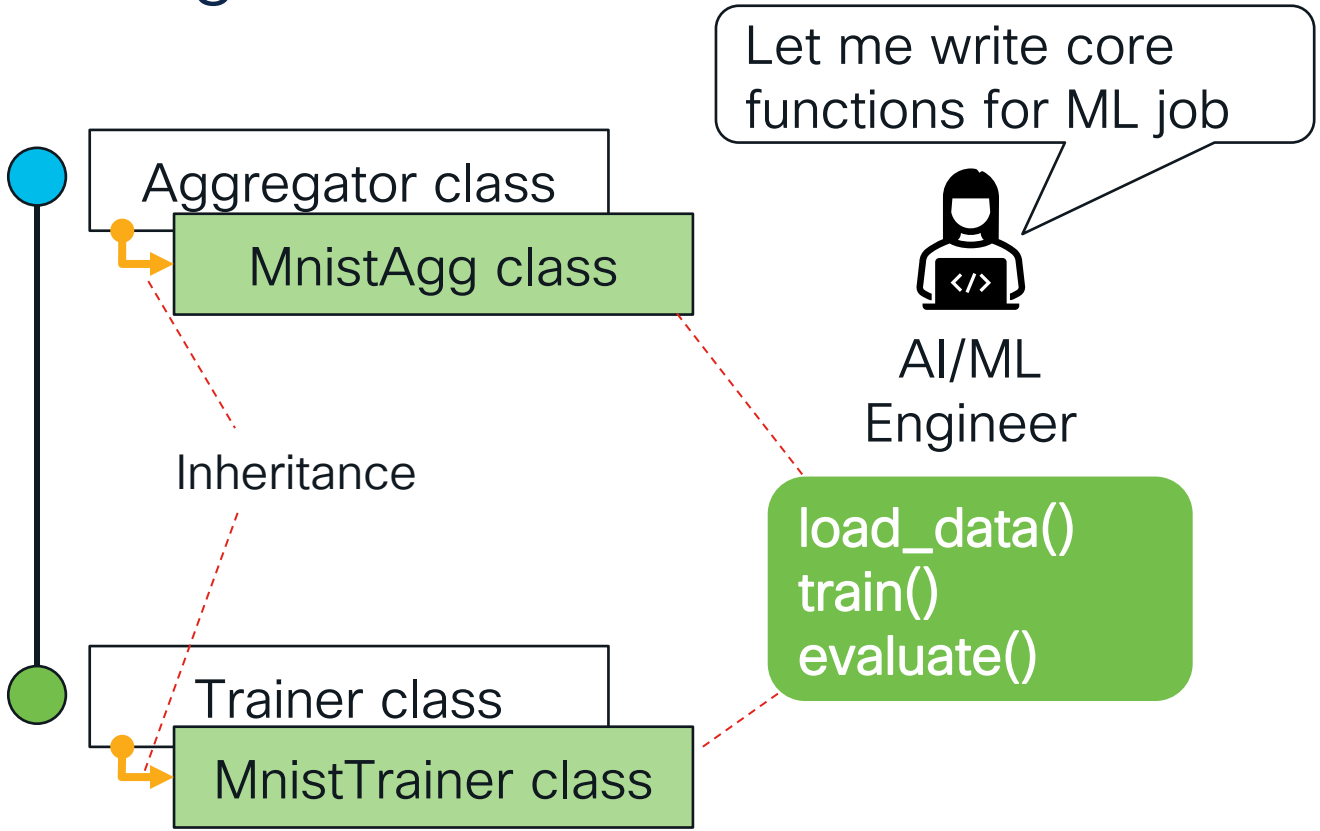
Preparing Training: User Persona



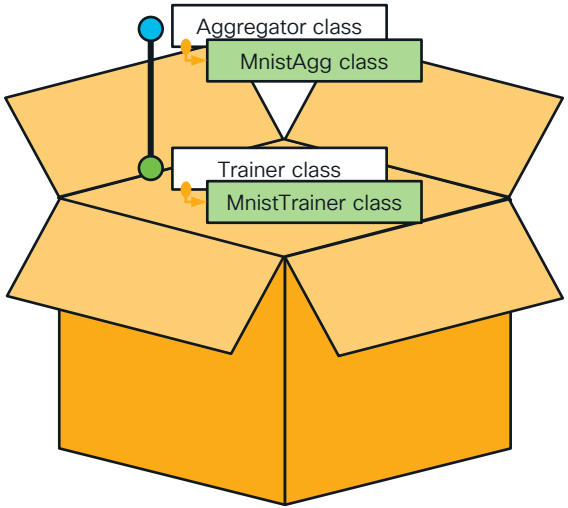
Modules supported out of box

- Functionality in Flame SDK
- Define/Implement protocol behaviors
- Support various topologies out of box

