Maximizing System Lifetime by Battery Scheduling

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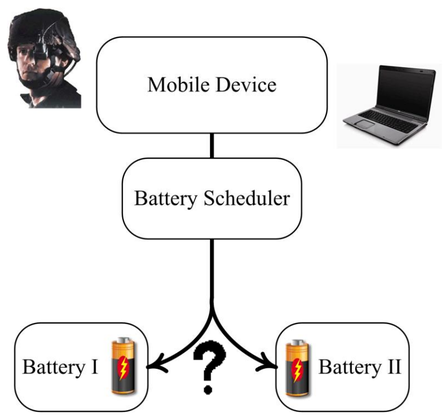
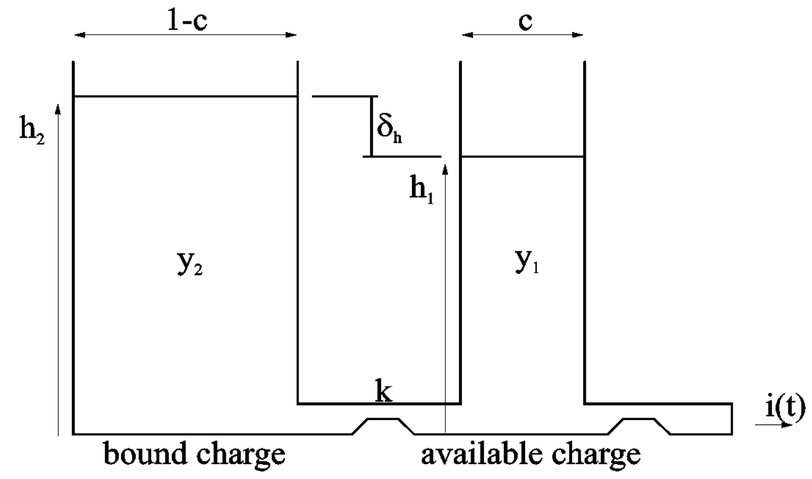
Introduction



What is the optimal way to schedule the batteries to the load of the mobile device?

Kinetic Battery Model



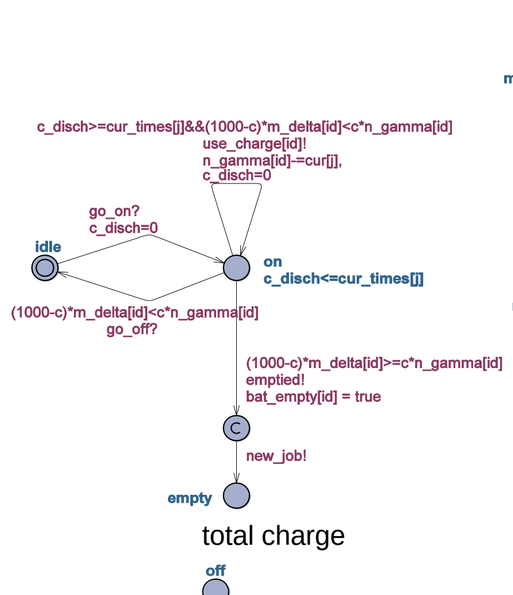
$$\frac{dy_1}{dt} = -i(t) + k(h_2 - h_1) \qquad \frac{dy_2}{dt} = -k(h_2 - h_1)$$

$$\gamma = y_1 + y_2 \qquad \delta = h_2 - h_1$$

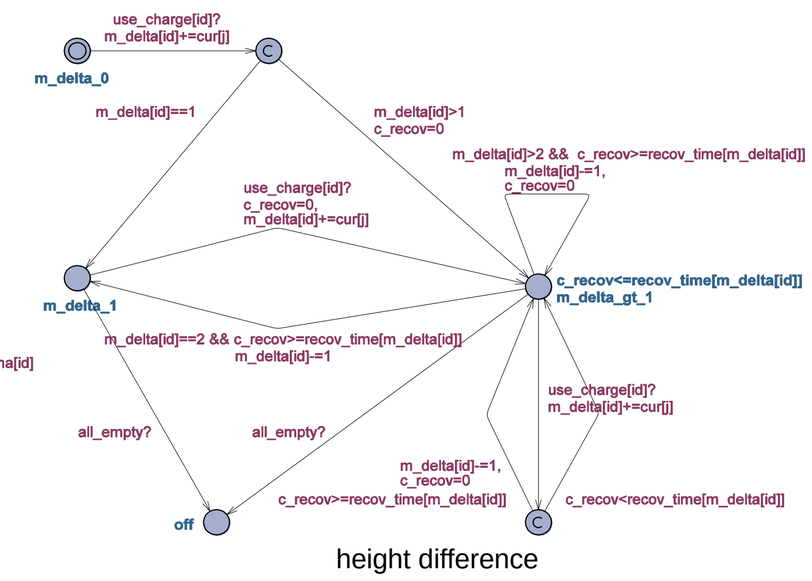
$$\frac{d\delta}{dt} = -\frac{i(t)}{c} - \frac{k}{c(1-c)}\delta \qquad \frac{d\gamma}{dt} = -i(t)$$

