Power-Aware Scheduling with Dynamic Priorities

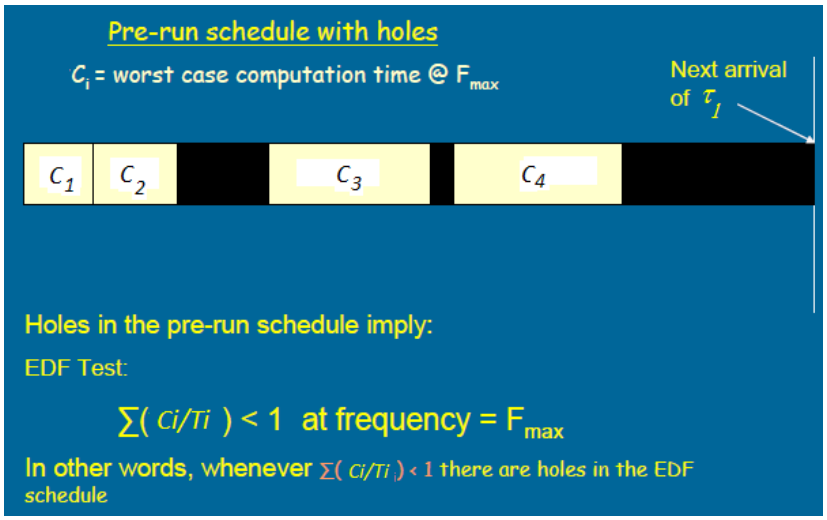
Raj Rajkumar

Lecture #11

Outline

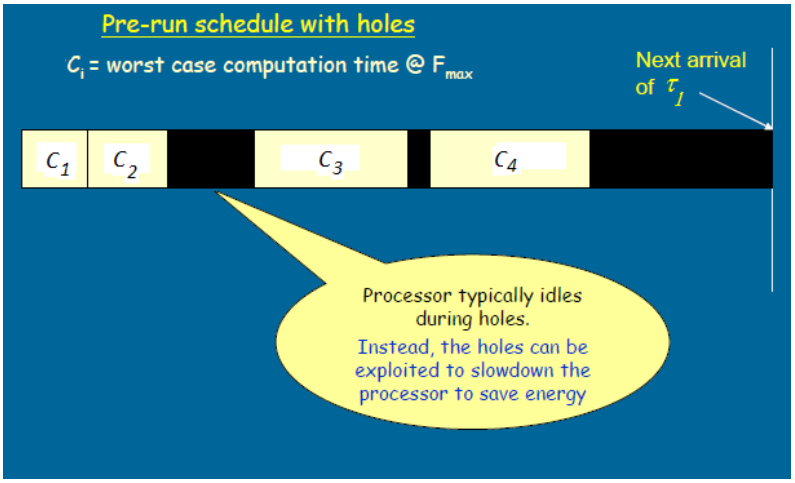
- Static voltage scaling with EDF
- Cycle-conserving Dynamic Voltage Scaling
- Look-Ahead Dynamic Voltage Scaling

Static Voltage Scaling w/ EDF: Motivation

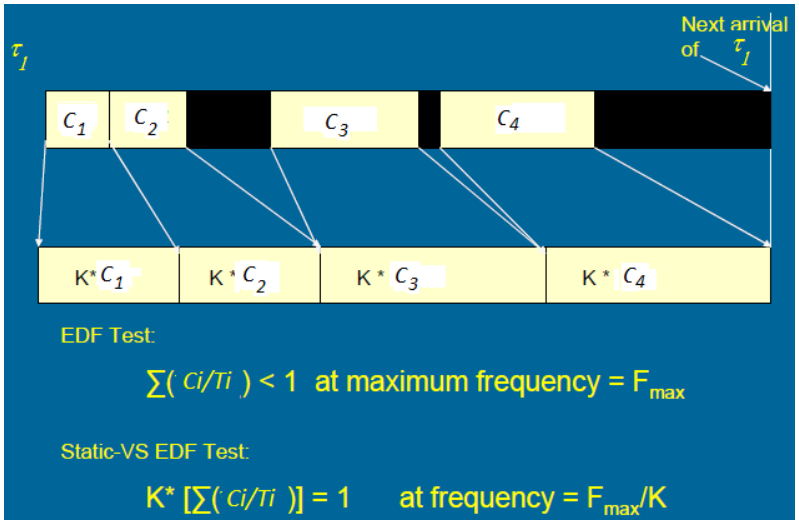


Static Voltage Scaling w/ EDF: Exploiting "Holes"

"Holes" in the schedule correspond to idle times on the processor.