Preparing Training: User Persona



Preparing Training: User Persona

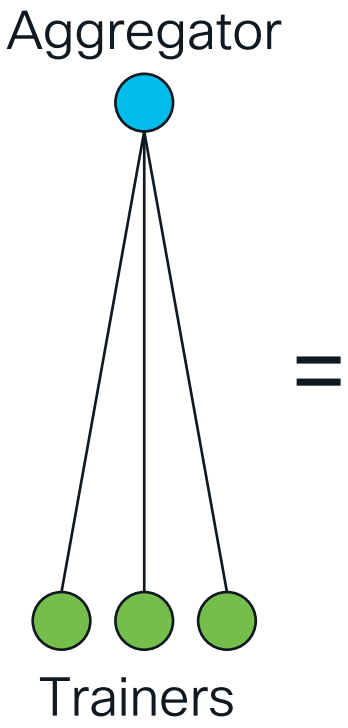


Packaging as a job
(via CLI tool)

Submit Job

Flame
Control Plane

Customized Training



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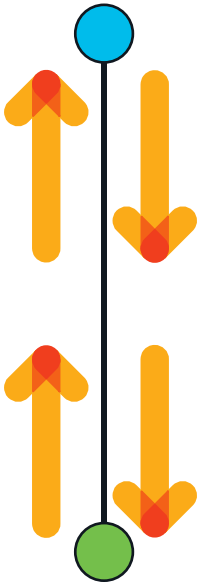
TAG Templates