Priced-Timed Automata Battery Scheduling Model

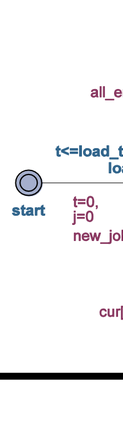
- discretized Kinetic Battery Model:
  - total charge automaton
  - height difference automaton
- load automaton calls scheduler at start of new job
- scheduler non-deterministically calls one of the batteries to go on and supply charge
- with maximum finder the optimal battery schedule is determined
- the optimal scheduler is compared with 3 different deterministic battery schedulers:
  - sequential
  - round robin
  - best-of-two
- 6 different deterministic test loads:
  - 3 continuous loads (CL), discharge currents 250 mA, 500 mA and alternating
  - 3 intermittend loads (IL), discharge currents 250 mA, 500 mA and alternating



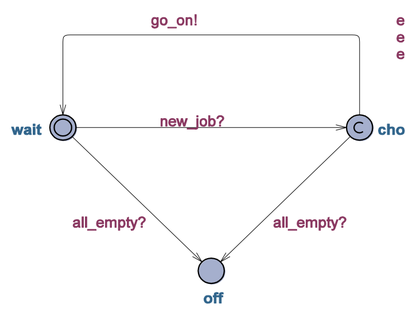
total charge



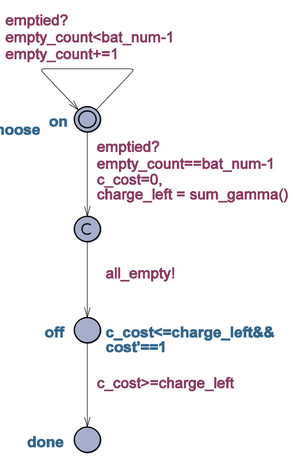
height difference



load



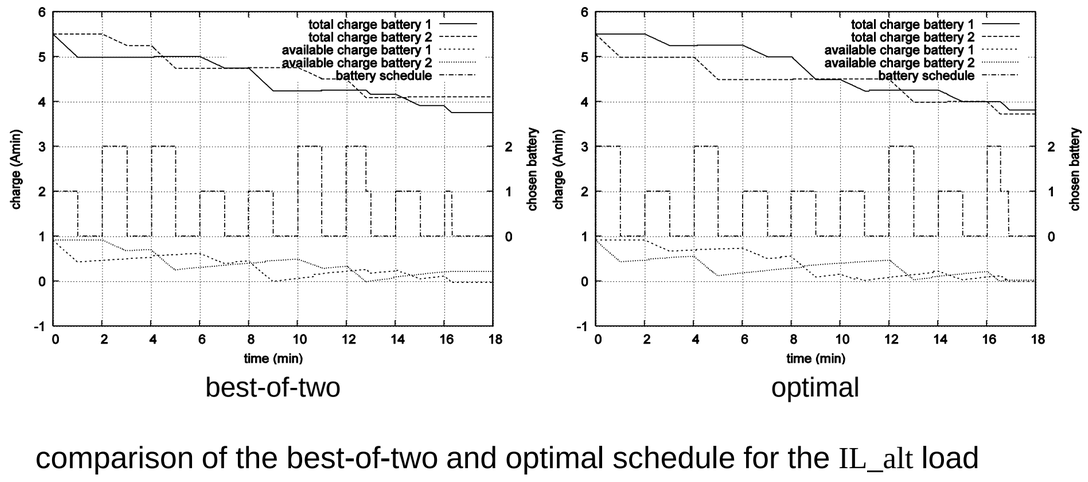
scheduler



maximum finder

Results deterministic loads

test load	sequential lifetime (min)	round robin lifetime (min)	best-of-two lifetime (min)	optimal lifetime (min)
CL_250	9.12	11.60	11.60	12.04
CL_500	4.10	4.53	4.53	4.58
CL_alt	5.48	6.10	6.12	6.48
IL_250	22.80	38.96	38.96	40.80
IL_500	8.60	10.48	10.48	10.48
IL_alt	12.38	12.82	16.30	16.91

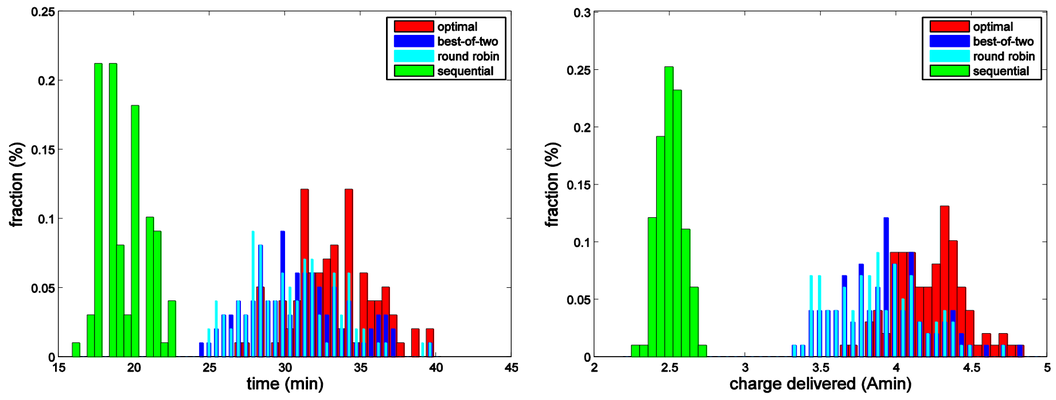


best-of-two

optimal

comparison of the best-of-two and optimal schedule for the IL_alt load

Results random loads



t_{on} ~ U(0.5 min, 1.5 min), t_{off} = 1min, I_{on} = 0.25 A,
Cap = 5 Amin, c = 0.166, k = 0.122 min^{-1}

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