

# Mainstream: Adaptive compute sharing for video analysis

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## Overview

### Goal:

- Efficiently run concurrent streaming video analysis apps

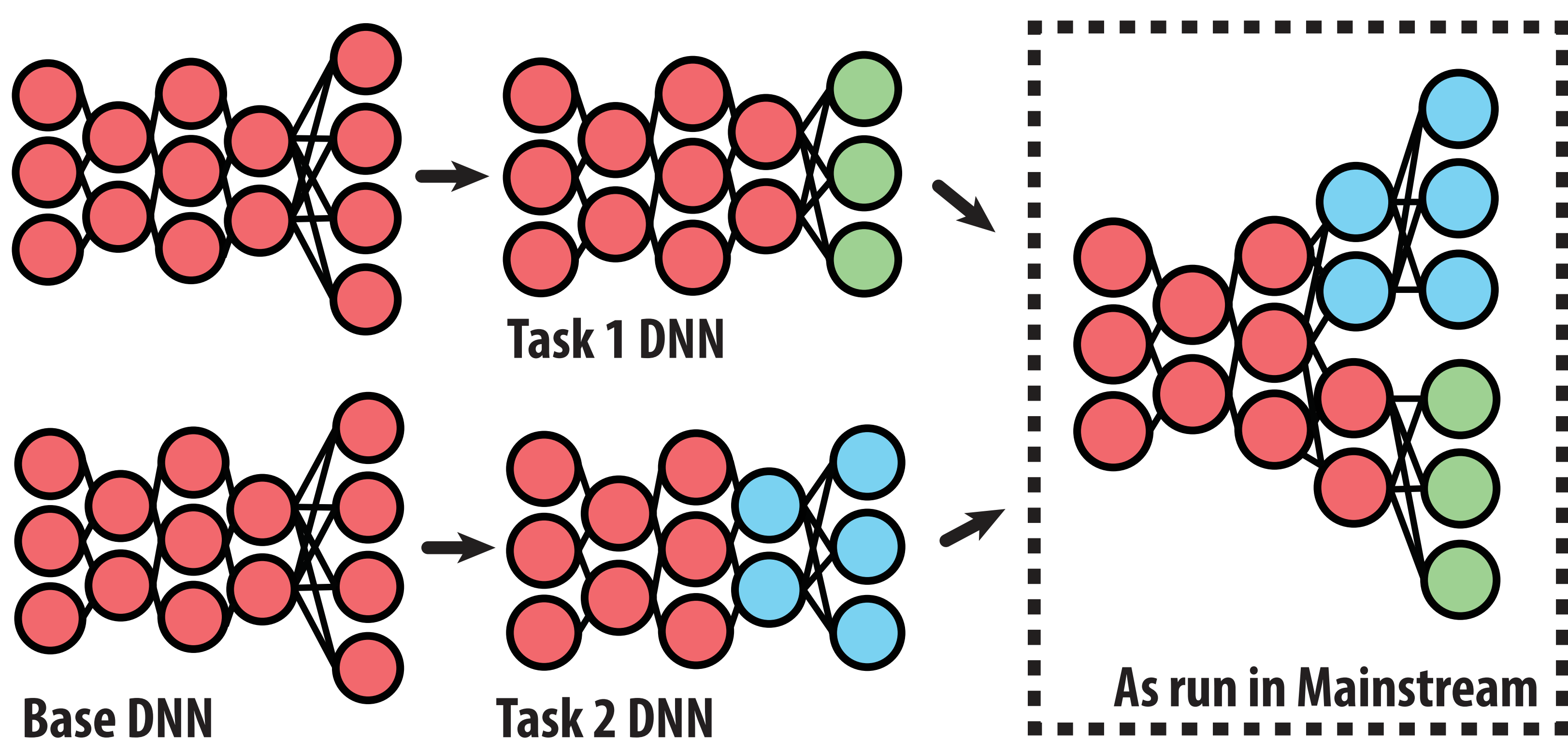
### Problem:

- Most video analysis apps perform DNN inference
  - Running several full DNNs becomes very slow

