ENERGY EFFICIENT SCHEDULING FOR BATTERY DRIVEN REAL-TIME EMBEDDED SYSTEMS

Based on Paper :

Rolling-Horizon Scheduling for Energy Constrained Distributed Real-Time Embedded Systems by Chuan He et al.

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EMBEDDED SYSTEM: State, Demand & Constraint

- Embedded systems are now ubiquitous. Most computing devices are based on embedded systems.
- Embedded systems are now going to Distributed Architectures because of its demands in Complex Systems e.g. Transport system, Smart homes.
- Energy consumption and battery life are major constraints in the embedded world.
- Embedded systems can either be real-time or non-real time

Real-Time Embedded Systems (RTES)

- Most embedded systems are real-time e.g. robotics, industry processing, microwave, etc.
- RTES are more challenging to build
- Correctness does not depend on result of computation alone, but with stringent consideration on timing of results

Energy Consumption of Embedded Systems

- Energy consumption is very important.
- Lots of hardware and software have been developed for low energy consumption.
- Mostly using the Dynamic Voltage Scaling (DVS) technique.
- What of Task Scheduling?

Purpose of Paper

- Tackles real-time embedded systems energy optimization and task scheduling challenge.
- DVS for energy optimization.
- Rolling Horizon (RH) and Energy-Efficient Adaptive Scheduling Algorithm (EASA) for task scheduling.

Related Works (Researchers Efforts)

- BEATA
  Considers both power consumption and schedule length to solve energy-latency problem in heterogeneous embedded systems.
- GCS
  an energy-aware scheduling algorithm for imprecise computation of real-time tasks to improve QoS and Energy Efficiency.
- DVS-FS
  a power-aware real-time scheduling scheme that applied the DVS technique and feedback control methodology to facilitate tradeoffs between energy consumption and control in embedded systems.
- Lots of research in this area…

RH SCHEDULING: Targeted System and Outline

- Targets an embedded system with a set of heterogeneous Processor Elements (PEs).
- Scheduler model in distributed system can either be distributed or centralized
- RH scheduling uses centralized scheduler model
- In RH technique, a scheduler consists of a rolling-horizon, real-time controller and voltage controller

