Mobile Multicores

Use Them or Waste Them

Aaron Carroll
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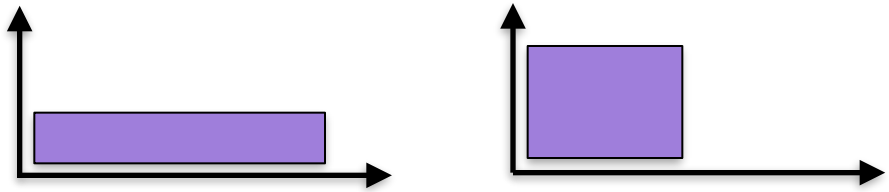
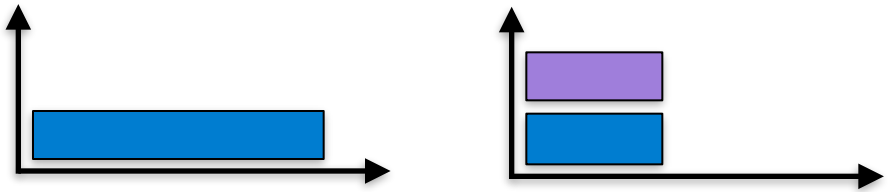
Introduction

- power control knobs:
  - DVFS



  - #online cores



Problem

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- trade-off between the two mechanisms?
- optimal **operating point**
  - frequency and #online cores
- **idle** energy management
  - under-utilised CPU
  - reduce energy
  - performance unaffected (ideally…)

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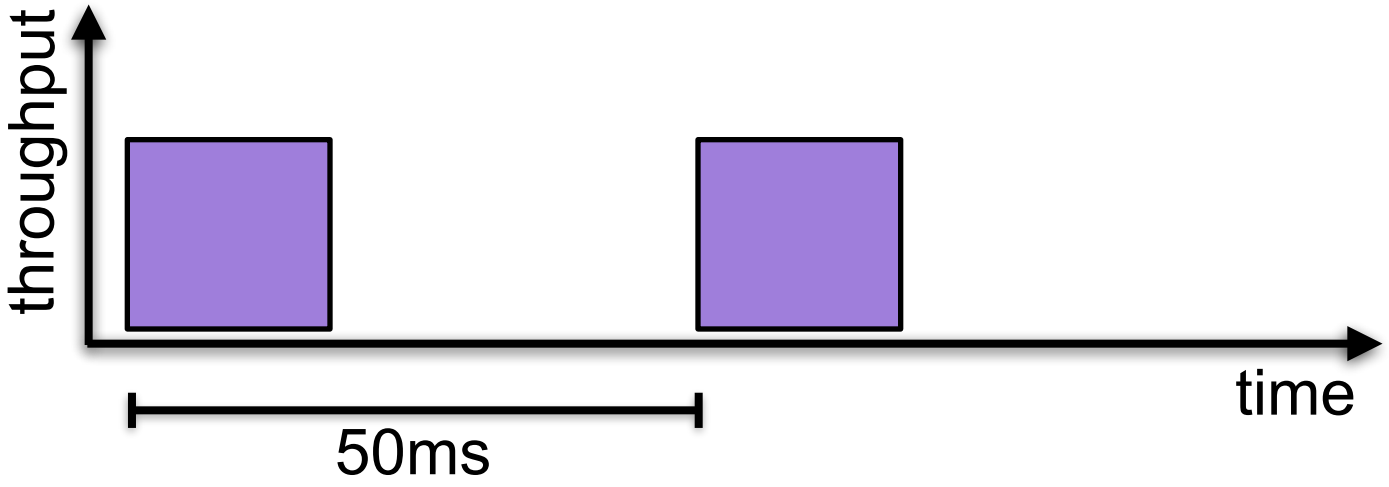
loadcpu



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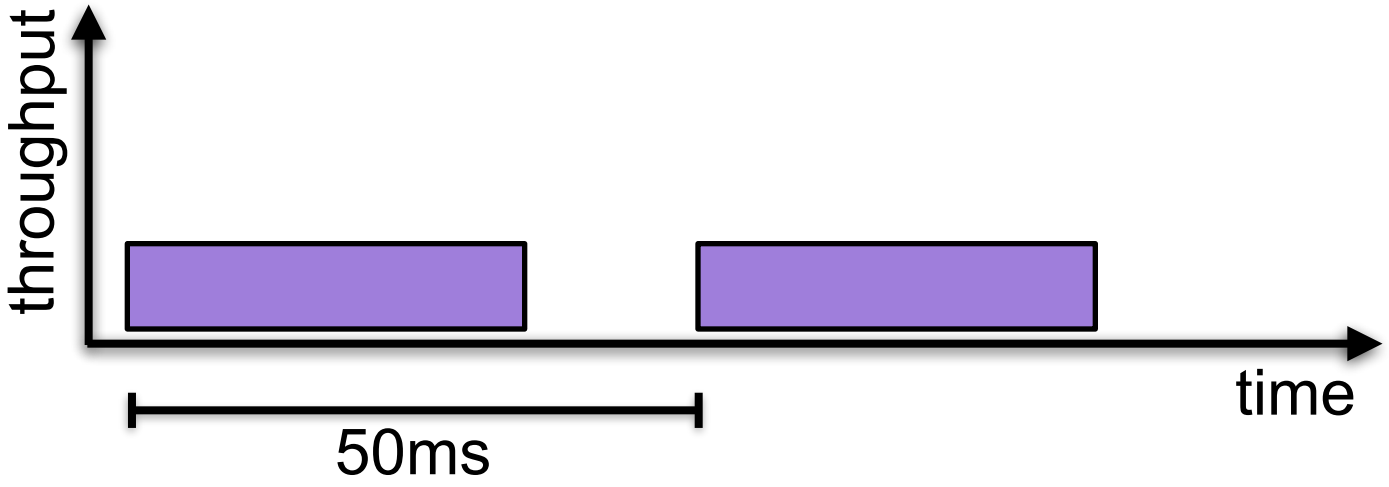
loadcpu