### Mainstream:

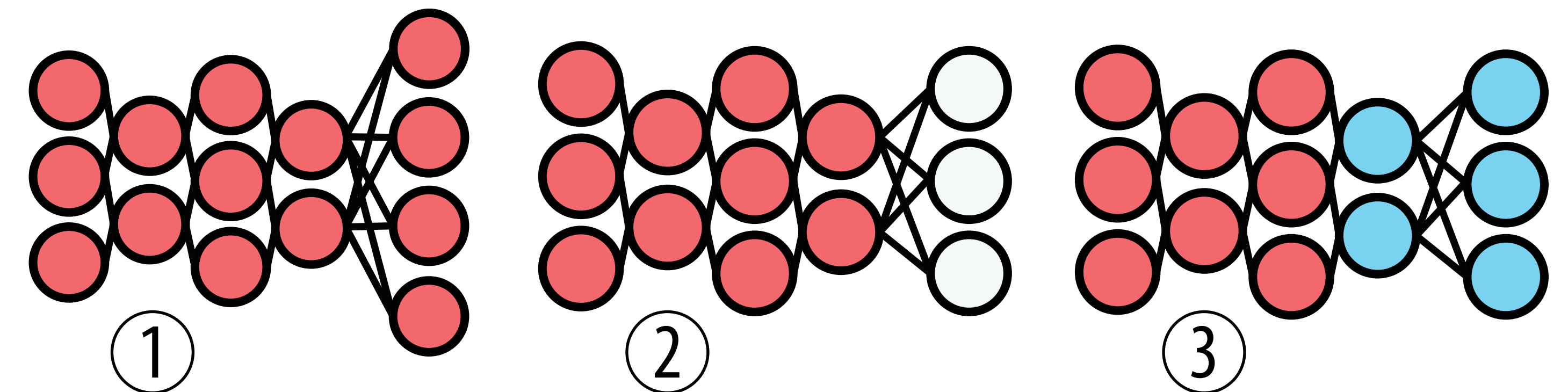
- Identifies and shares redundant DNN computation
  - By exploiting nature of fine-tuned DNNs
- Decides at runtime how much to share
  - Balances specialization vs. sharing trade-off
- Optimizes when hardware and set of apps is known