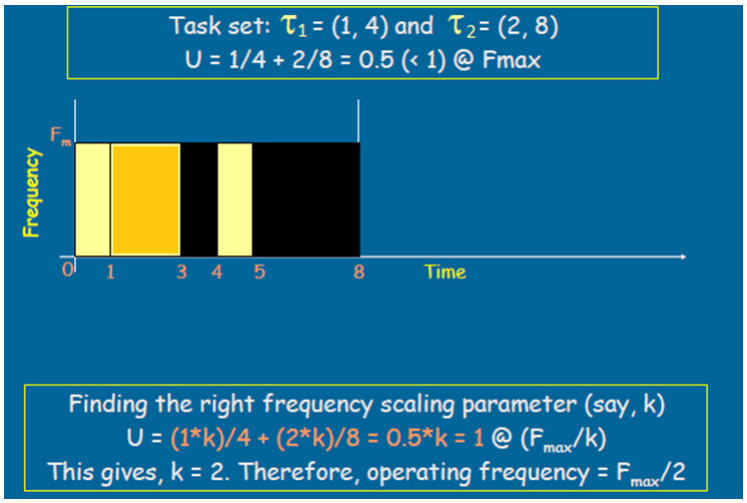
Static Voltage Scaling w/ EDF



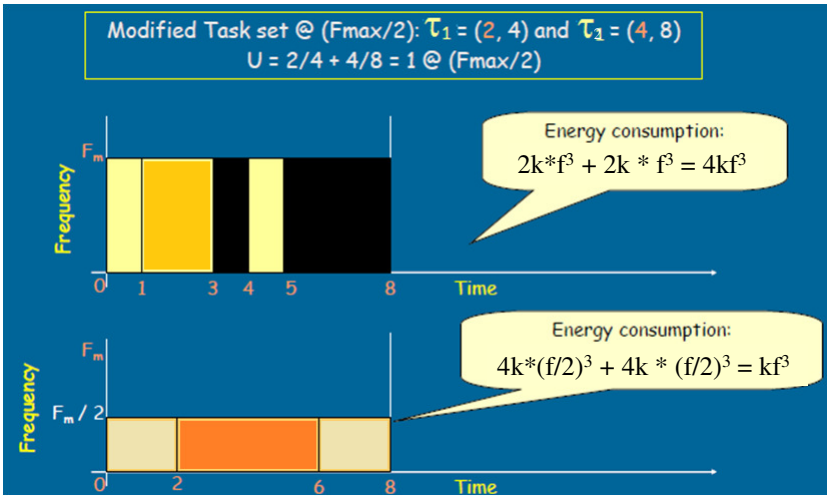
Static Voltage Scaling: Example Taskset

- Taskset: τ_1 = (1, 4) and τ_2 = (2, 8)
- U = 1/4 + 2/8 = 0.5 @ F_{max}
- What is the value of scaling factor *k* at which the taskset is still schedulable @ (F_{max} / *k*)?
  - U = (1*k*)/4 + (2*k*)/8 = k (1/4 + 2/8) = 1
  - Solving for *k*,
    - *k* = 2
  - Therefore, we should operate at *f* = F_{max} / 2 in order to meet all task deadlines.

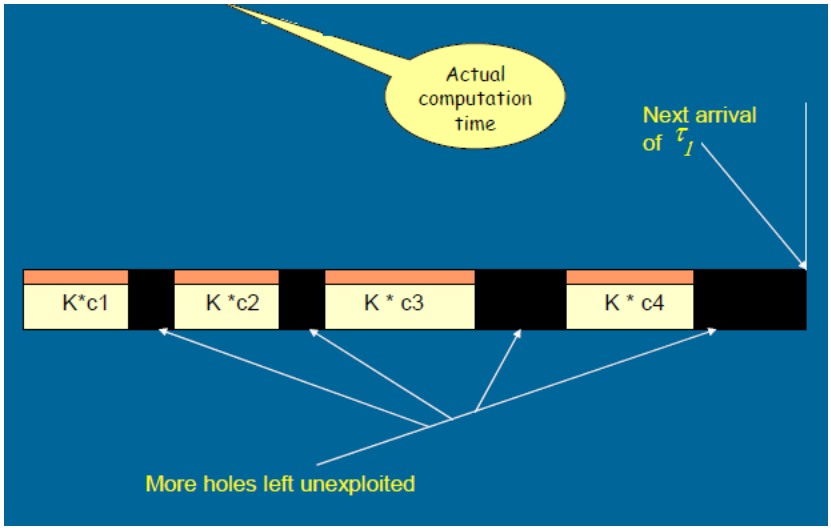
Static Voltage Scaling: Example (1 of 2)