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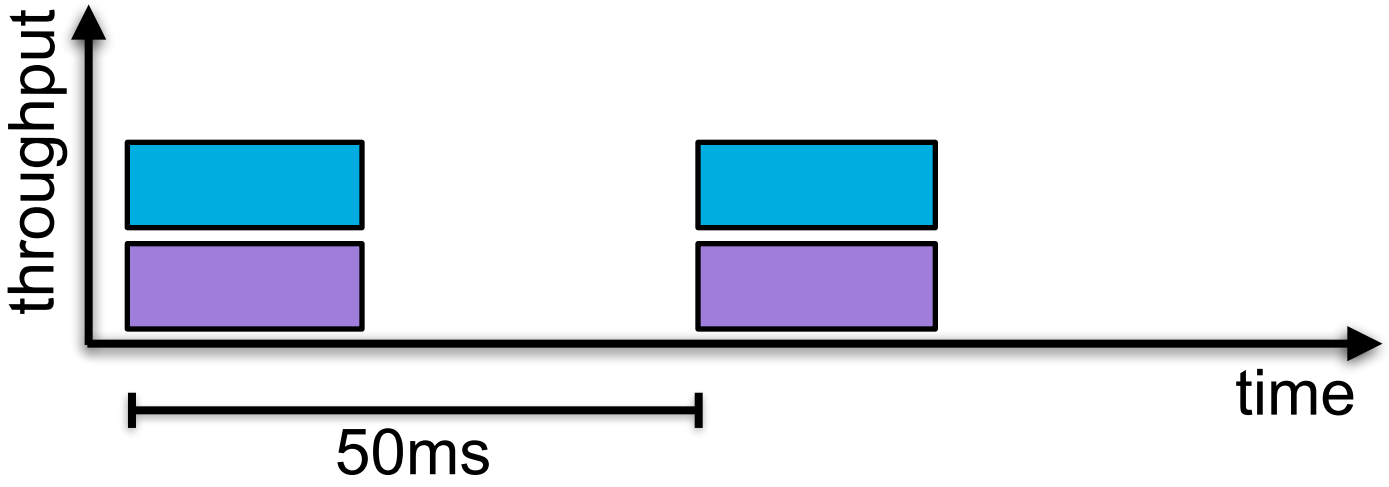
loadcpu



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Devices

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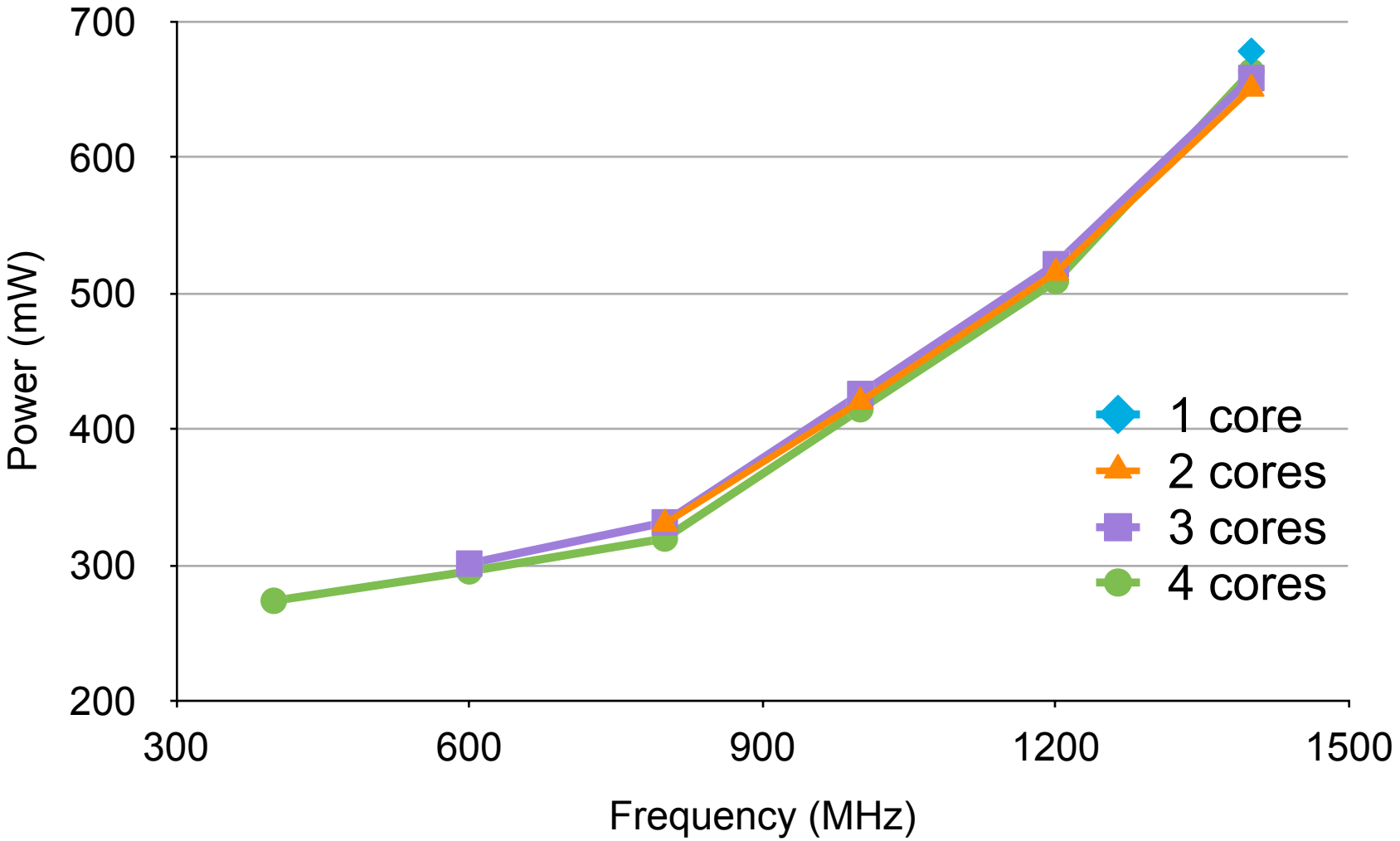
loadcpu S3 25%