Customized Training

Aggregate local models

Distribute customized models per trainer



Upload local model

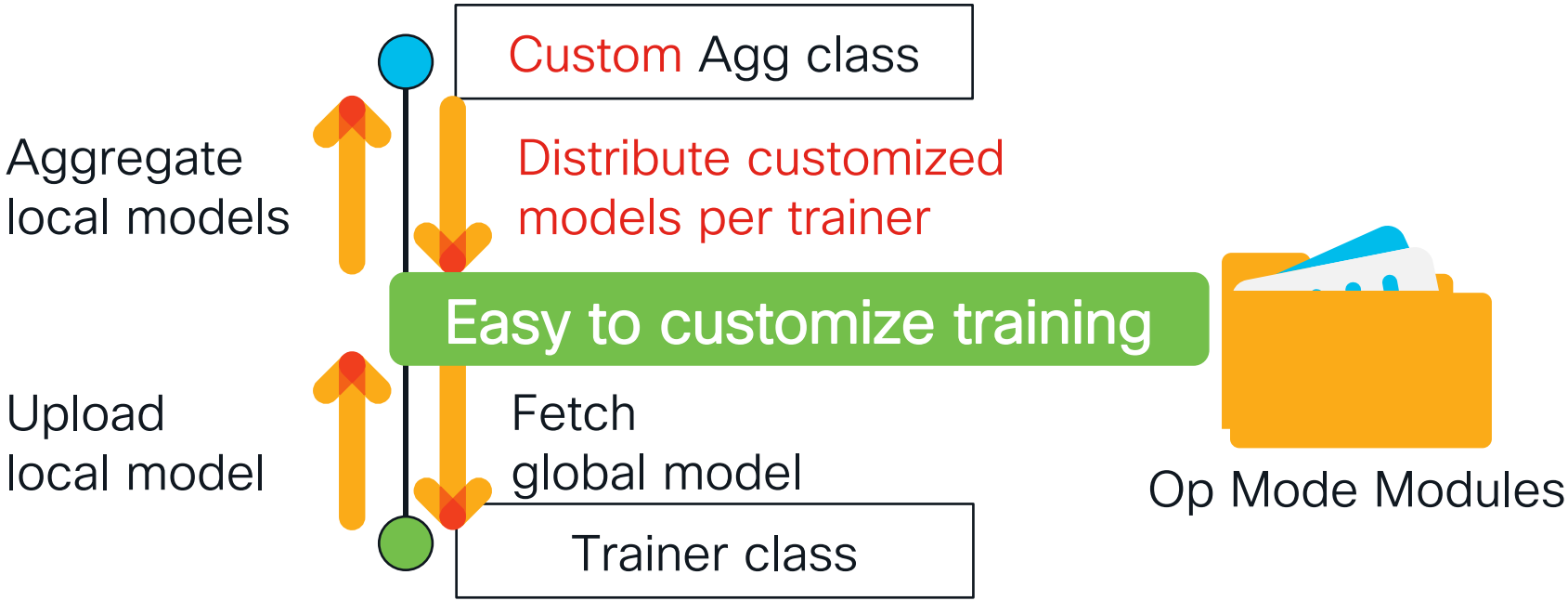
Fetch global model

Custom Agg class

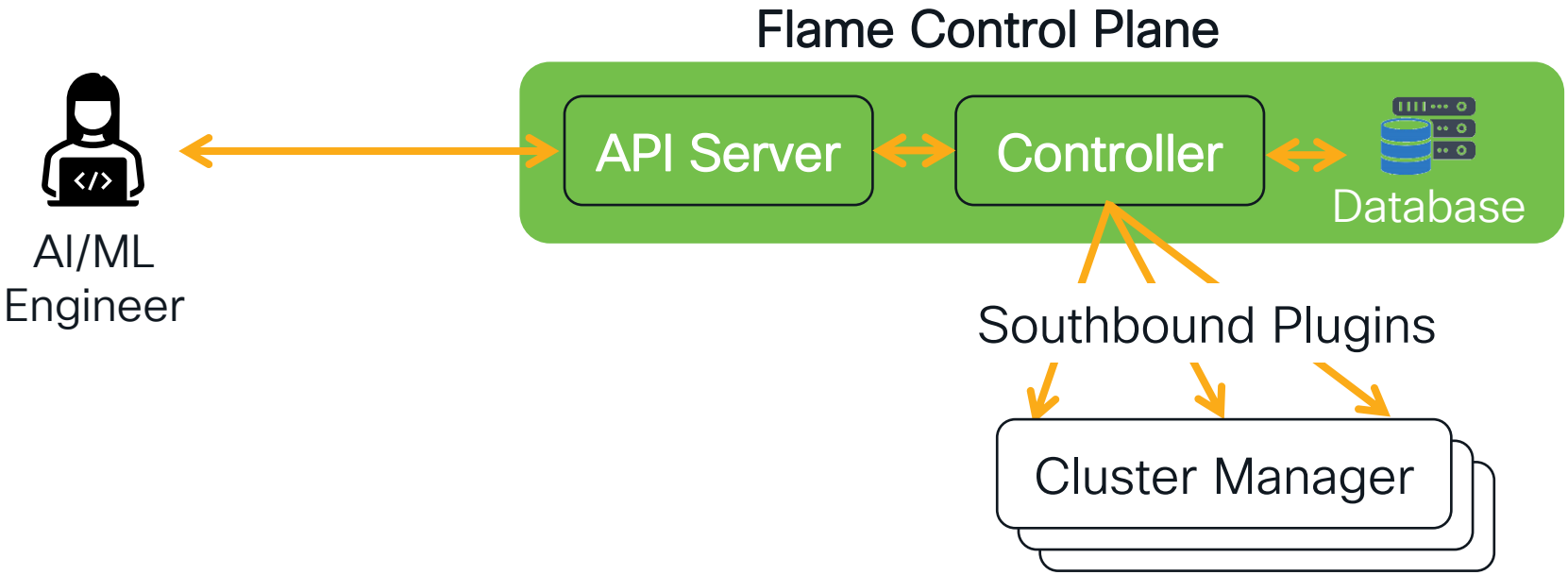