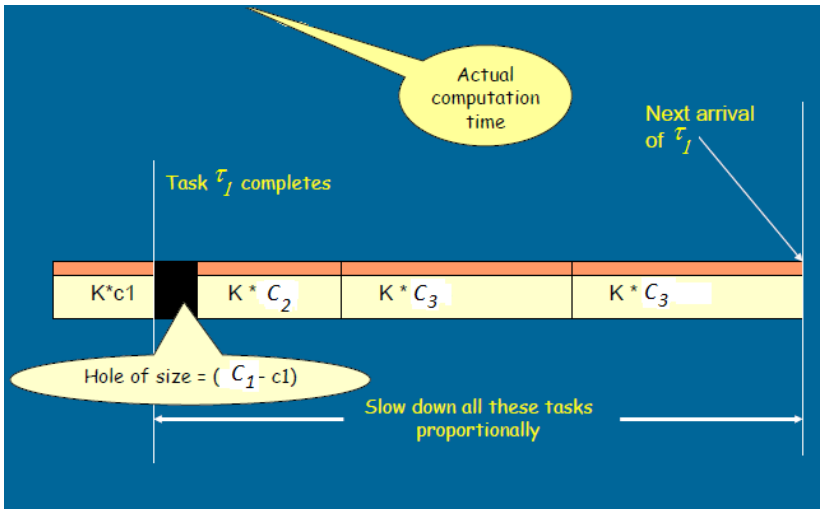
Static Voltage Scaling: Example (2 of 2)



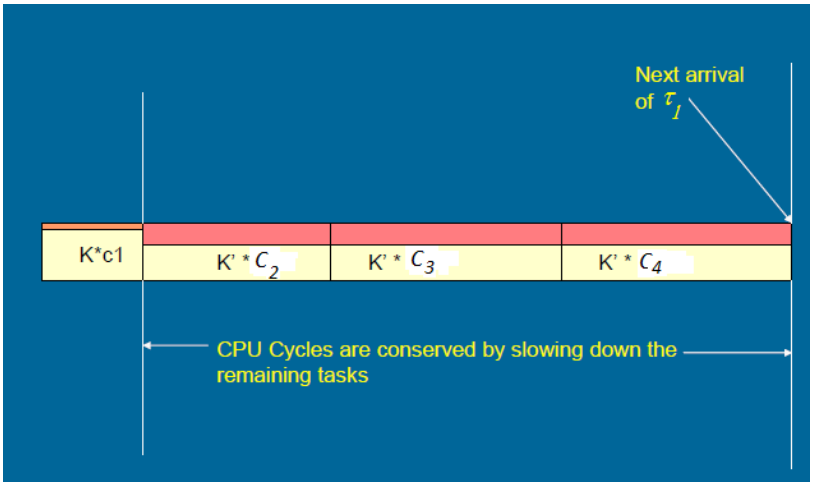
What if ($c_i < C_i$)? (1 of 3)



What if ($c_i < C_i$)? (2 of 3)



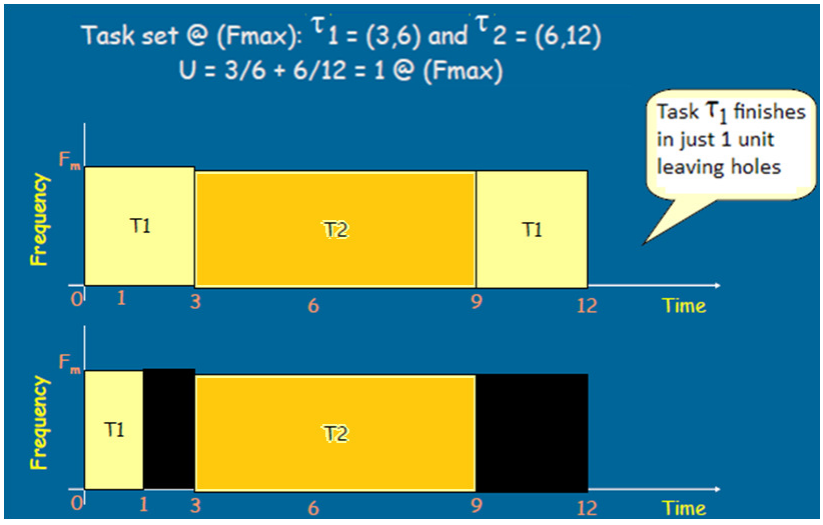
What if ($c_i < C_i$)? (3 of 3)