## Sharing Computation



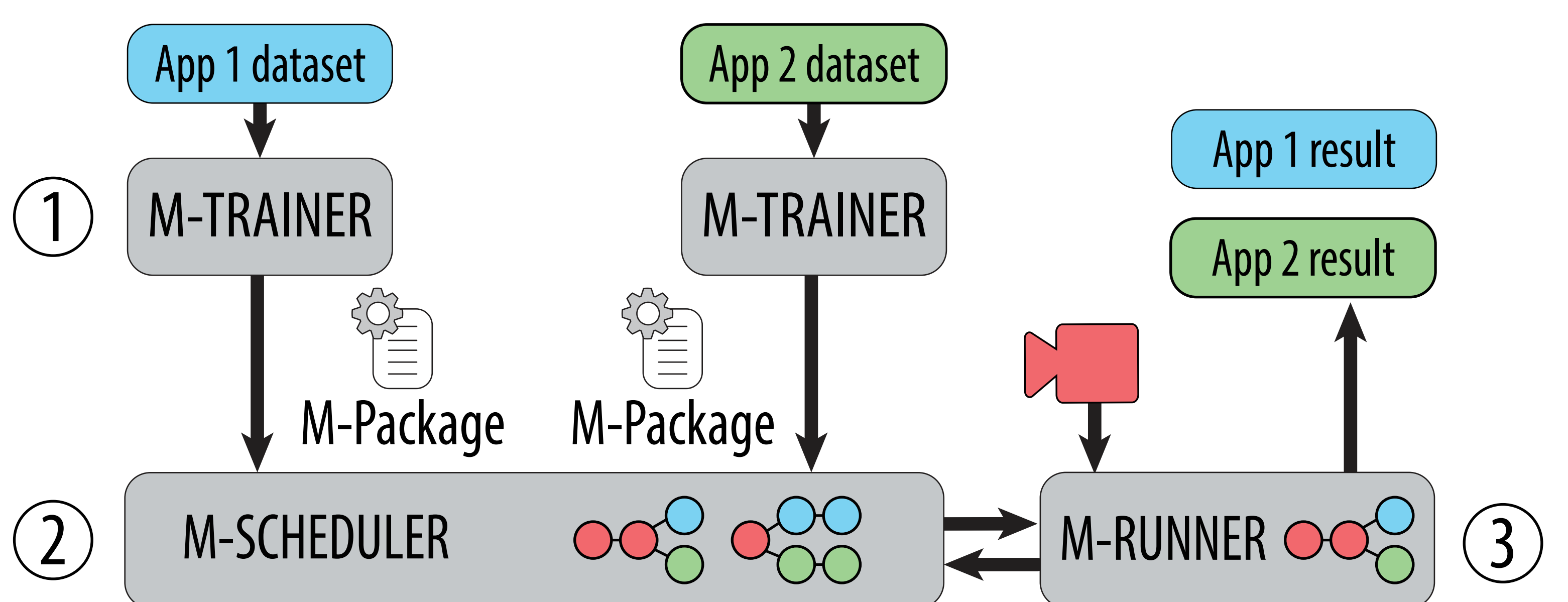
## Transfer Learning

- When training task B, start with DNN pre-trained for task A
  - Common practice for training networks



- Network is trained from scratch for task A (e.g., ImageNet)
- Replace A-specific final layer with B-specific final layer
- Fine-tune part of network for task B, other layers held frozen

