

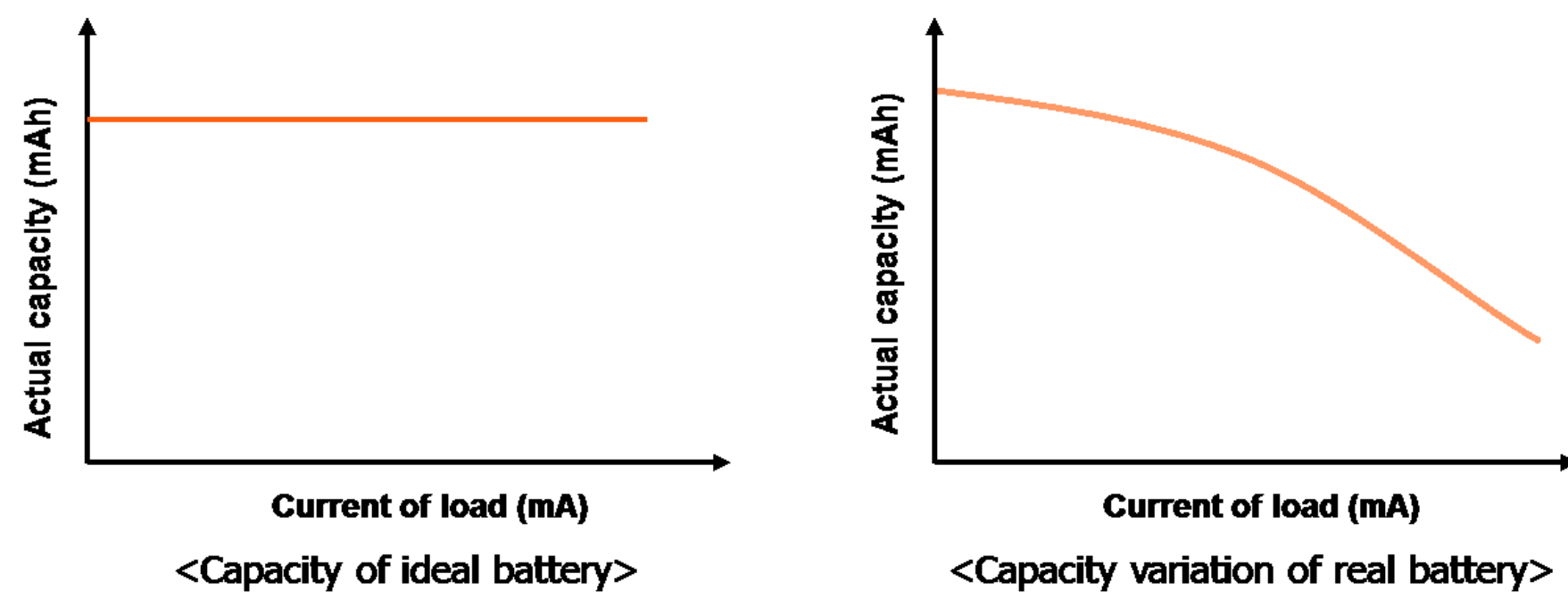
A Model by Efficiency of Battery Capacity for Mobile Computing Systems

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Motivation & Introduction

Effective capacity of a battery

- Different from the battery capacity specification
- Varies by drain current of a system due to rate capacity effect