RH SCHEDULING: Outline

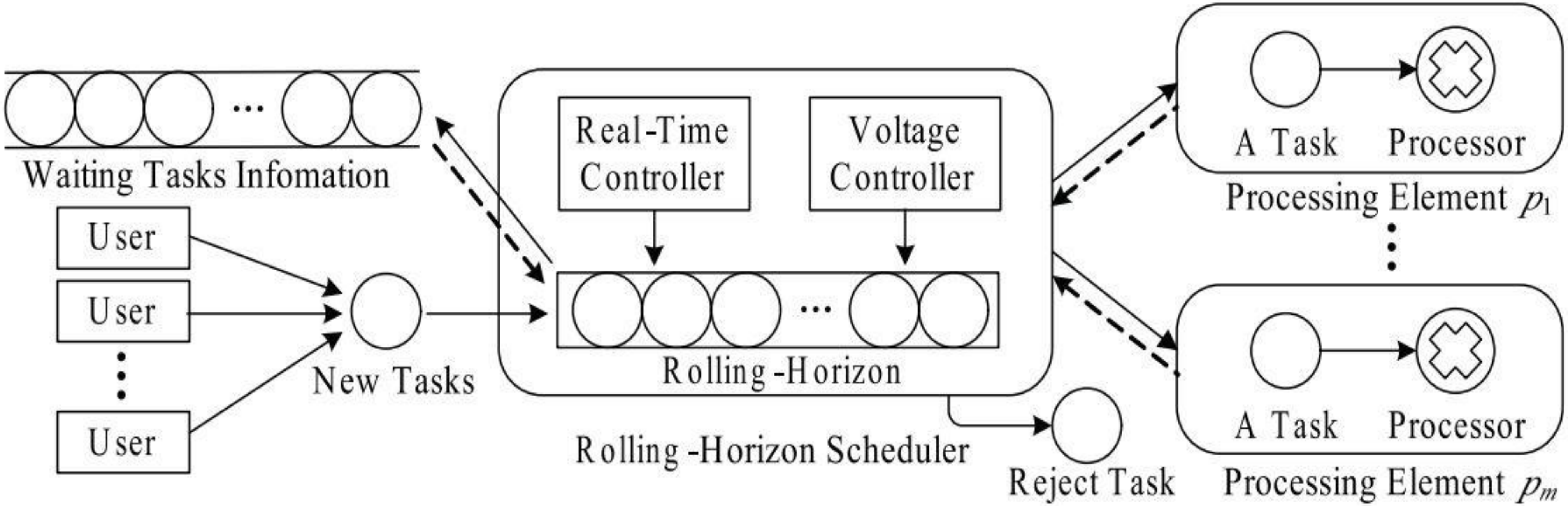

Fig. 1. Rolling-horizon energy-efficient real-time scheduler model.

RH SCHEDULING: Scheduling Objectives

- Priority to schedulability
- Next energy consumption to execute accepted task
- Energy consumption of a system is Dynamic and Static

RH-EASA: Dynamic Scheduling Approach

- Dynamic scheduling can either be immediate or batch mode
- RH-EASA uses immediate mode
- RH-EASA places all awaiting task in the rolling-horizon
- Schedules are adjusted for the schedulability of the new task and possible low-supply-voltage execution.

RH-EASA: Strategy

- Decides for a task where and when to execute.

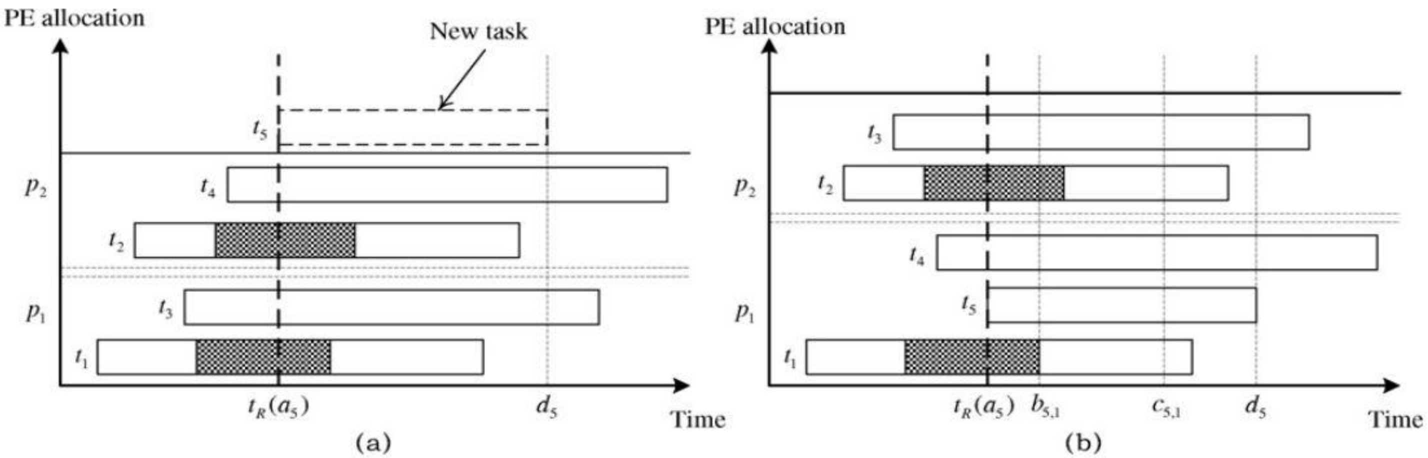

Fig. 3. Dynamic scheduling by employing rolling-horizon strategy.

- Task go from new task, to waiting task, then running task and .
- Migration does not incur any overhead.

