PoliFi: Airtime Policy Enforcement for WiFi

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Outline

- Background
- PoliFi design
- Evaluation
- Future work

Main Contributions

PoliFi is an airtime policy enforcement system that:

- Supports individual station and group policies
- Runs entirely on the access point
- Is included in the mainline Linux kernel from v5.1

Background

- 802.11 Performance Anomaly
- Previous Work: Airtime Fairness Scheduler

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802.11 Performance Anomaly

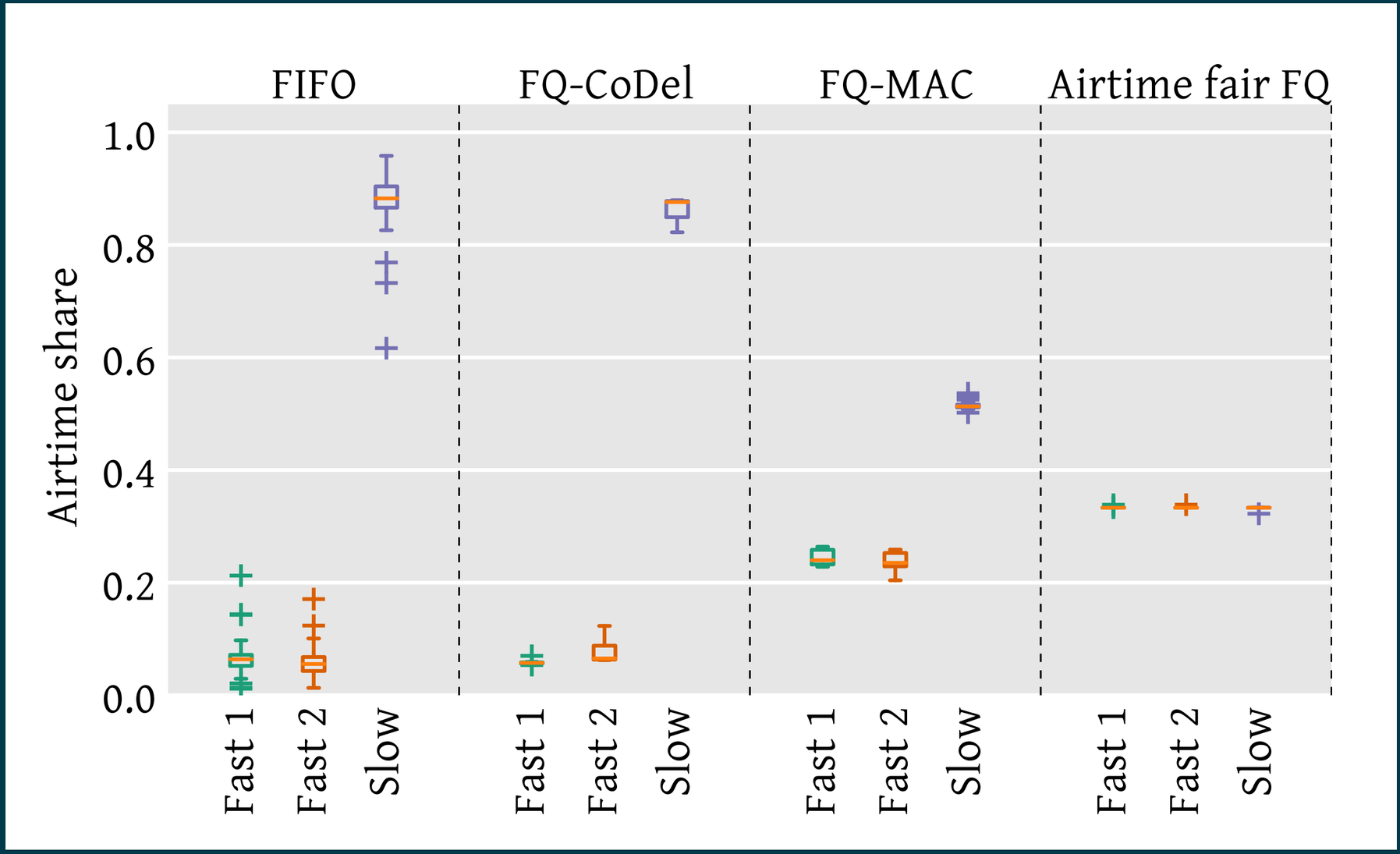
Effective transmission time $T(i)$ and rate $R(i)$ (for station $i \in I$):

$$T(i) = \begin{cases} \frac{1}{|I|} & \text{with fairness} \\ \frac{T_data(i)}{\sum_{j \in I} T_data(j)} & \text{otherwise} \end{cases}$$

$$R(i) = T(i) R_0(i)$$

Where $R_0(i) = \frac{L_i}{T_data(i) + T_oh}$ is the effective rate of a station transmitting without collisions.