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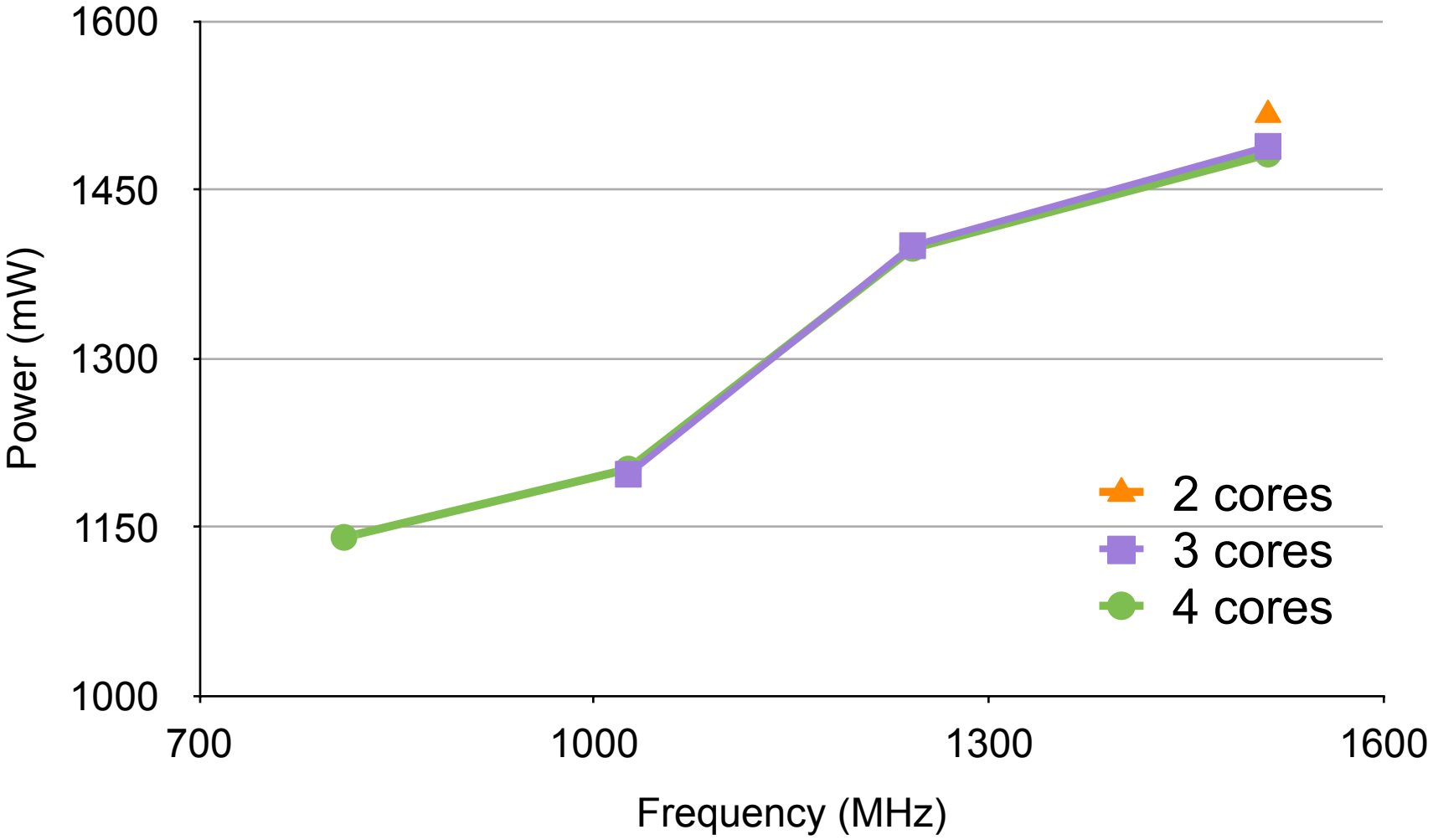
loadcpu MDP 50%