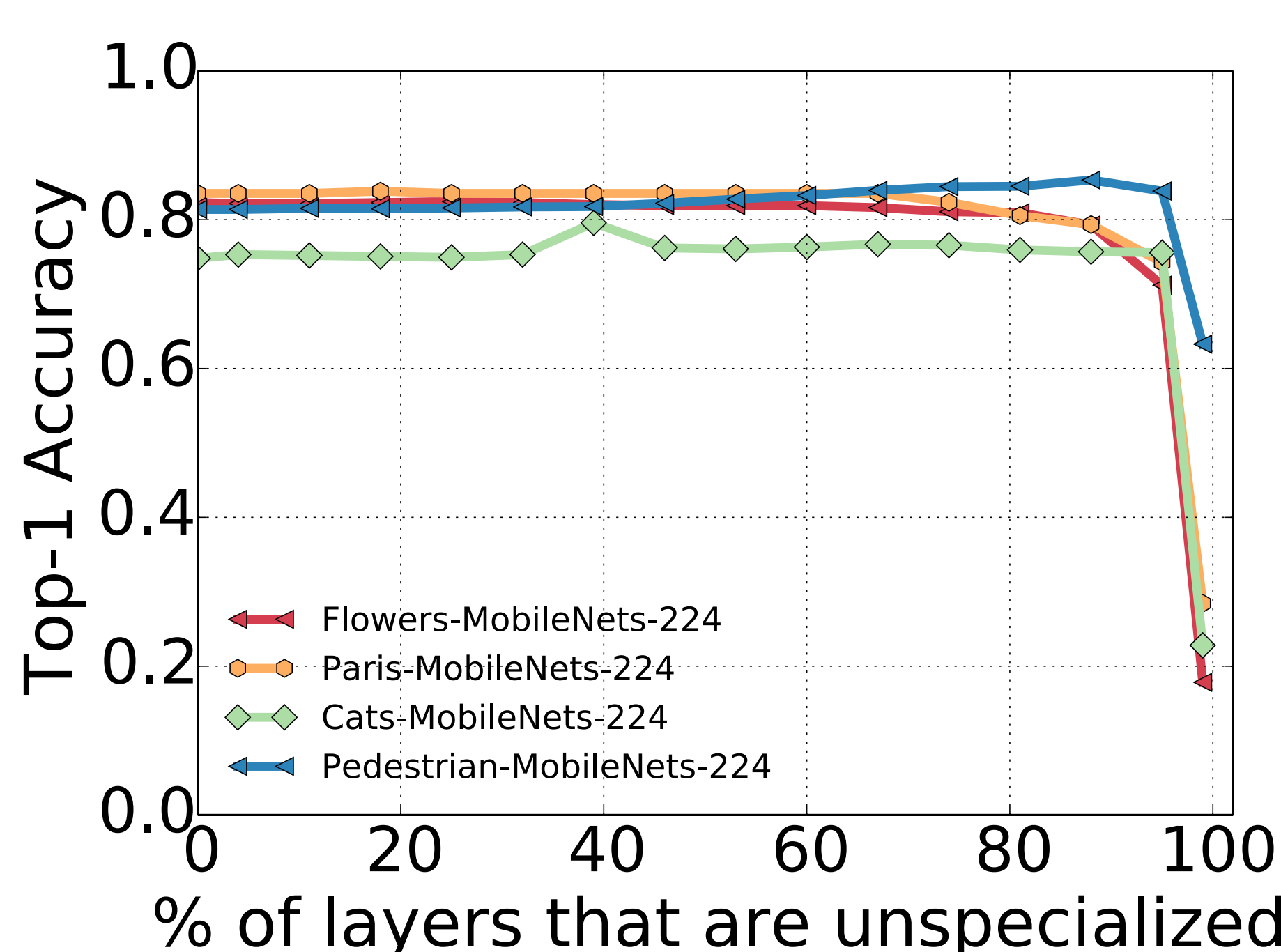
## Mainstream Architecture



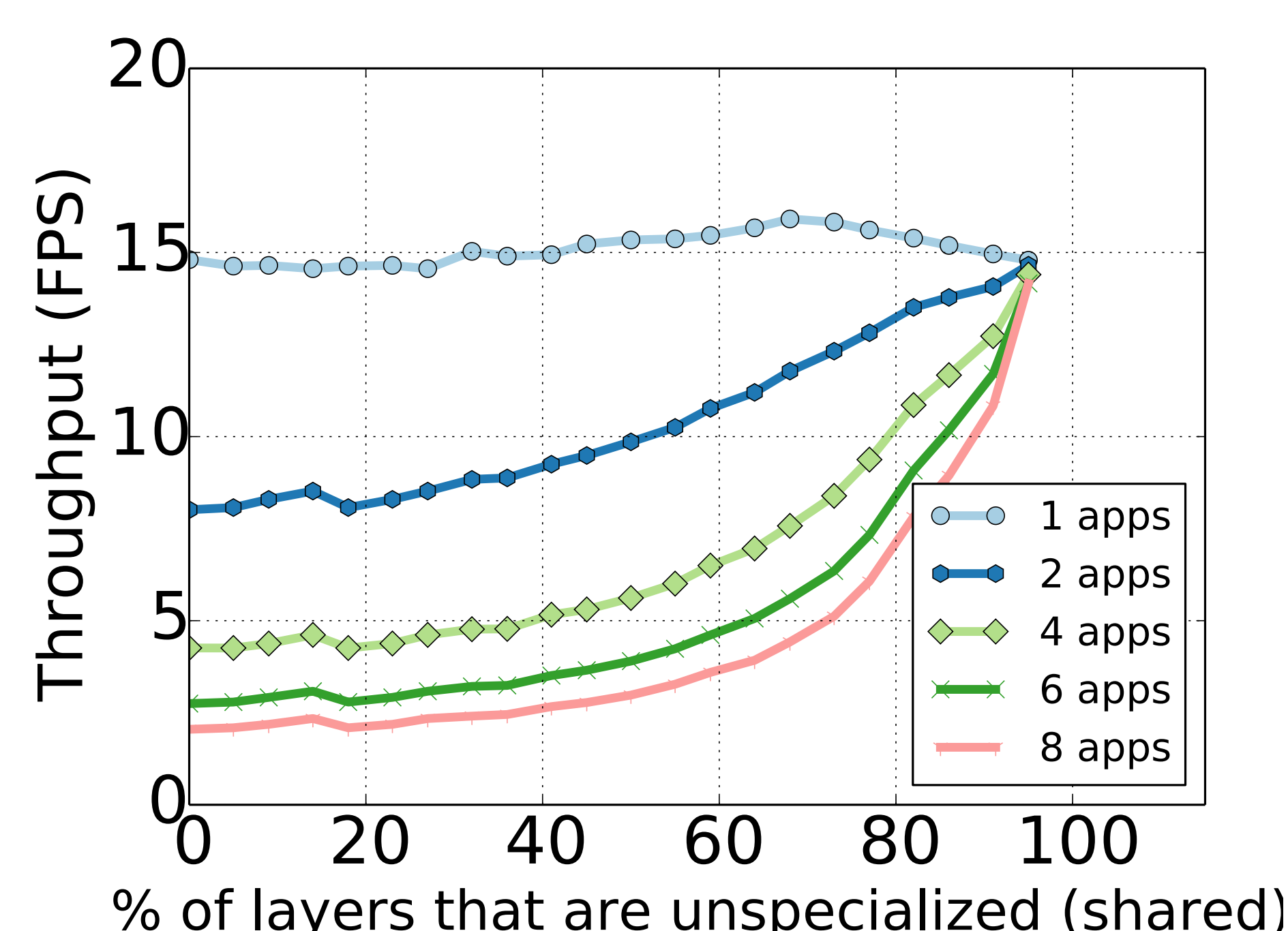
- M-trainer trains DNNs with varying % of network held frozen
- M-Scheduler determines amount of DNN to share for each app
- M-Runner processes video stream using deployed DNNs