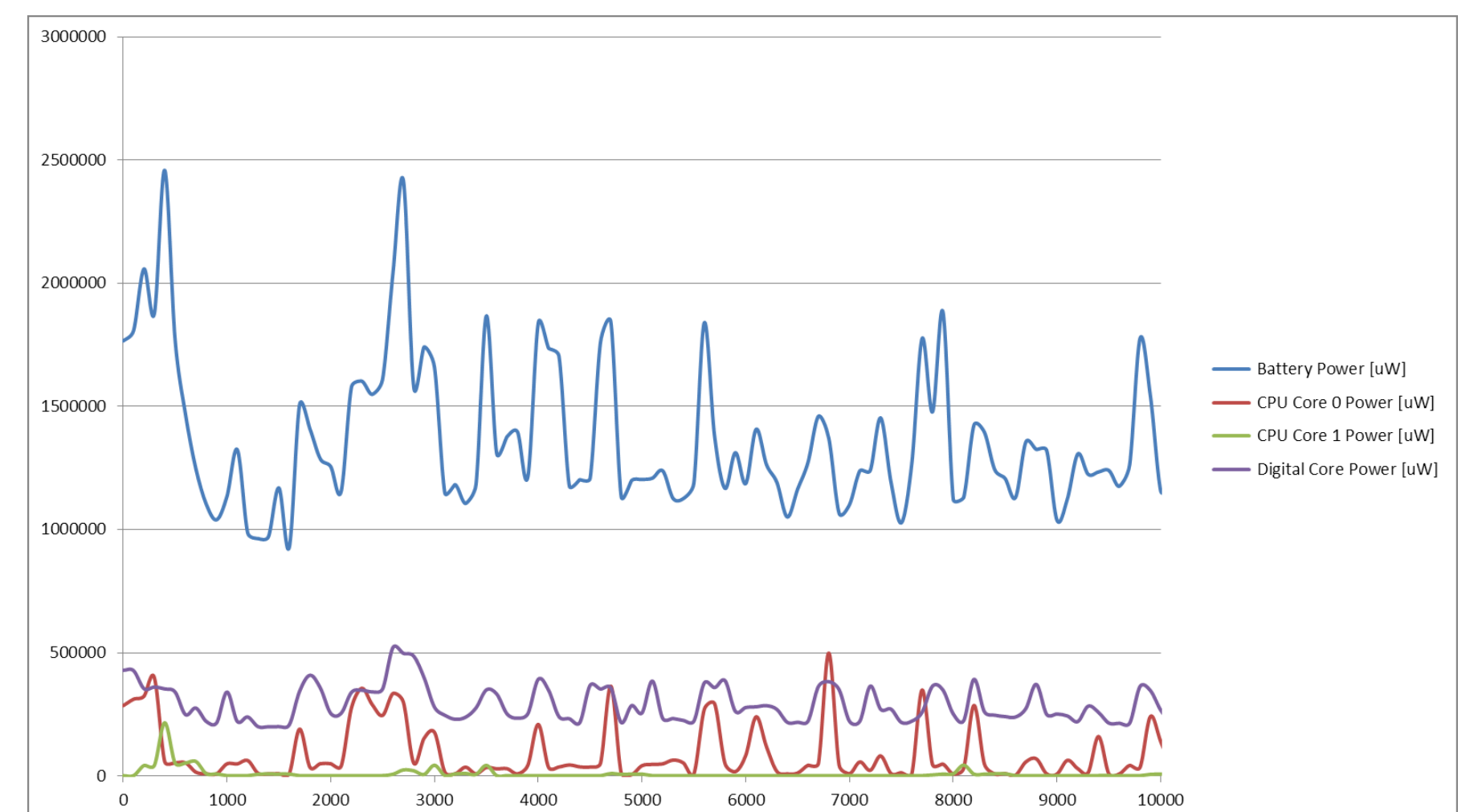
Efficiency of battery varies by drain current level

Current level of a system in higher efficiency increases battery lifetime with same power consumption
 → Longer run-time of the system!!