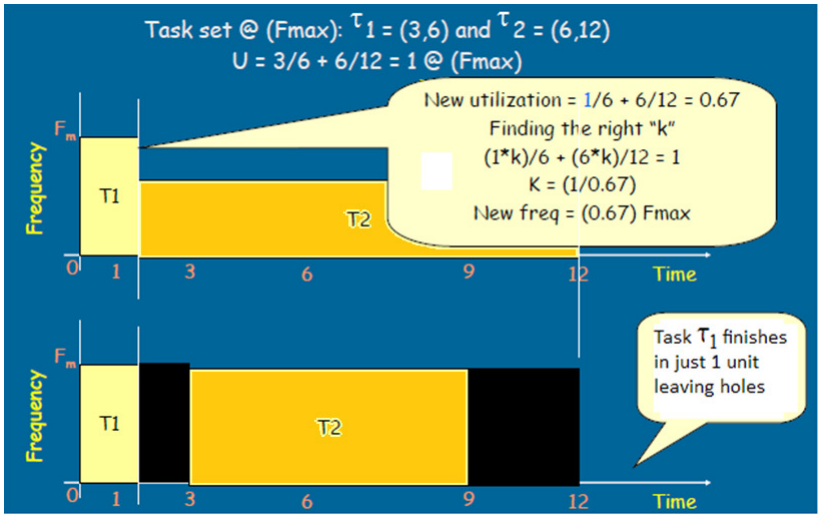
Cycle-Conserving EDF: Taskset

- Taskset:
  - $\tau_1 = (3, 6)$ and $\tau_2 = (6, 12)$
- $U = 3/6 + 6/12 = 1$ @ F_{max}
- What is the value of scaling factor *k* at which the taskset is still schedulable @ (F_{max} / *k*)?
  - $U = (3k)/6 + (6k)/12 = 1$
  - Solving for *k*,
    - $k = 1$
  - Therefore, we should operate at $f = F_{max}$ in order to meet all its deadlines.

Cycle-Conserving EDF Example



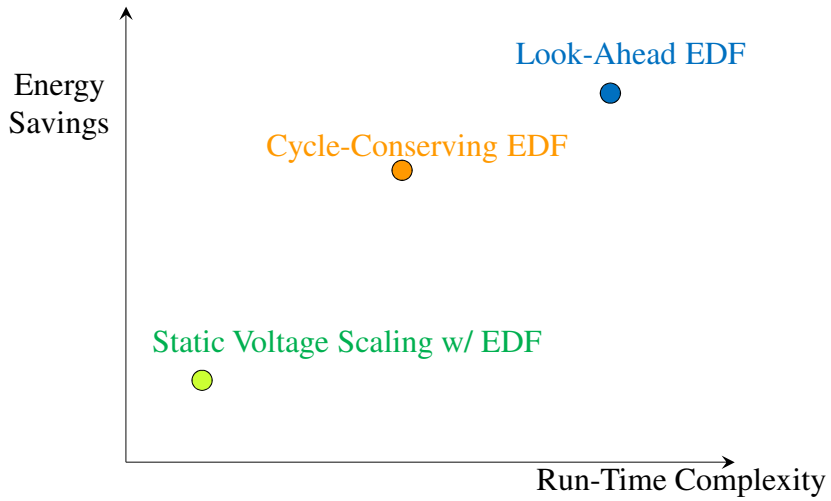
Cycle-Conserving EDF Example (contd.)



Look-Ahead EDF

- Defers as much work as possible.
- Sets the operating frequency to meet the minimum work that must be done now to ensure all future deadlines to be met.

Relative Performance



Conclusions

- RT-DVS schemes are designed to ensure
  - predictability while saving as much energy as possible in real-time systems.