## Specialization vs. Sharing Trade-off

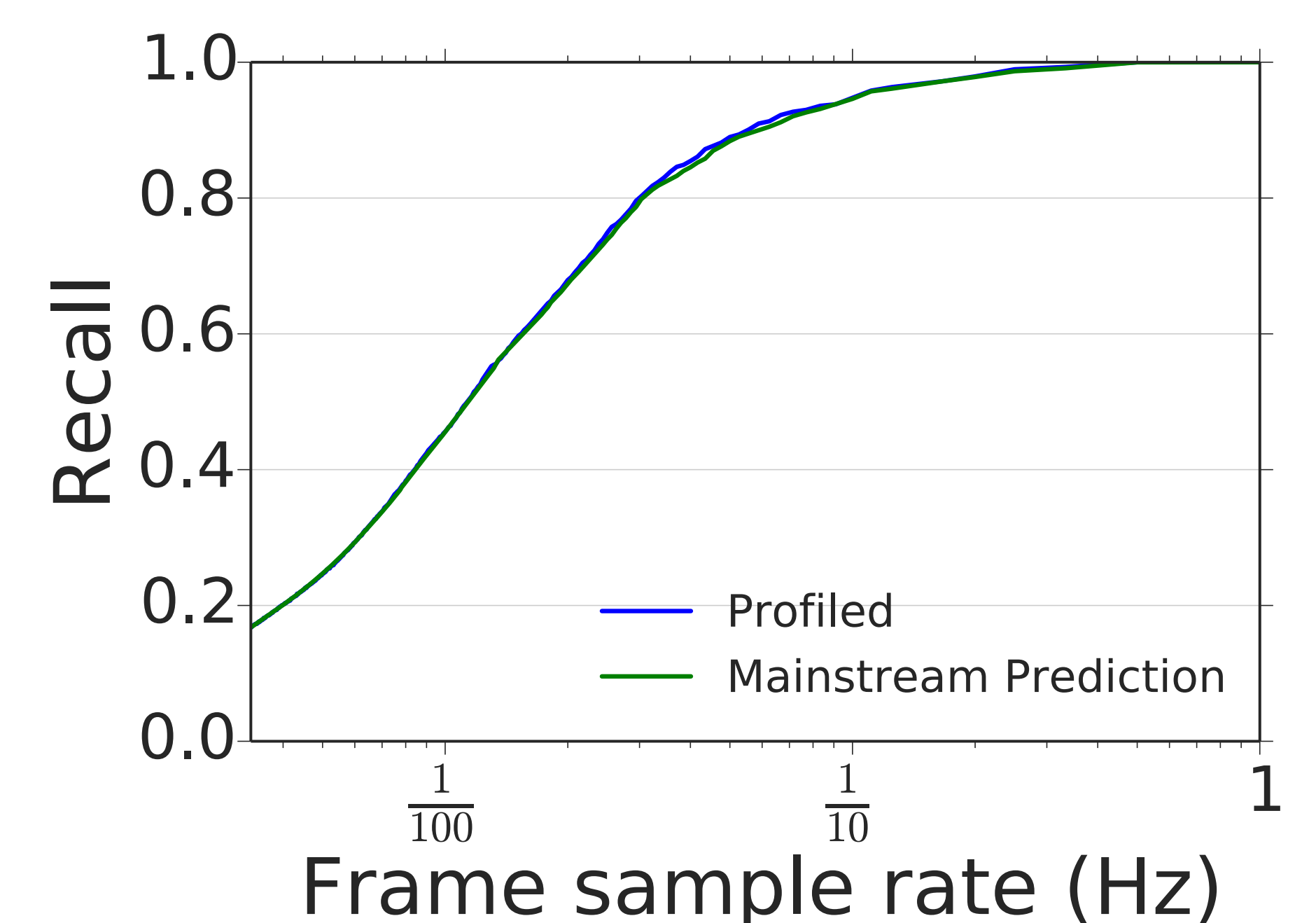
**Experimental Setup:** Train image classifiers using MobileNets-224. Run simultaneous classification pipelines on an Intel NUC.