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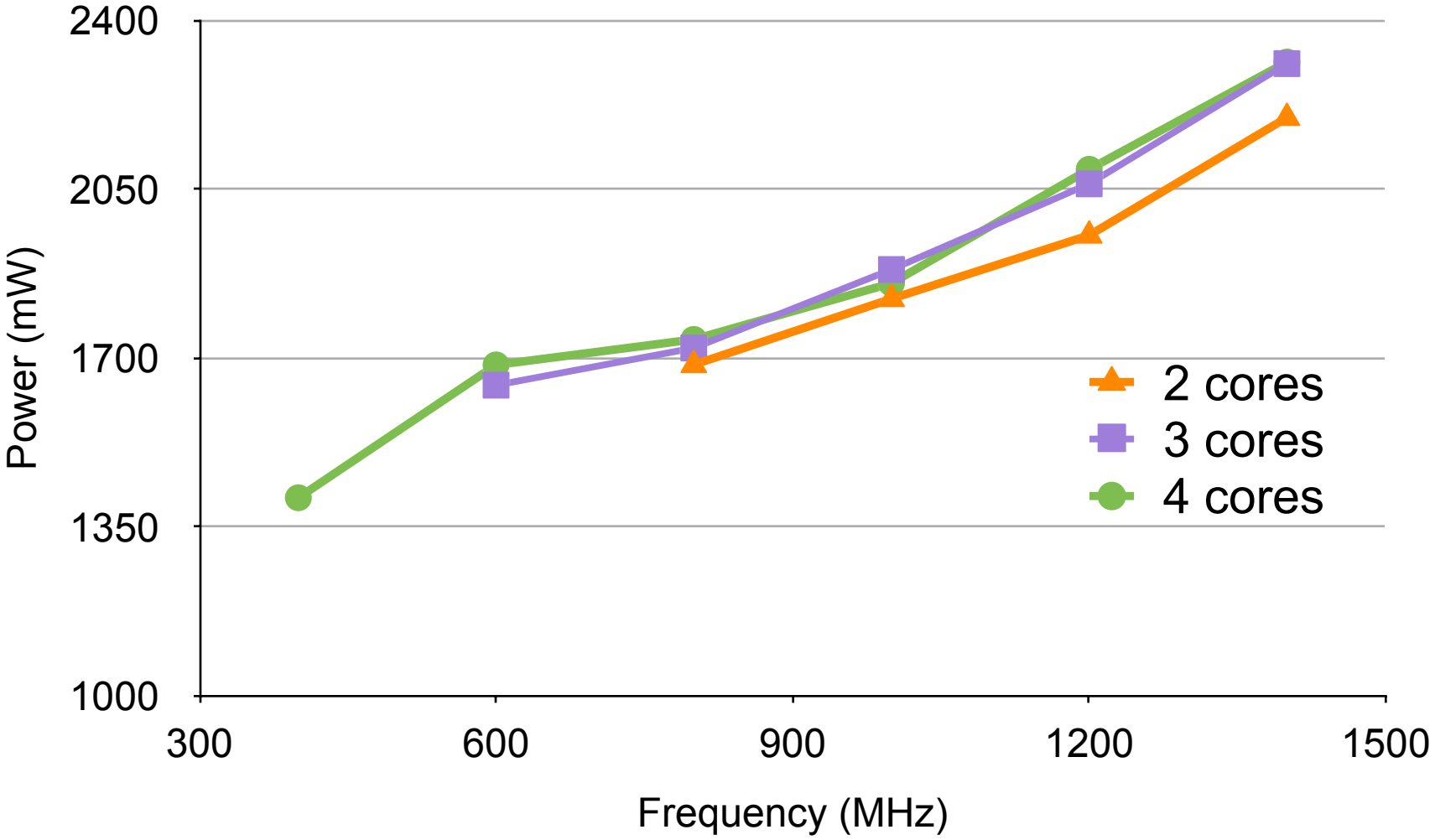
video S3