Trainer class

Op Mode Modules

Customized Training



Flame System Workflow



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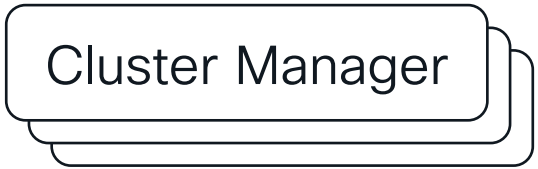
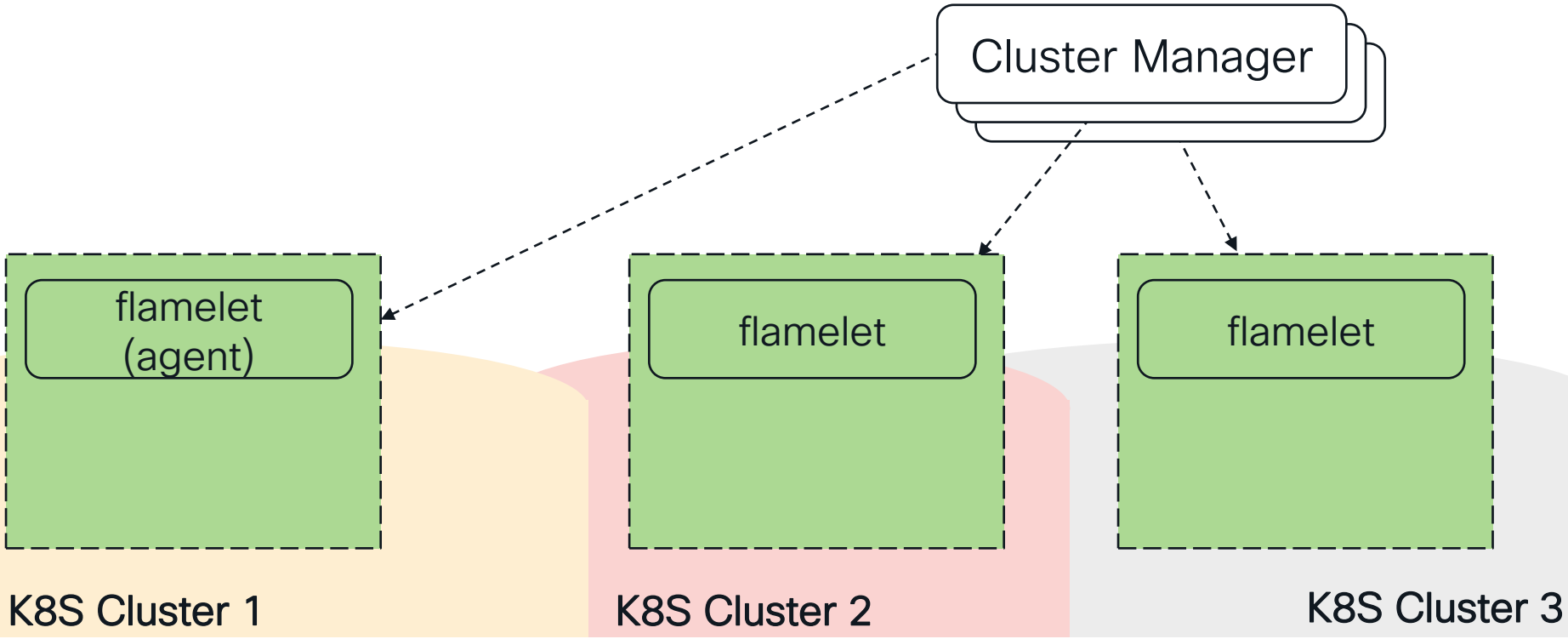