Environment of Mobile Systems

Power usage pattern

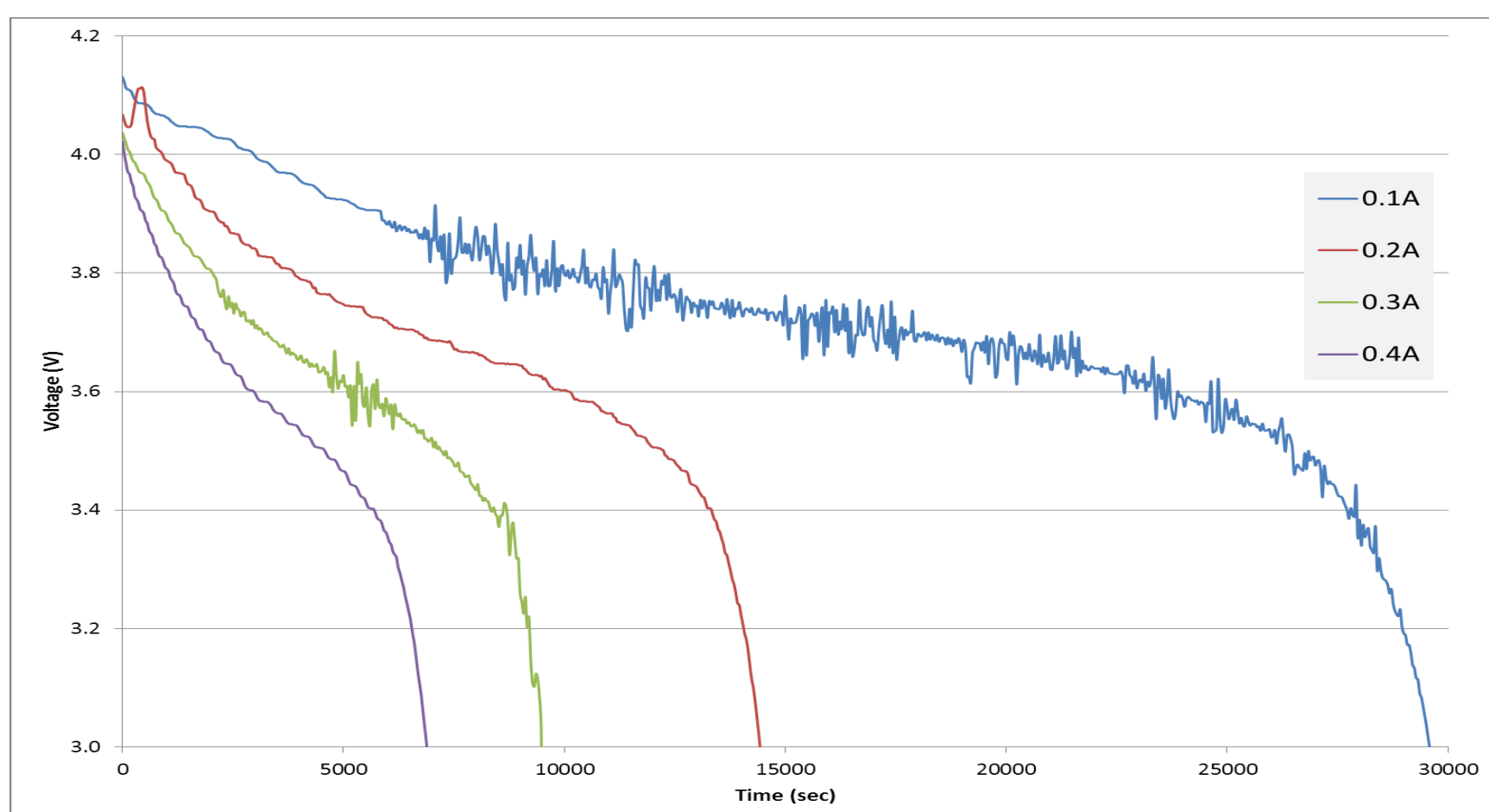
- Various devices shares the power delivery domains
- Peak power consumption when multiple devices are running



Measure

Measure lifetime of a battery

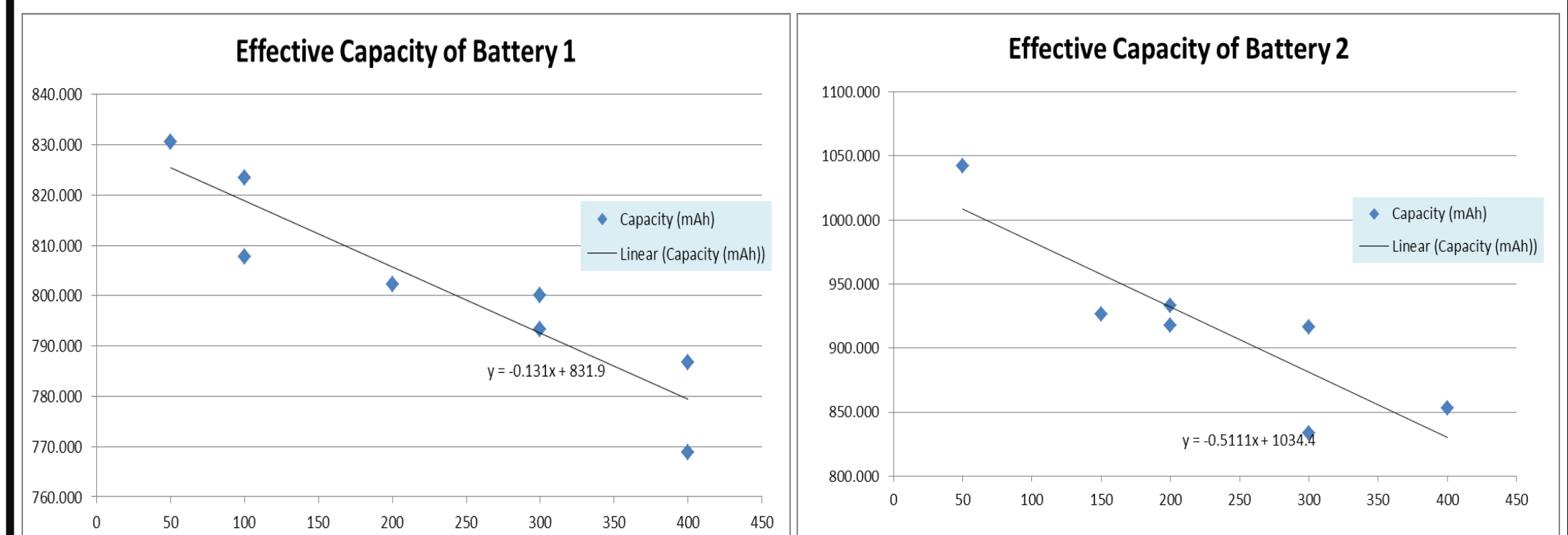
- Lithium-ion battery: nominal voltage 3.7V, 950mAh
- Lifetime: fully-charged state → fully-discharged state (battery voltage: 4.0V) → (below cut-off voltage 3.0V)
- Draining various constant current