Previous Work: Airtime Fairness Scheduler



PoliFi Design

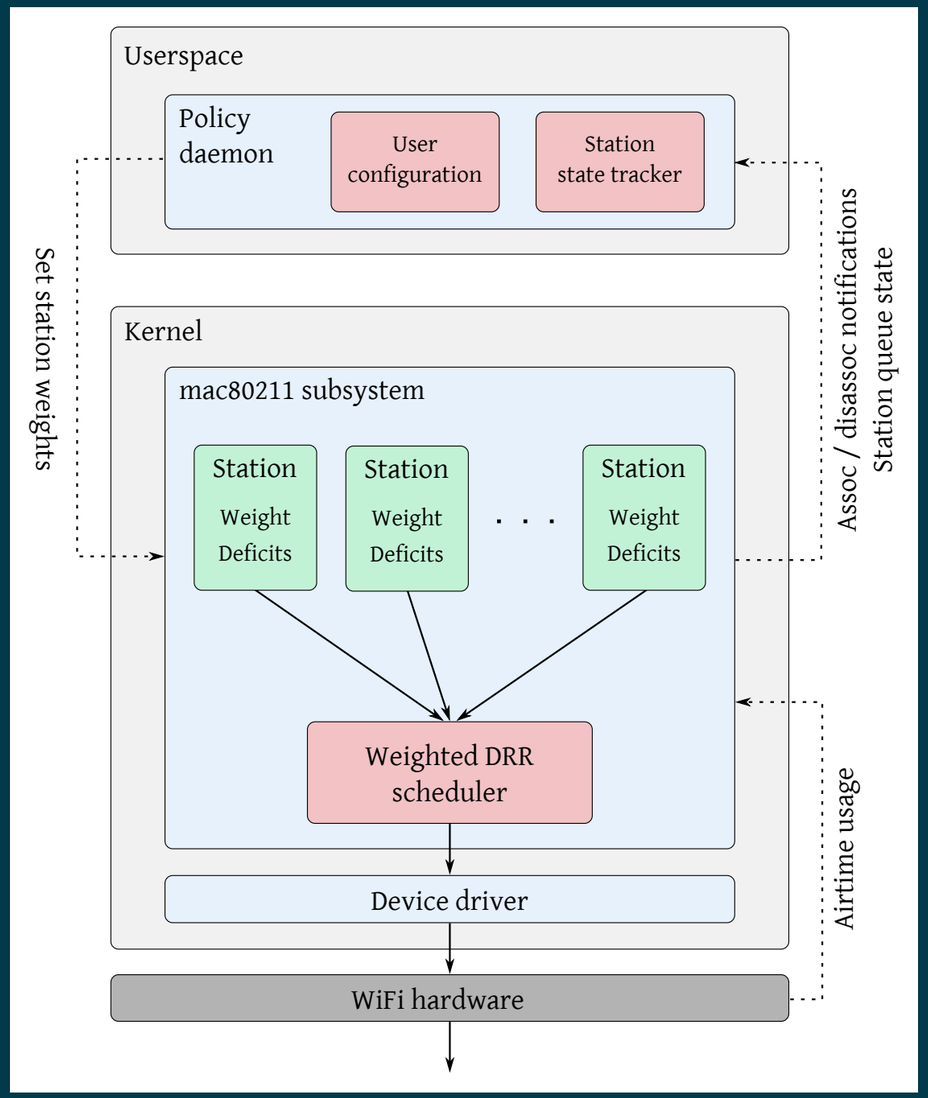
What if we don’t want straight fairness?