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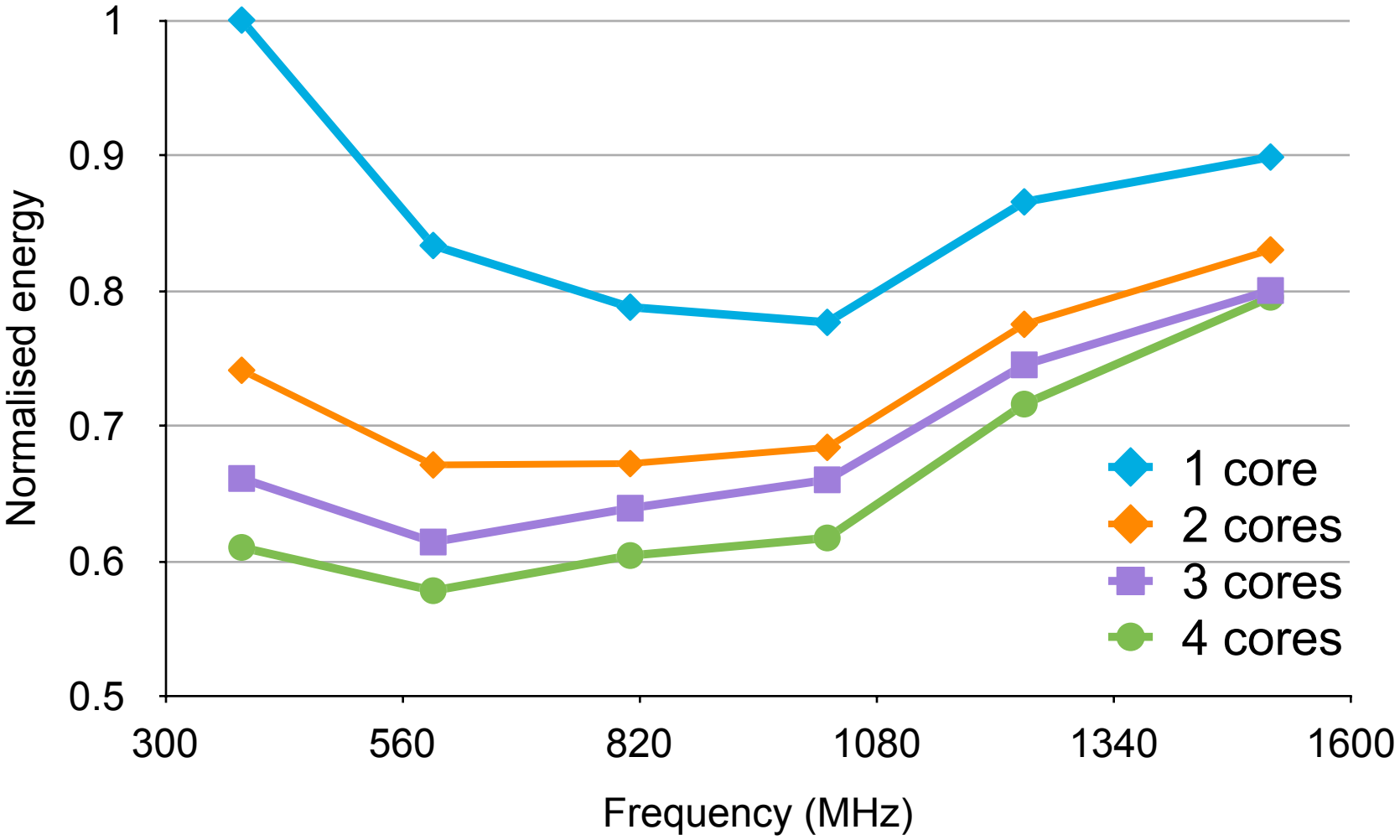
spin MDP



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Observations

- Periodic
  - *P* independent of *n* at fixed *f*
  - decrease *f* => lower *P*

- Compute-bound
  - *P* is a complex function of *f*
  - increase *n* => lower *P*

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Analysis

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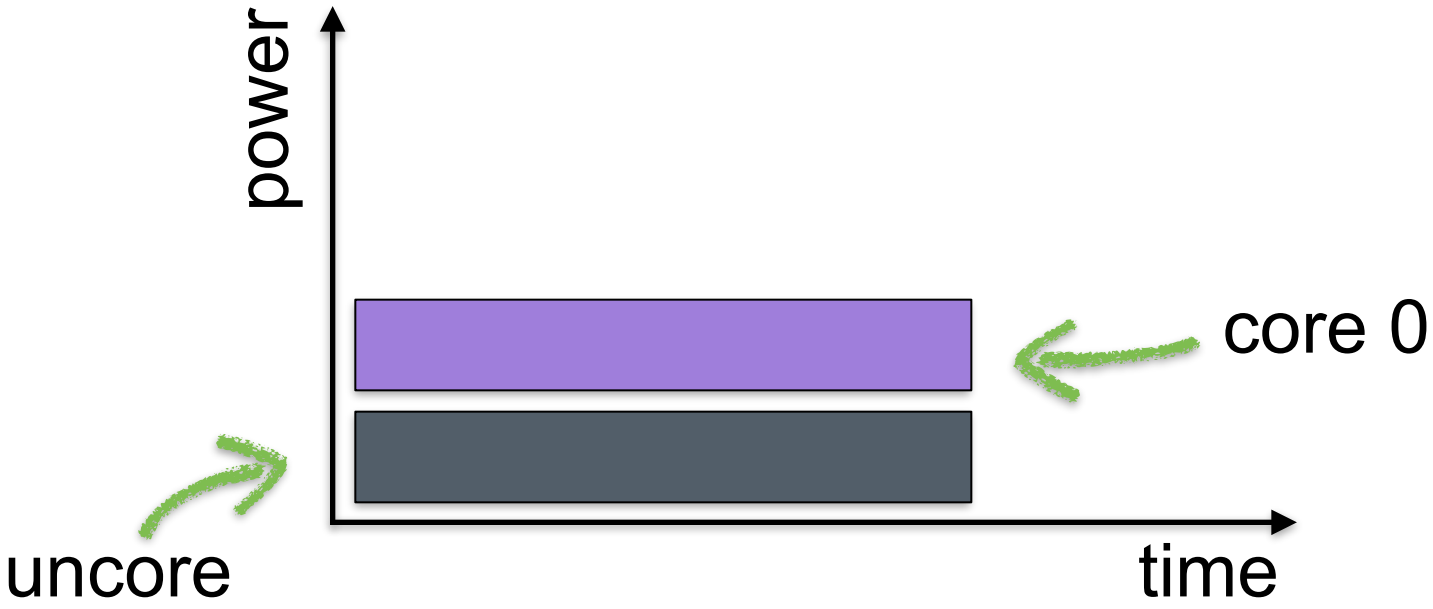
Compute-bound:



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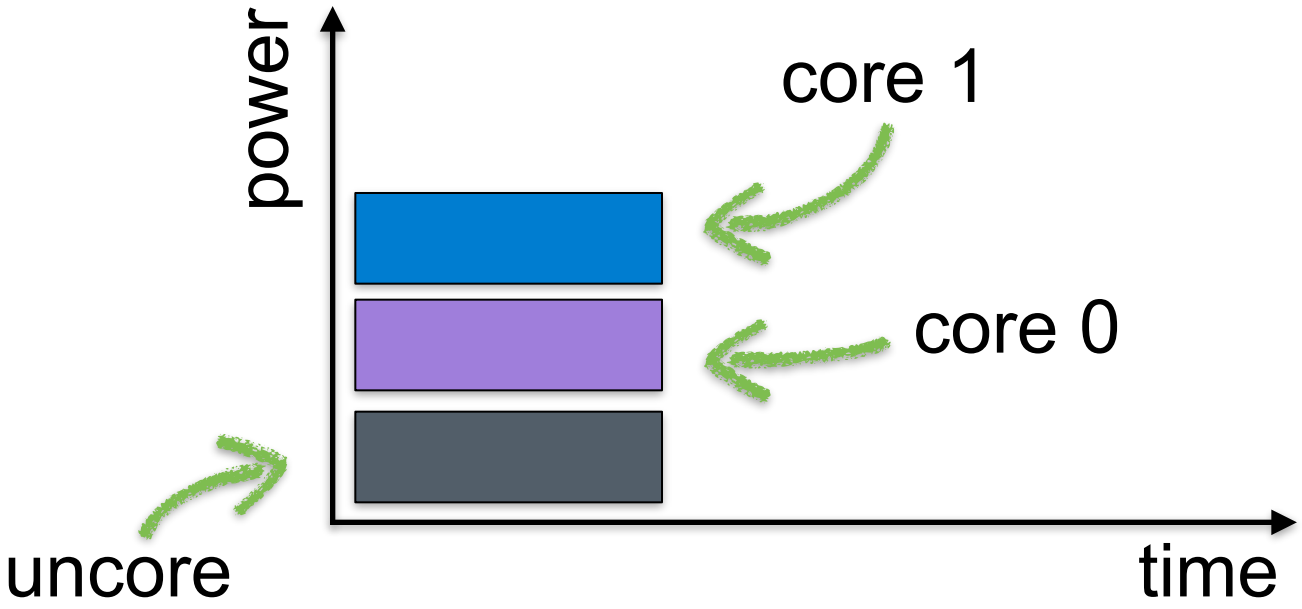
Analysis

Compute-bound:



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Analysis

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Compute-bound:

$$P = P_{\text{uncore}} + nP_{\text{core}}$$

$$E = P_{\text{uncore}}t + nP_{\text{core}}t$$

Assume scalability: $t \propto \frac{1}{n}$

$$E \propto \frac{P_{\text{uncore}}}{n} + P_{\text{core}}$$

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Analysis

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Periodic:

$$P = P_{\text{uncore}} + n(P_{\text{active}} + P_{\text{idle}})$$

$$= P_{\text{core}}$$

T = period of workload

t = execution time

Assume scalability

$$E = (P_{\text{uncore}} + nP_{\text{idle}})T + k$$

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Analysis

If

$$P_{\text{idle}} \ll P_{\text{uncore}}$$

then *P* is independent of *n*.