Flame System Workflow



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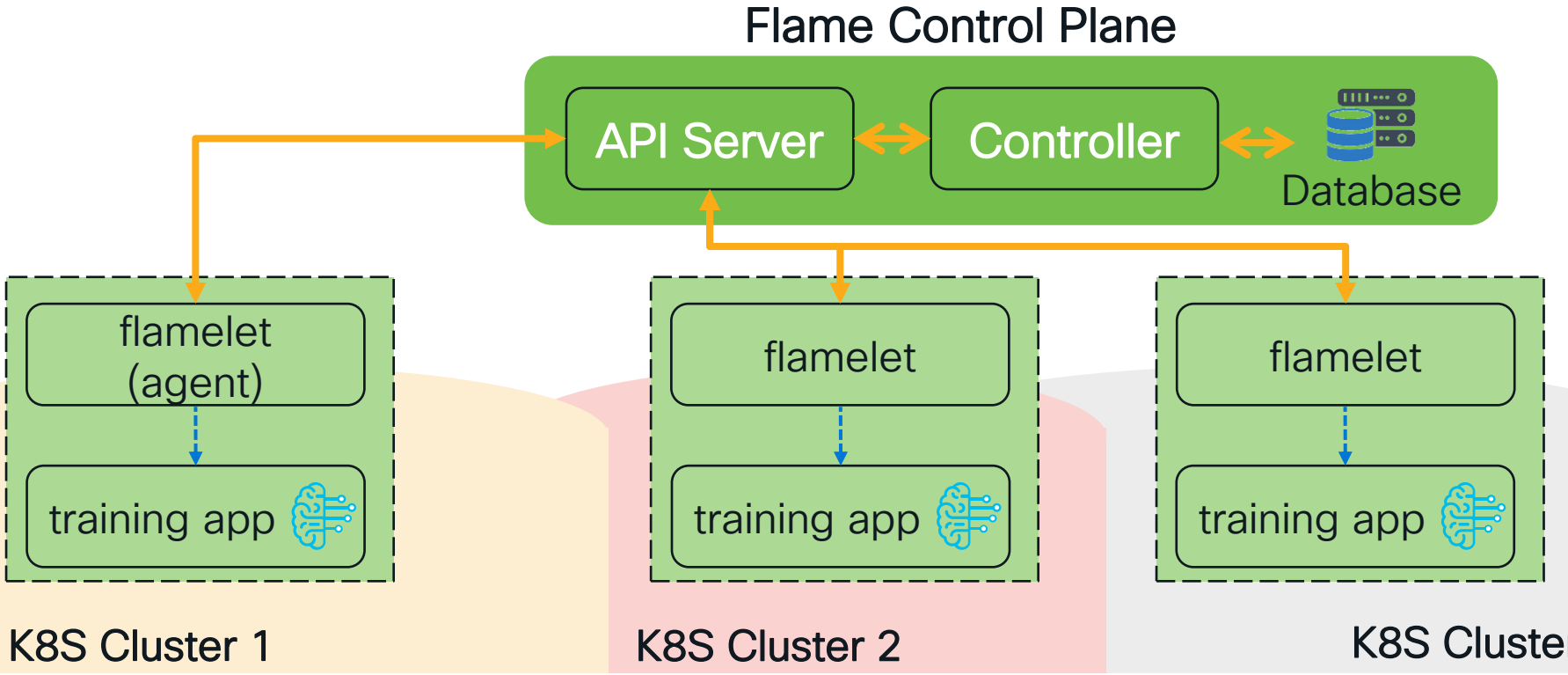

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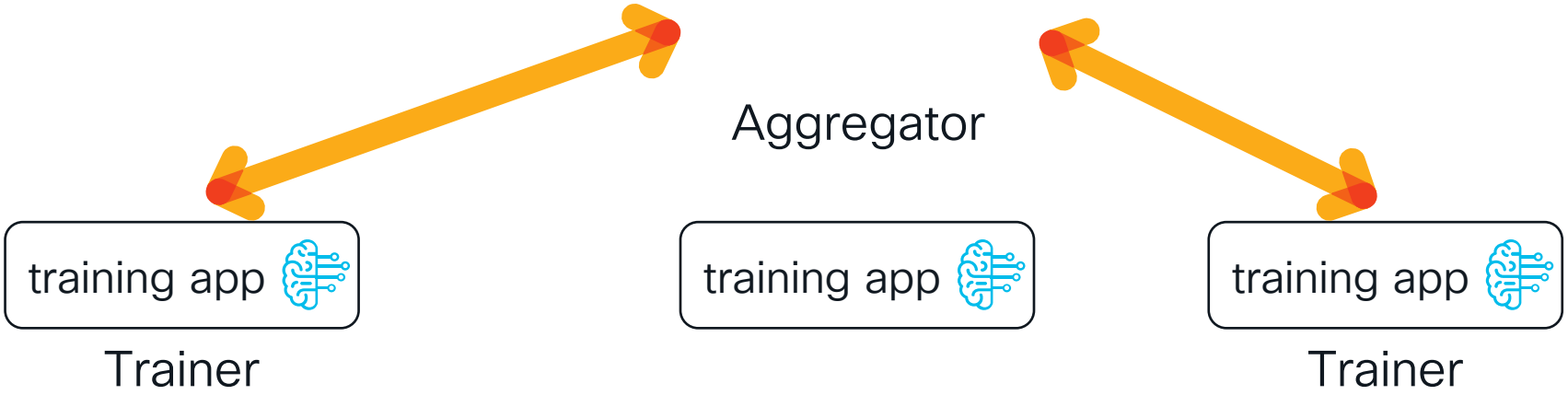