Design Goals

Enable airtime policy enforcement, supporting:

- Prioritising single devices
  - Use case, e.g.: “My TV needs more airtime”
- Balancing device groups
  - Use case, e.g.: 5G network slicing
- Limiting groups of devices to a maximum capacity share
  - Use case, e.g.: Guest network

PoliFi Design



Operating Modes

Weights set by userspace daemon (hostapd), supporting three modes:

- Static mode: Specify MAC priority in config
- Dynamic mode: Specify weight per group (BSS)
- Limit mode: Like dynamic, but only limit some groups

Evaluation results

- 4 station test, 2 groups (BSSes)
- BSS 1: Stations 1, 2 and 3
- BSS 2: Station 4

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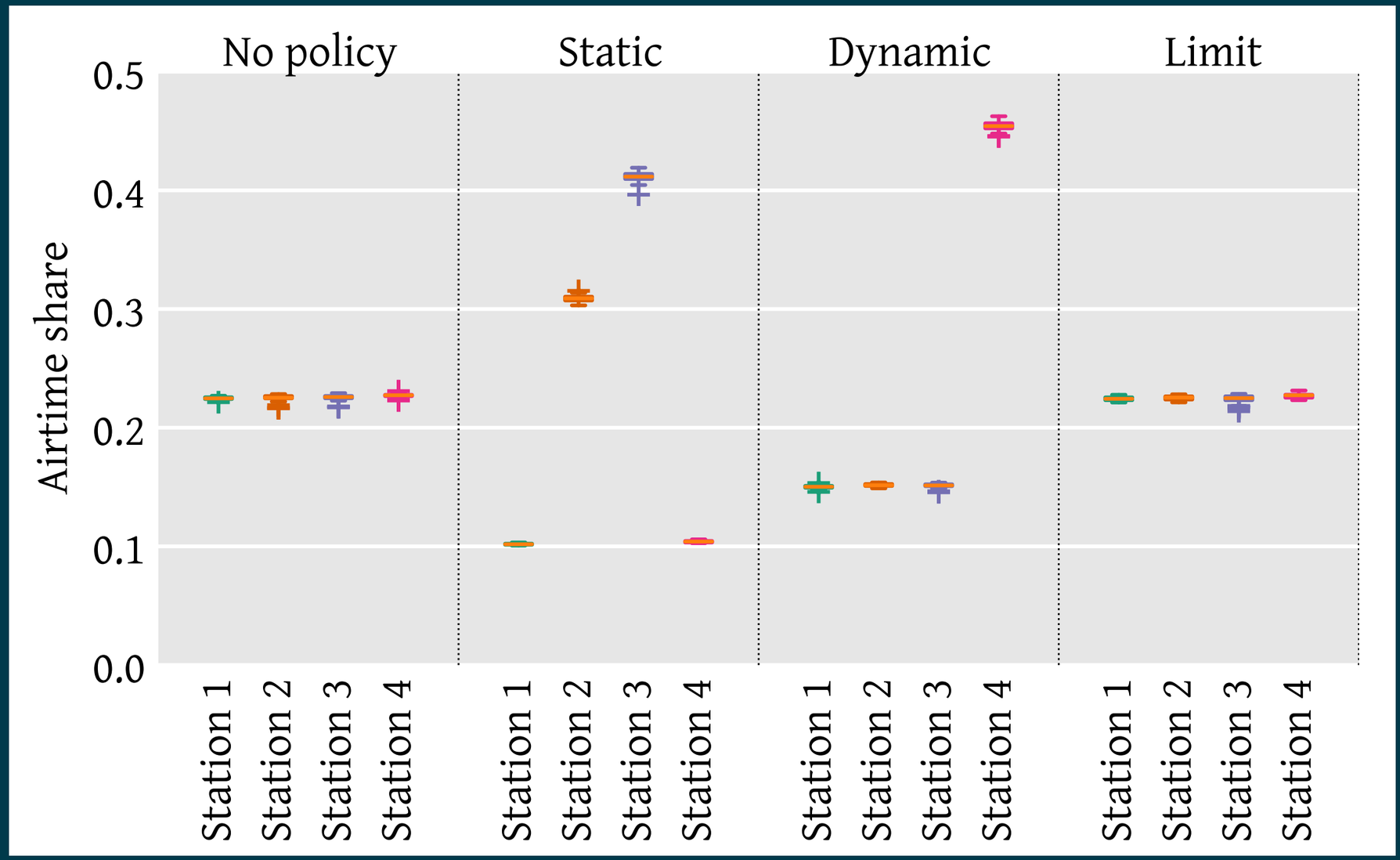
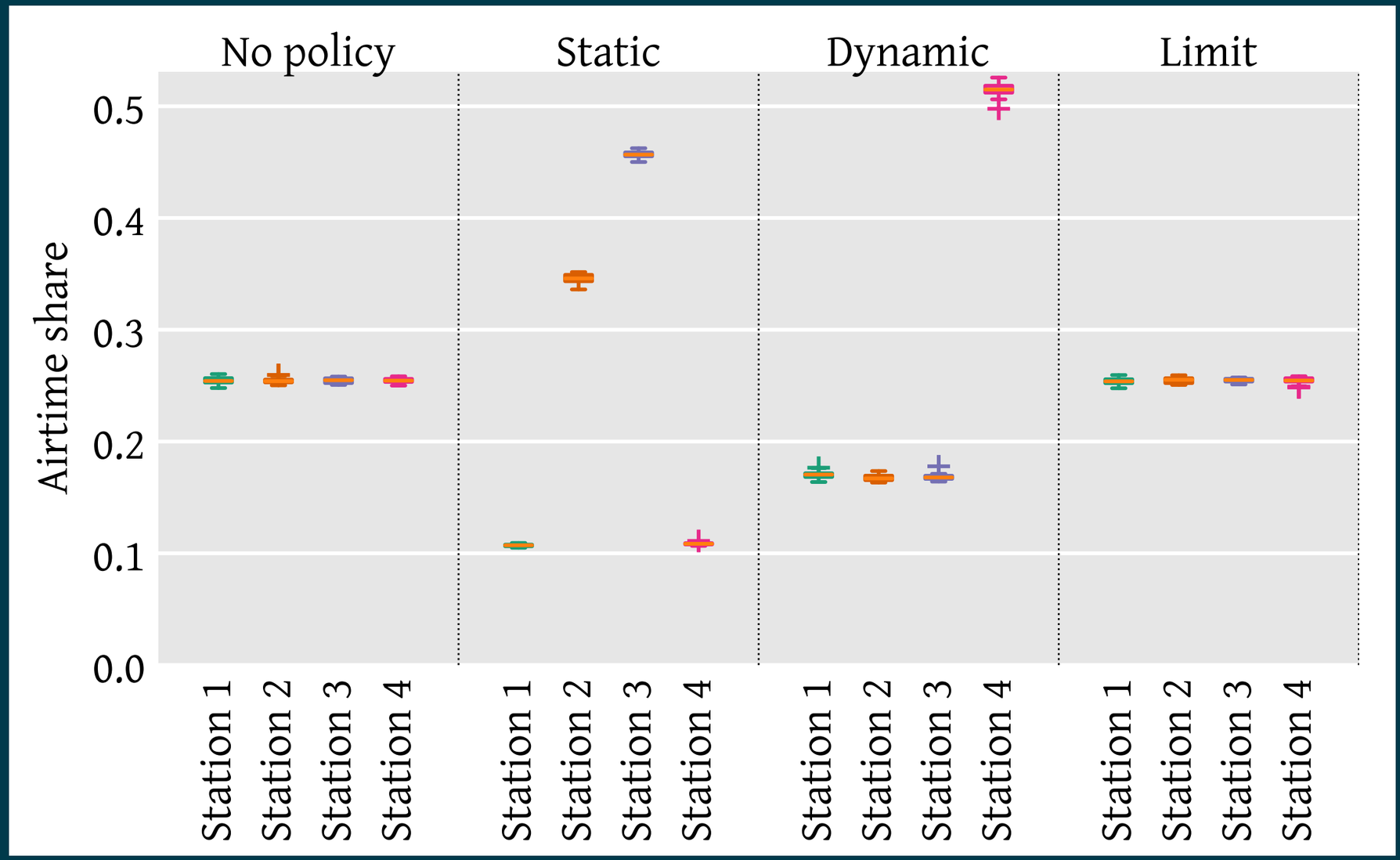
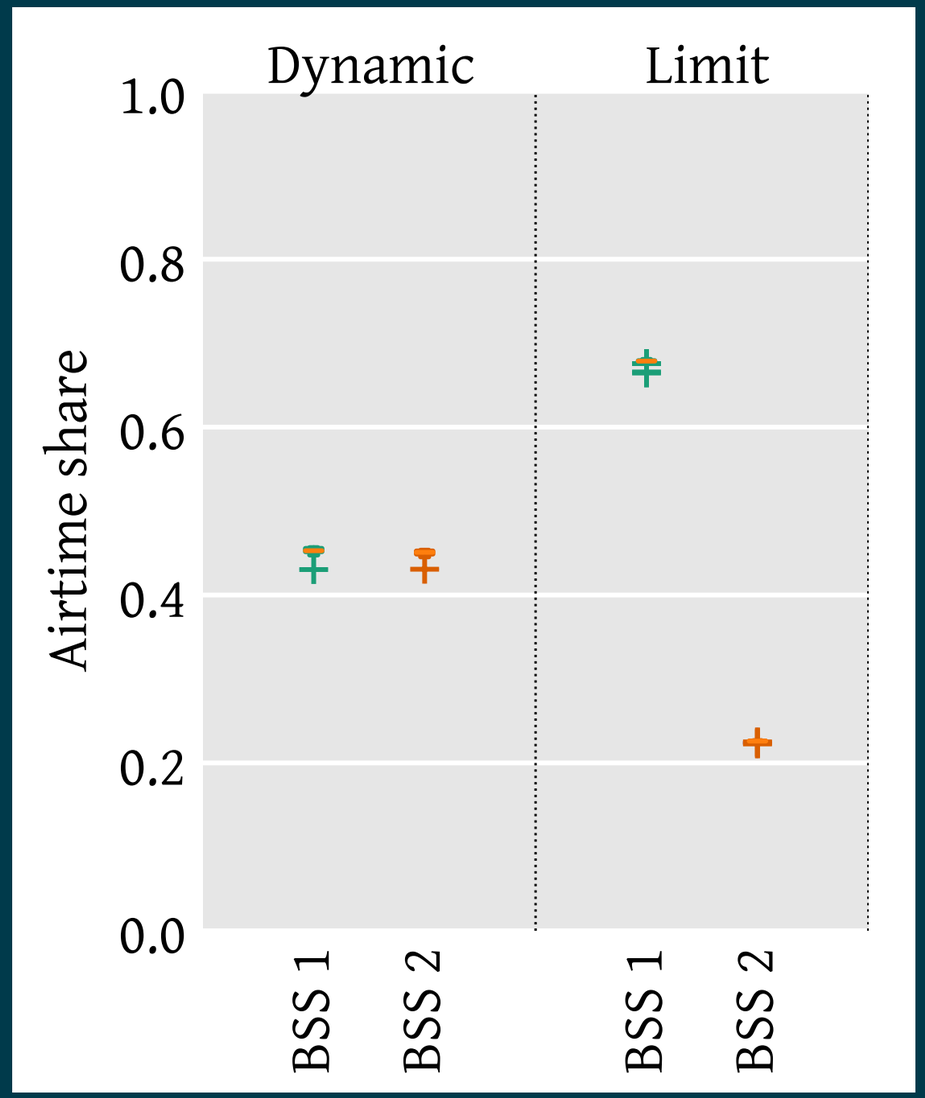
Airtime usage - UDP