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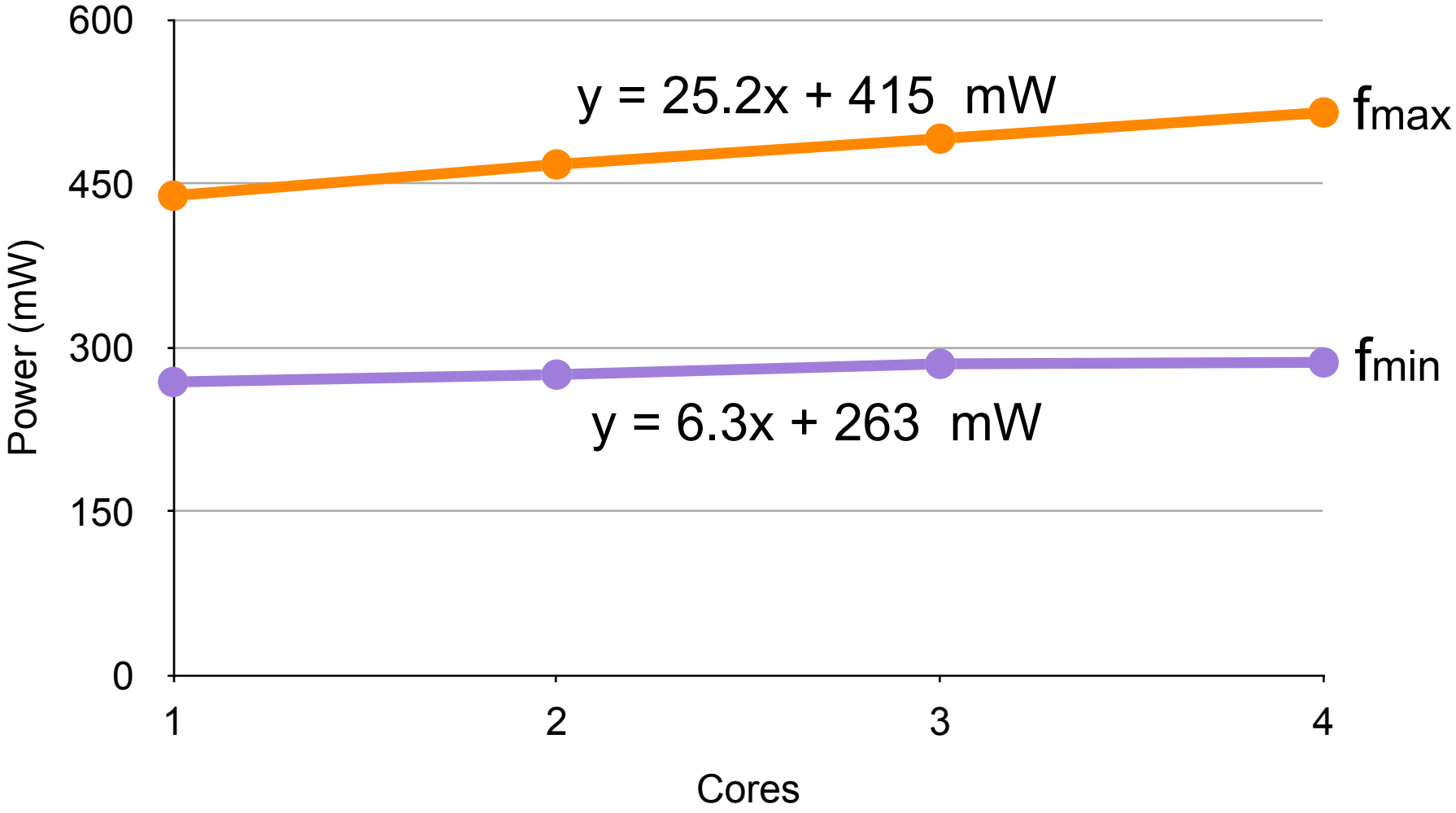
S3 idle power



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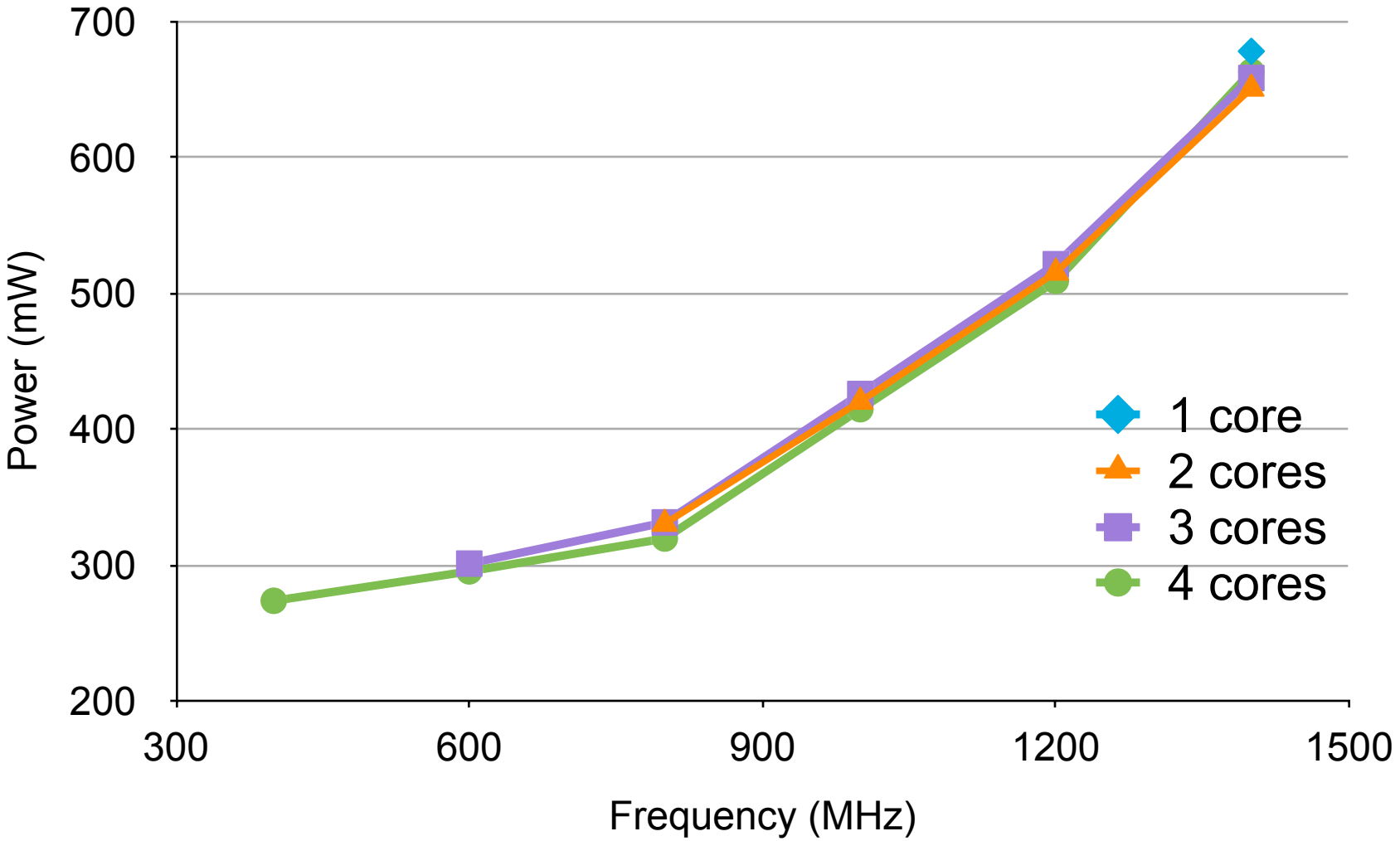
loadcpu S3 25%