Less specialization → Lower per-frame acc.



Less specialization → Higher throughput



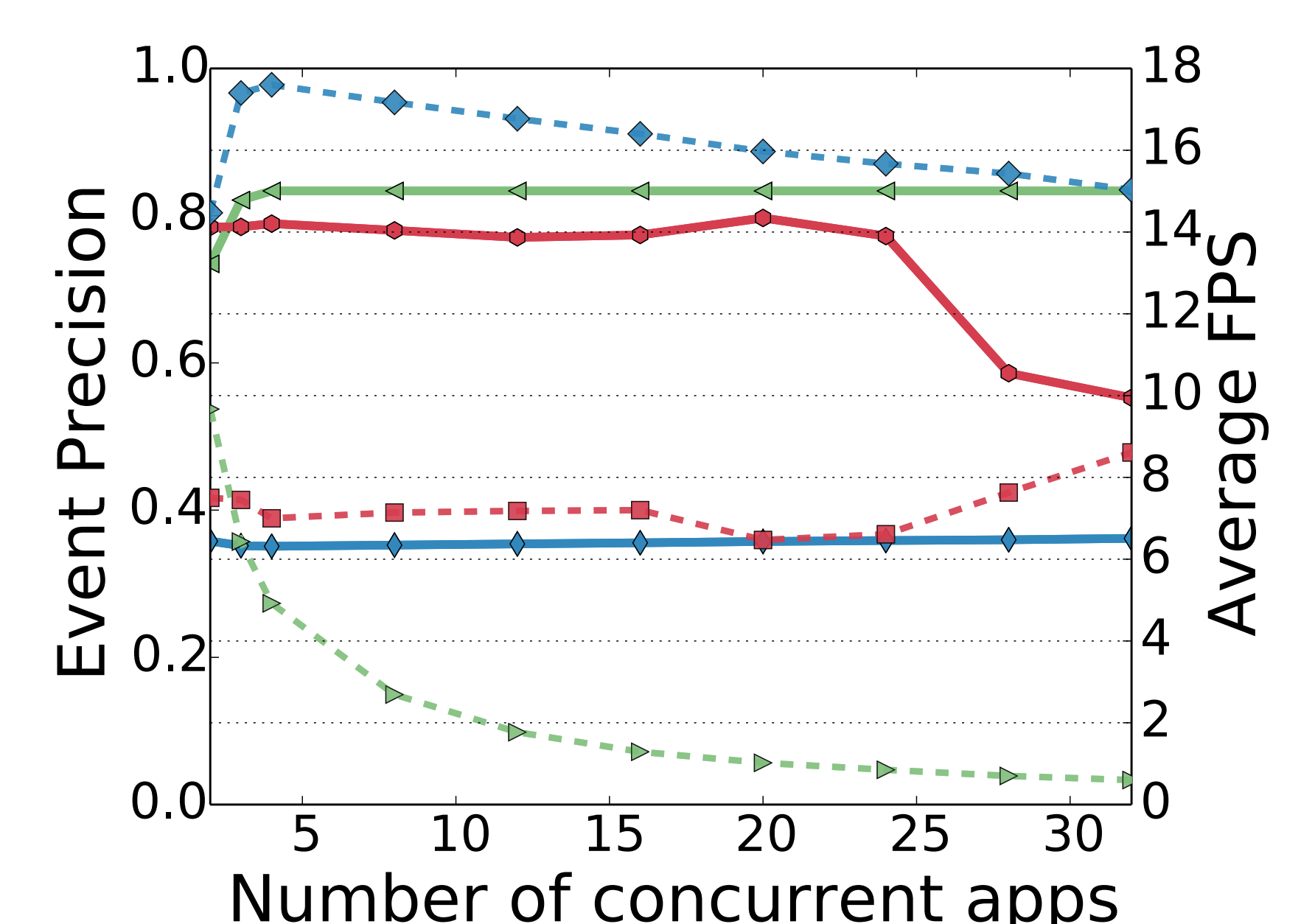
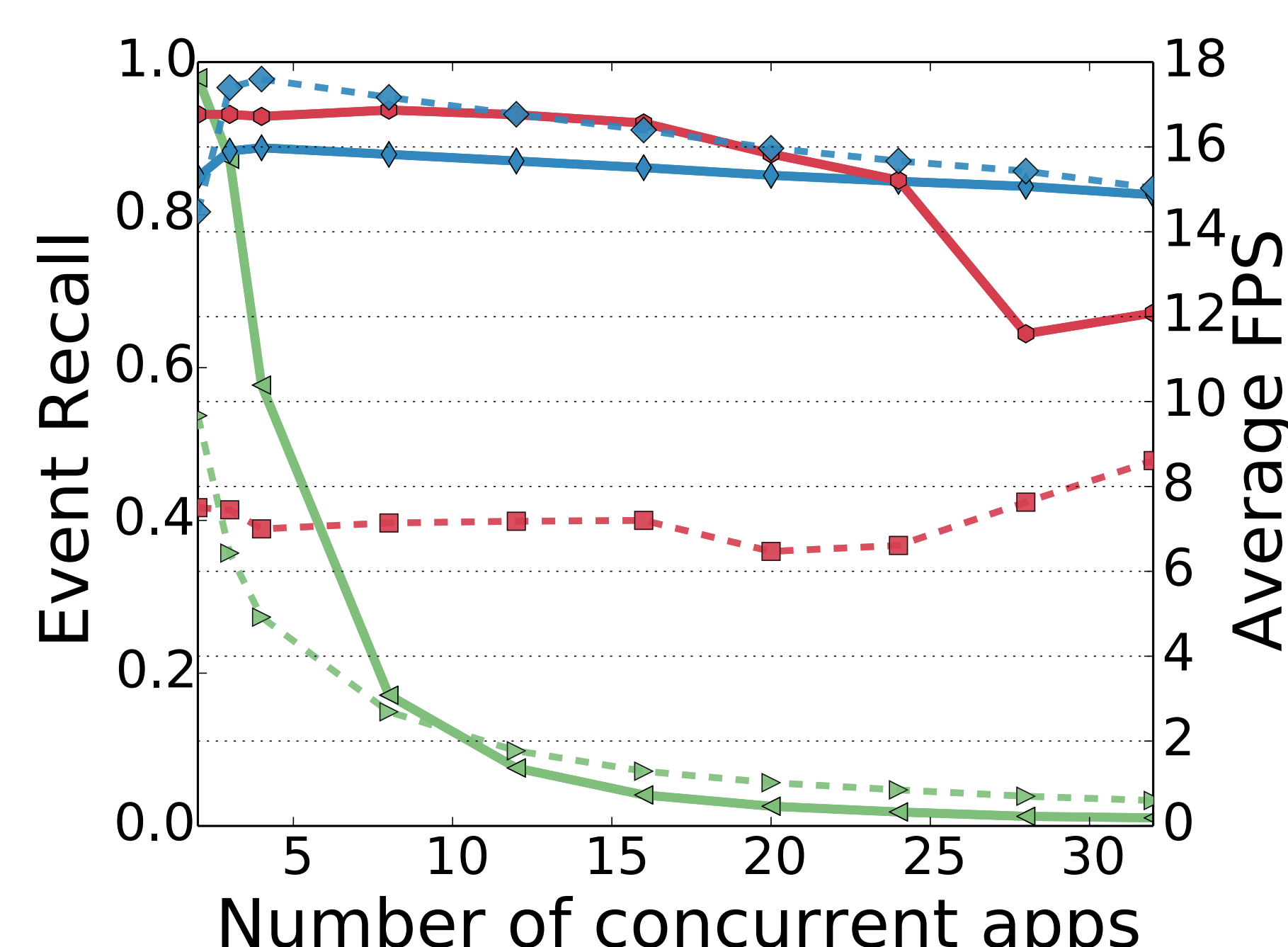
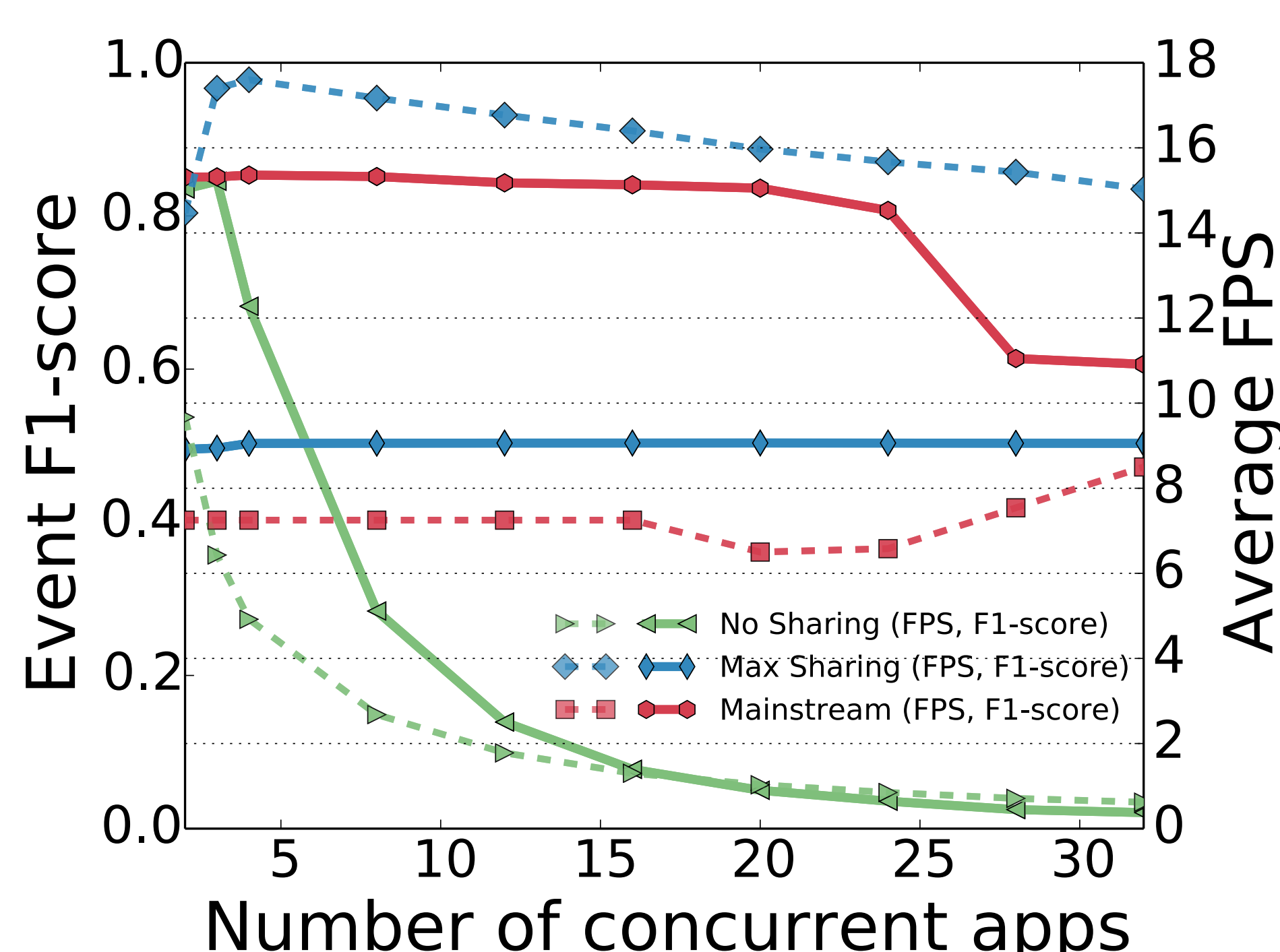
Use analytical model to find navigate trade-offs

## Application Performance

**Recall:** % of events detected;

**Precision:** % of detected events that are correct;

**F1 score:** Harmonic mean of precision and recall



- “No Sharing” deploys full DNN for each app
- “Max Sharing” shares all but final layer
- Mainstream achieves up to 28X higher F1

- “No Sharing” (NS) has low FPS, high acc
- NS misses events, incurring low recall
- Mainstream balances FPS and acc

- “Max Sharing” (Max) has high FPS, low acc
- Max’s false positives cause low precision
- Mainstream balances precision and recall