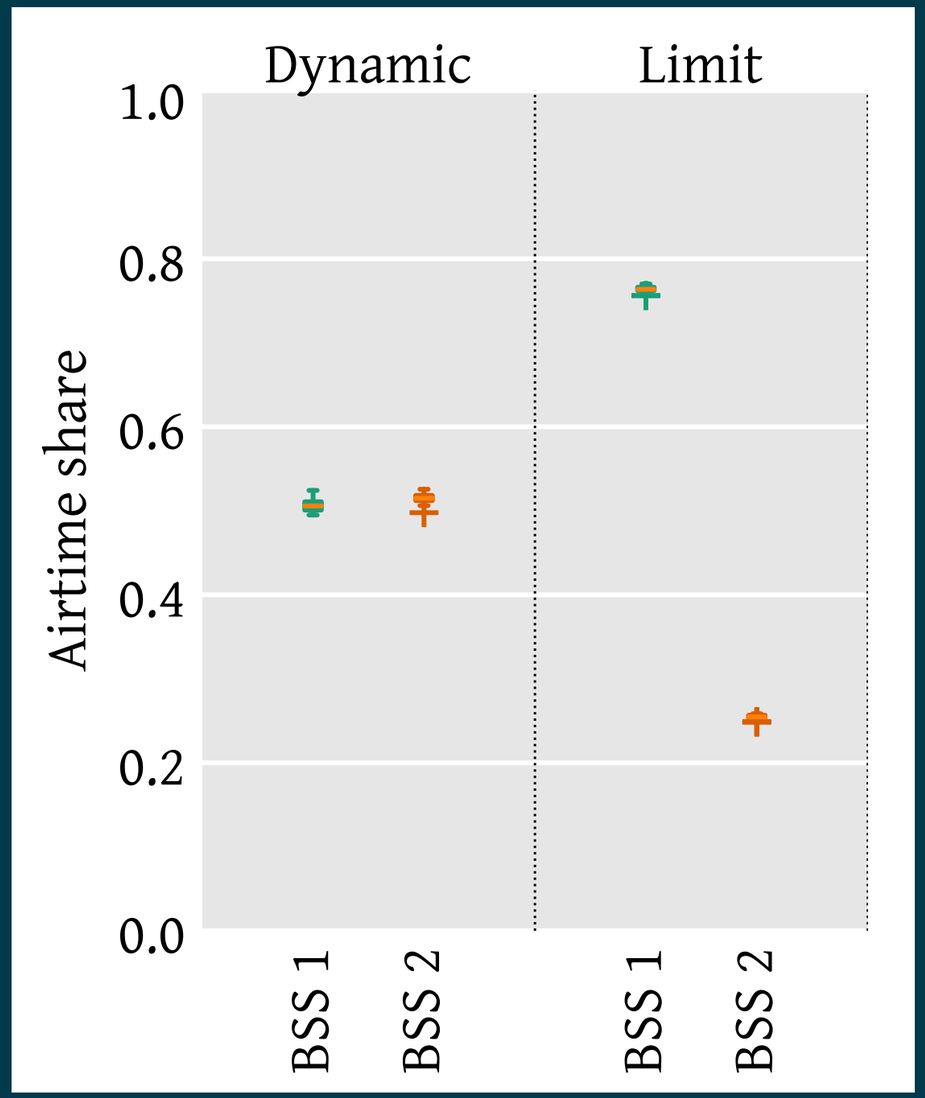


Airtime usage - TCP

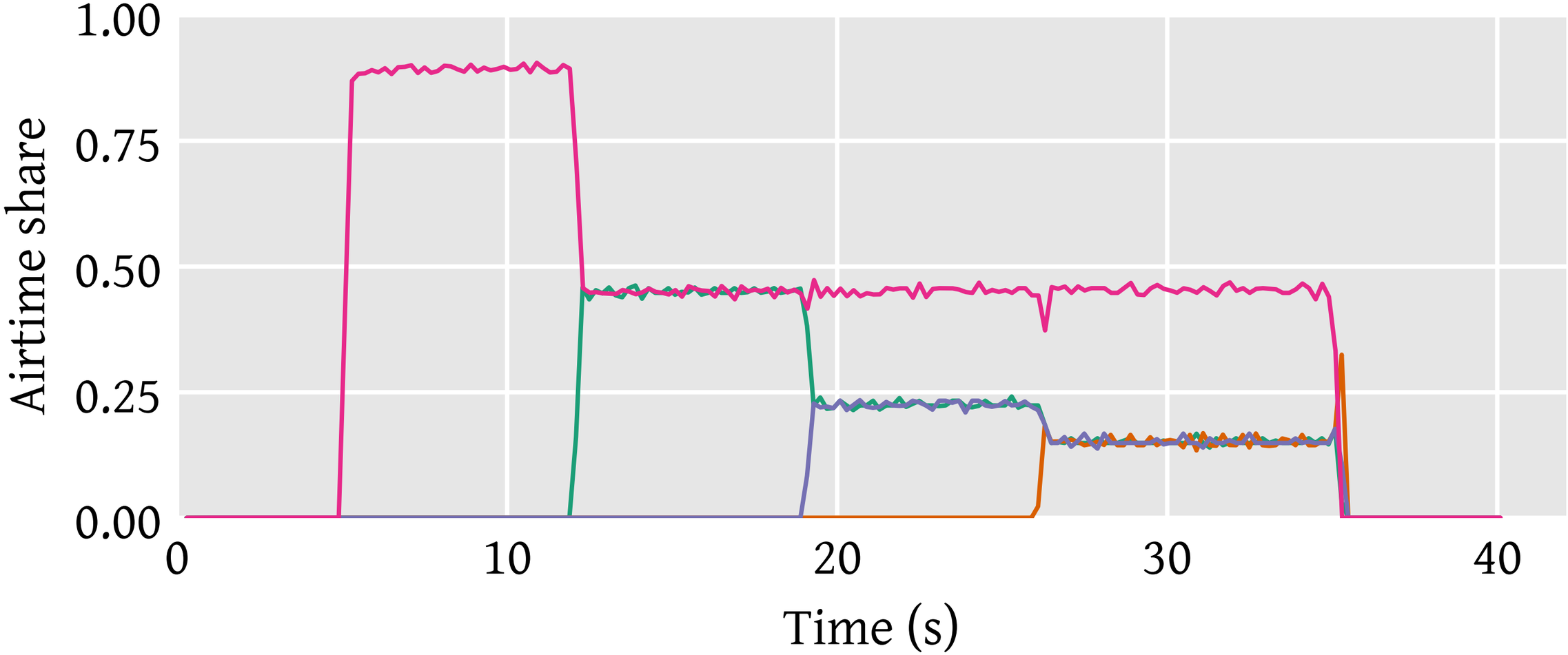


BSS airtime usage - UDP and TCP

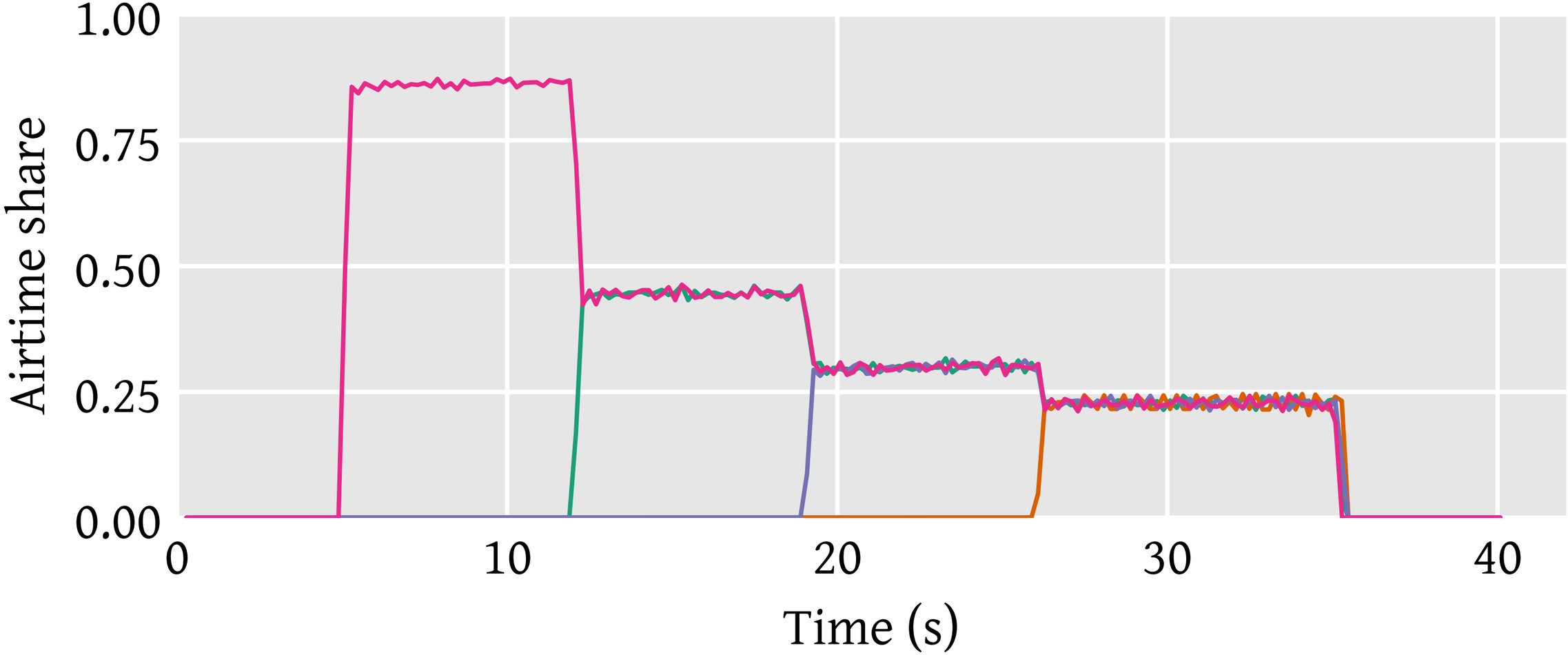




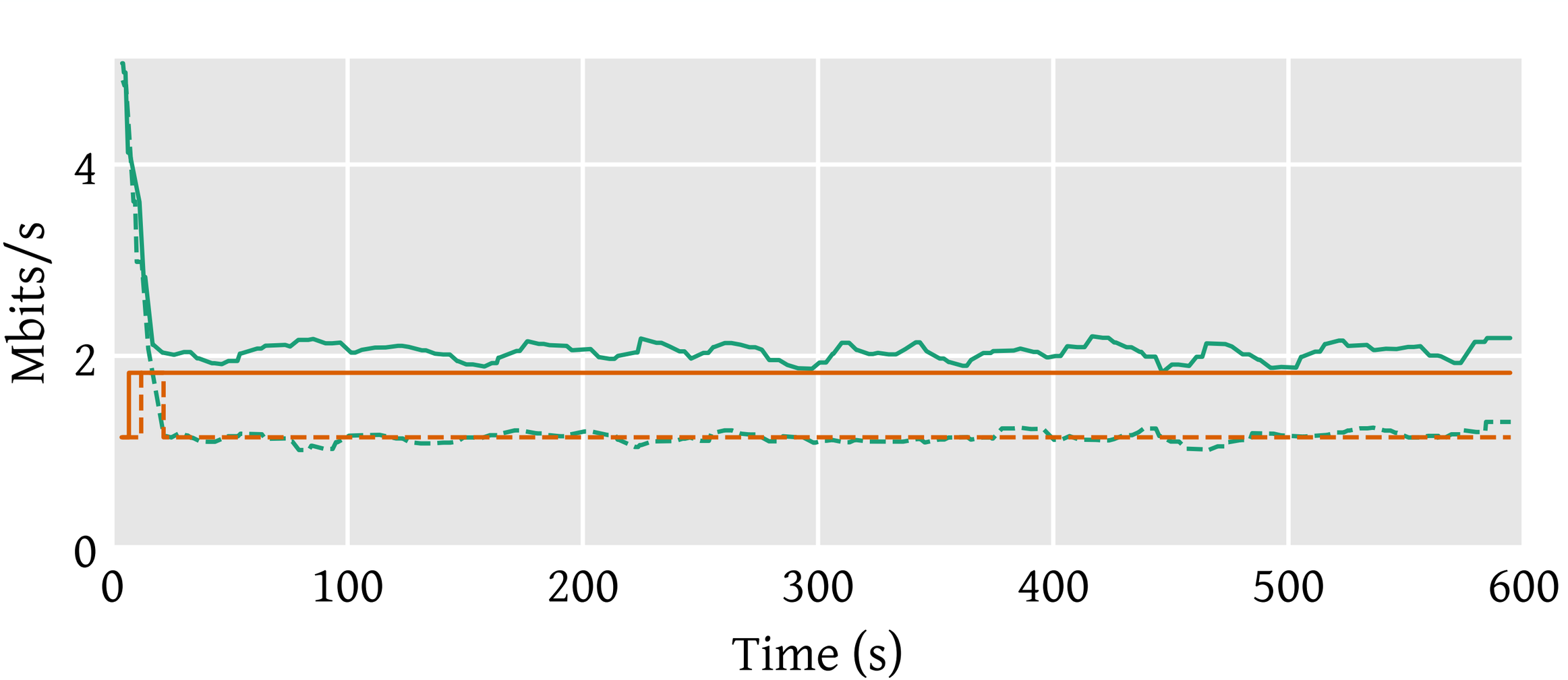
Reaction time - dynamic mode



Reaction time - limit mode



DASH video throughput



Future work

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Planned future work

Future work being discussed in upstream Linux:

- Switching to a virtual time-based scheduler
- Airtime estimation for devices that don't provide it
- Airtime-based queue limits

Summary

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