Evaluation: Baseline Algorithms vs EASA

- Energy-Efficient Adaptive Scheduling Algorithm (EASA)
- Lowest Voltage Scheduling Algorithm (LVSA)
- High Voltage Scheduling Algorithm (HVSA)
- Greedy Scheduling Algorithm (GSA)
- RH-EASA, RH-LVSA, RH-HVSA, RH-GSA

Evaluation: PE Number Impact

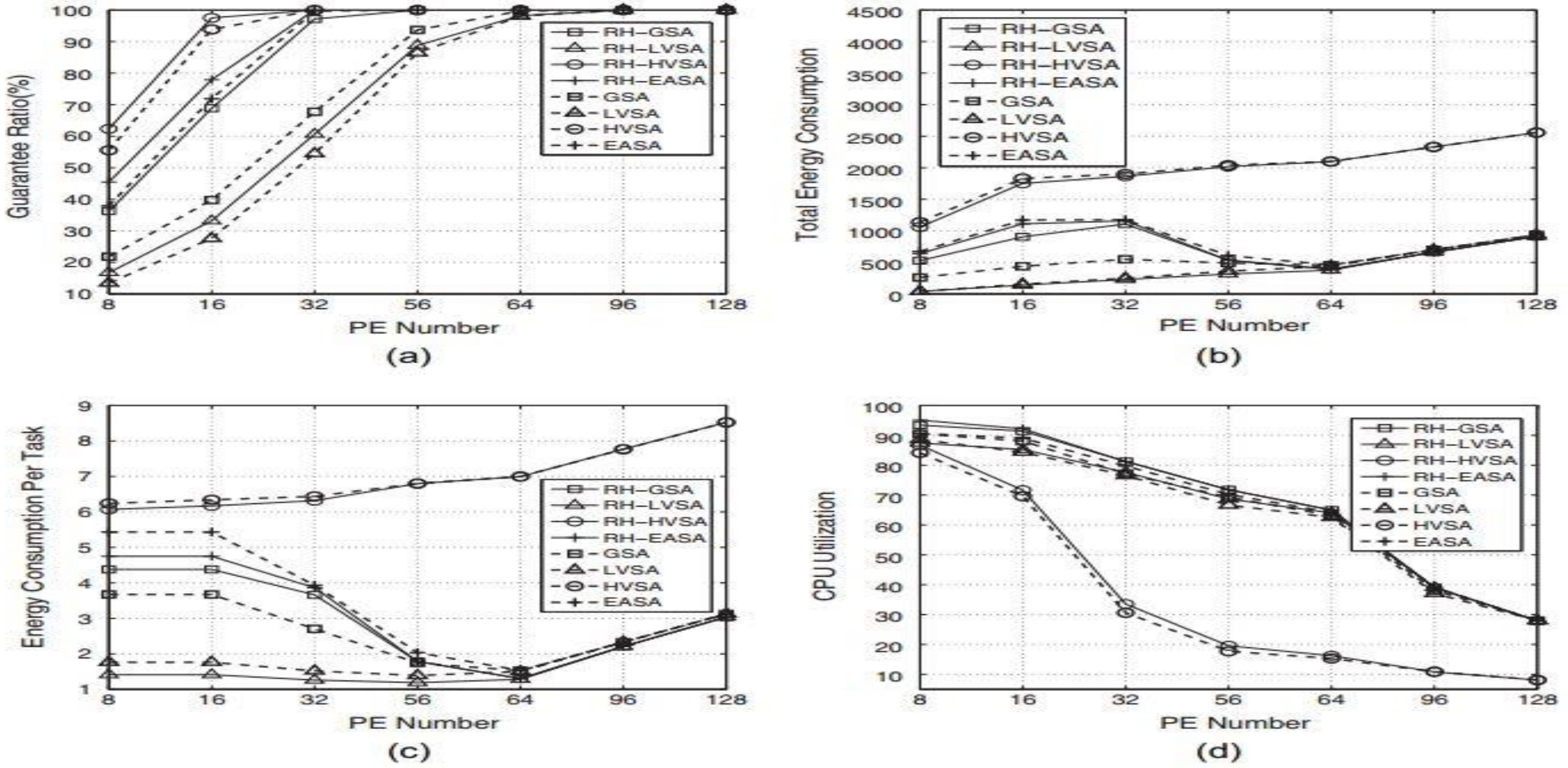

Fig. 4. Performance impact of PE number.