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Conclusions

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- Online cores to:
  - **unlock** lower frequencies
  - race to idle
- Policy design:
  - scale out before scaling up
  - offline cores conservatively
  - reduce frequency aggressively

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medusa

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- medusa: an offline-aware governor
- like ondemand: keep utilisation <100%
- try to achieve
  - minimum frequency
  - maximum #cores
- constrained by #threads

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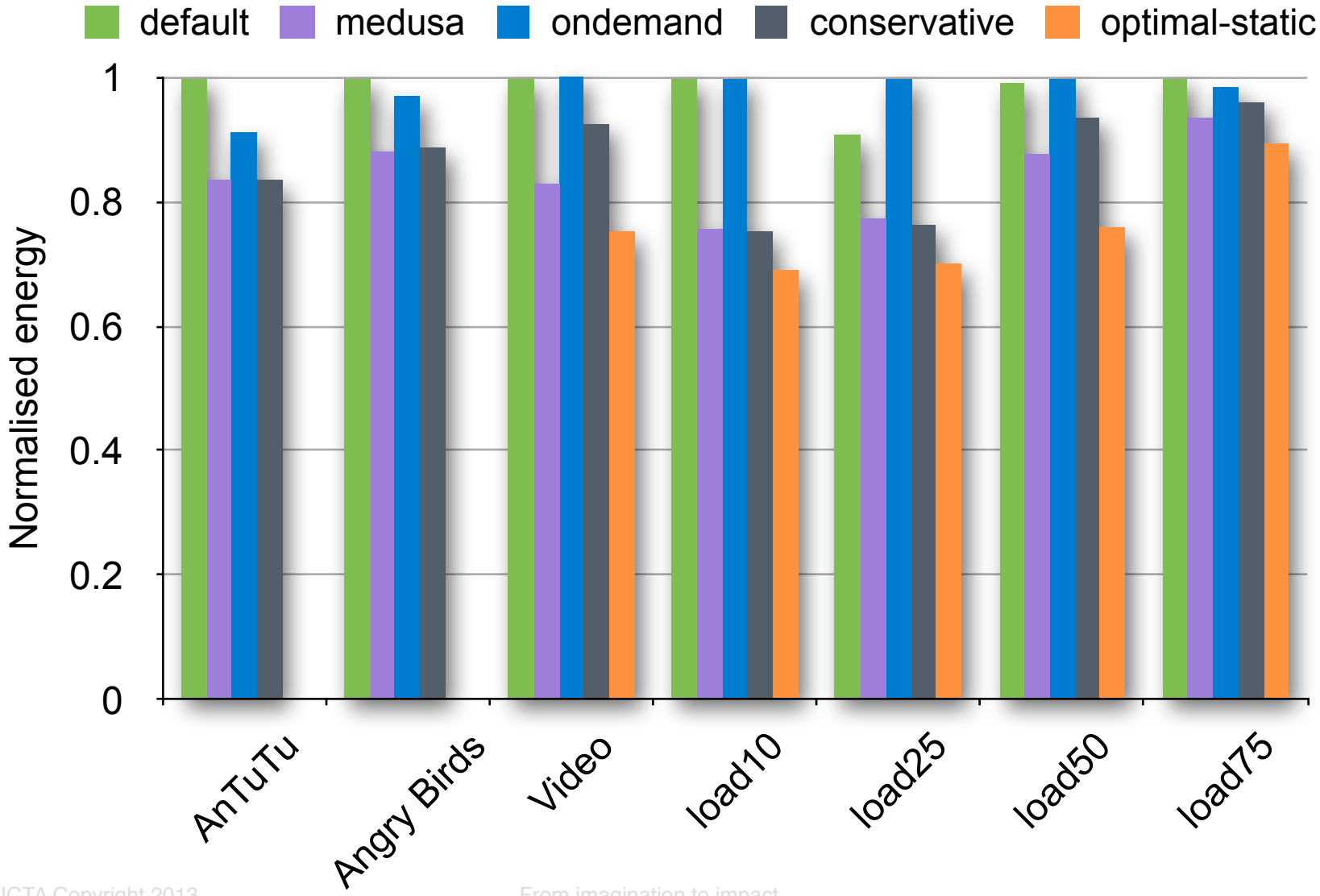
medusa



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Summary

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- onlining cores **reduces** energy consumption in most cases
  - access to lower frequencies
  - race to idle
- due to high uncore and low per-core static power
- medusa: up to 20% energy reduction

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