Measure

Effective capacity by drain current

- Measuring lifetime of two different 950mAh batteries
- Higher efficiency for lower current level



Drop of battery capacity
 $\Delta C = -\epsilon At$

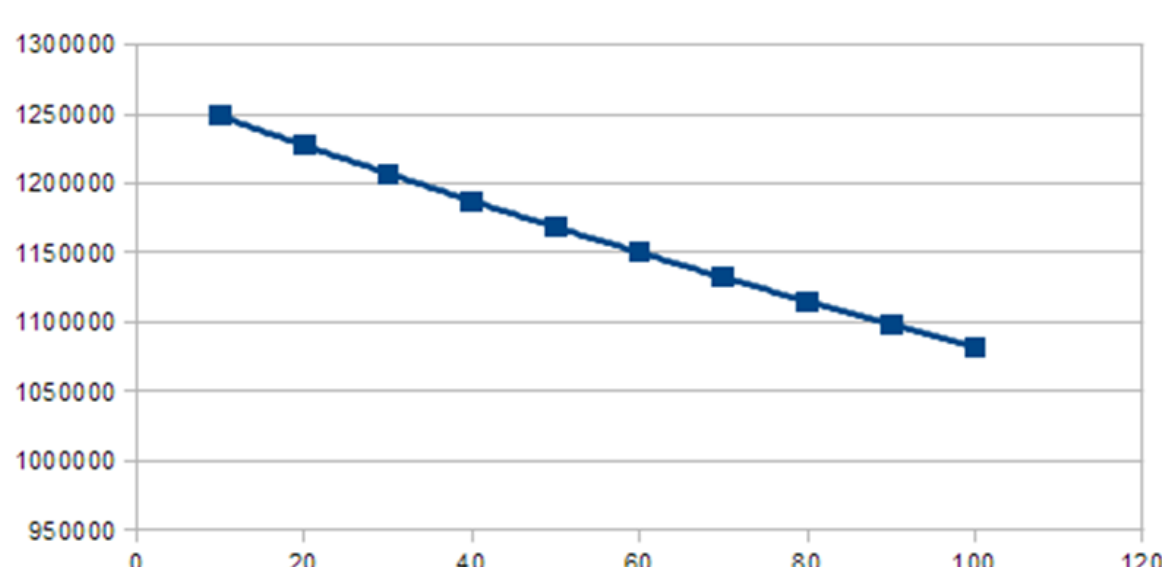
Battery-Aware Control

Realtime workload

- Same execution time and power consumption
- Select performance setting for lower battery capacity drop

Device usage control

- Avoid peak current drain to a battery
- Avoid overlapped device running



Overlap (%)	Time (ms)	Ratio
100	1082124	1.000
90	1098281	1.015
80	1115186	1.031
70	1132346	1.046
60	1150283	1.063
50	1168491	1.080
40	1187512	1.097
30	1207353	1.116
20	1227499	1.134
10	1248510	1.154

Future work

Battery aware scheduling

- CPU workload scheduling by DVFS
- Usage of devices scheduling

Considering efficiency of power delivery network

- Between power source and system
- Efficiency of actual battery capacity by drain current
- Efficiency of voltage regulator

Scheduling and control considering efficiency of power delivery network