Evaluation: Arrival Rate Impact

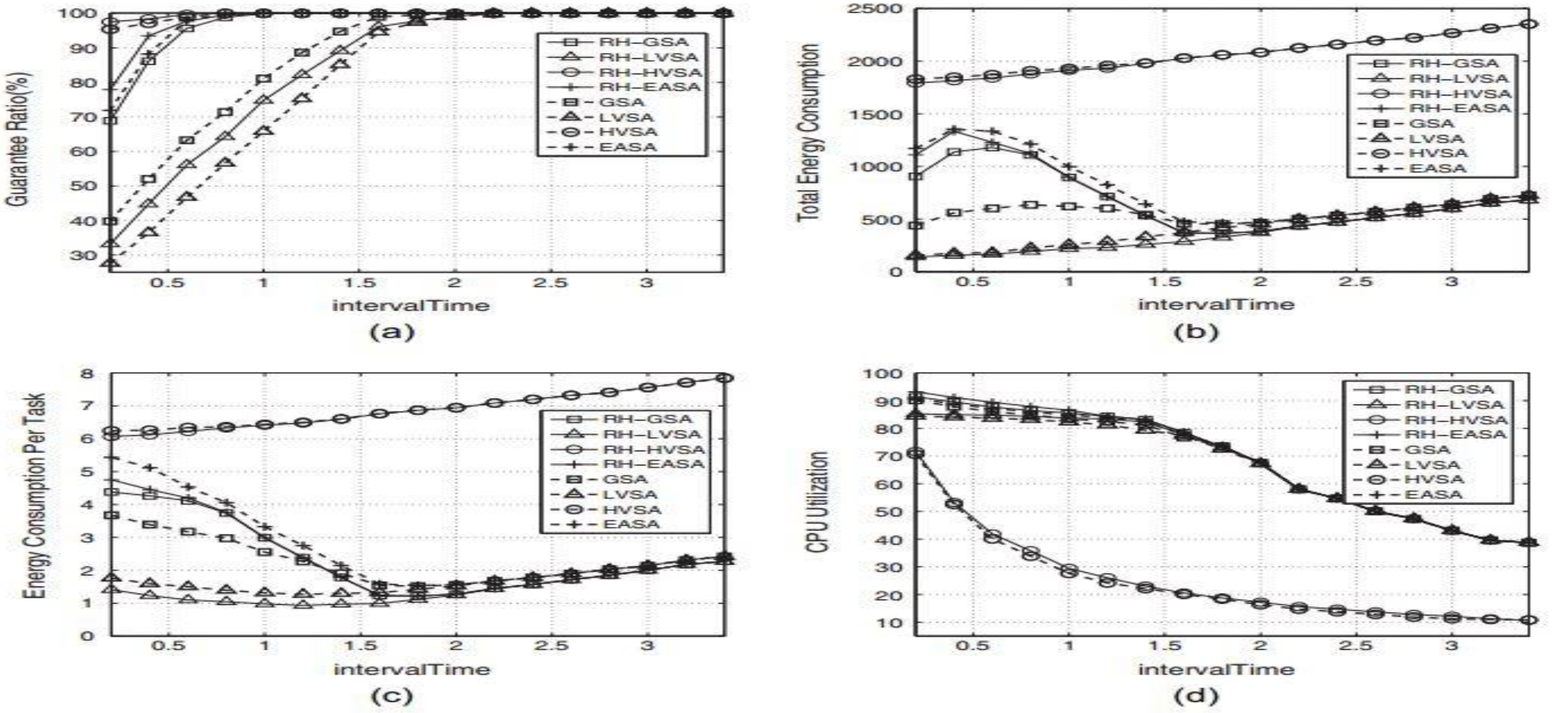

Fig. 5. Performance impact of arrival rate.