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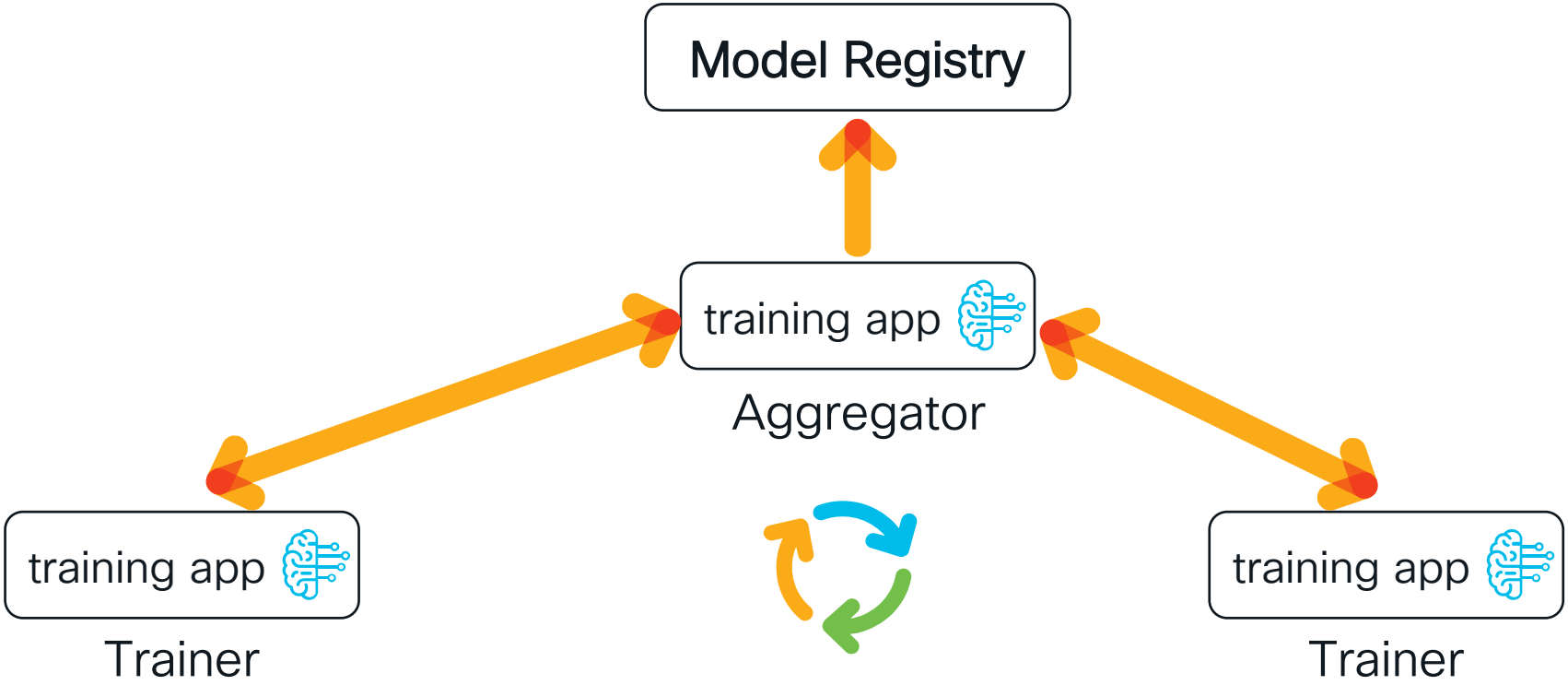
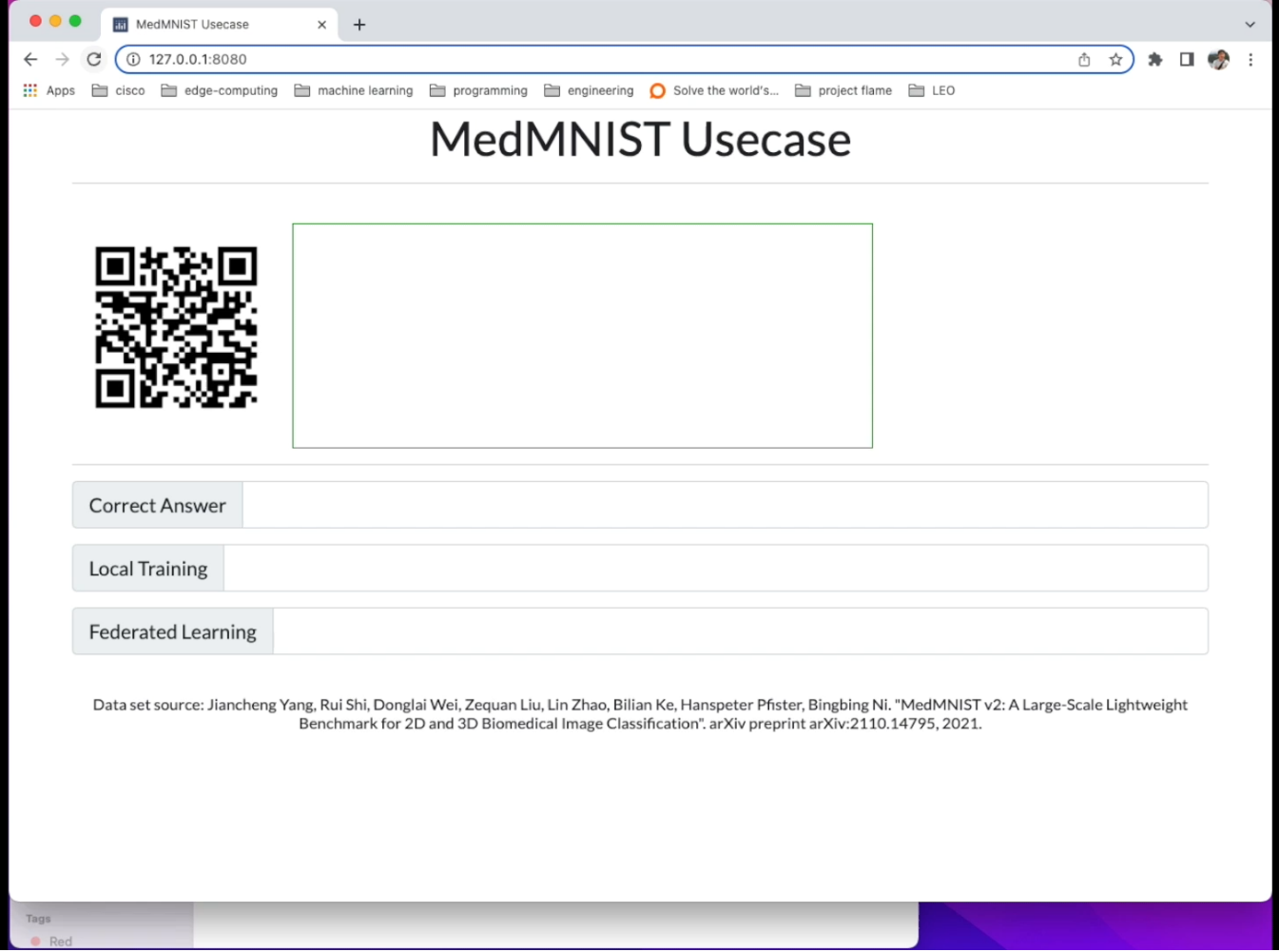


Demo



Summary

Flame is a community-driven open-source project for federated learning

Federated learning system

Flexible, configurable and extensible

Offers transparent MLOps for federated learning

Facilitates easy adoption of fast-evolving state-of-the-art FL techniques

Call to Action

Check out Flame

- https://github.com/cisco-open/flame

Let's create synergy

- Explore it and improve it collectively

Reach out to us

- research@cisco.com
- flame-github-owners@cisco.com
- myungjle@cisco.com

Technical Session Surveys

- Attendees who fill out a minimum of four session surveys and the overall event survey will get Cisco Live branded socks!
- Attendees will also earn 100 points in the Cisco Live Game for every survey completed.
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