Evaluation: Task Deadline Impact

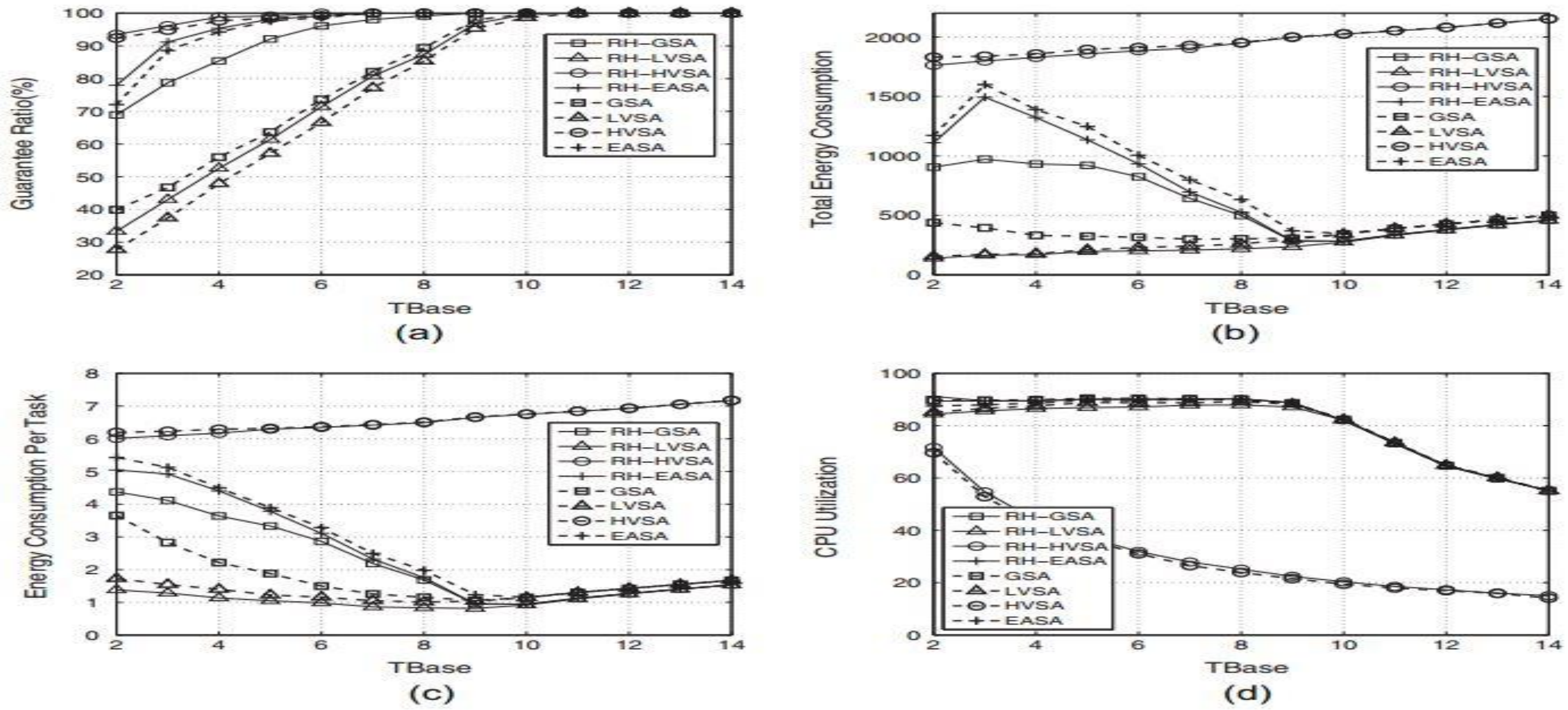

Fig. 6. Performance impact of task deadline.

Evaluation: Task Length Impact

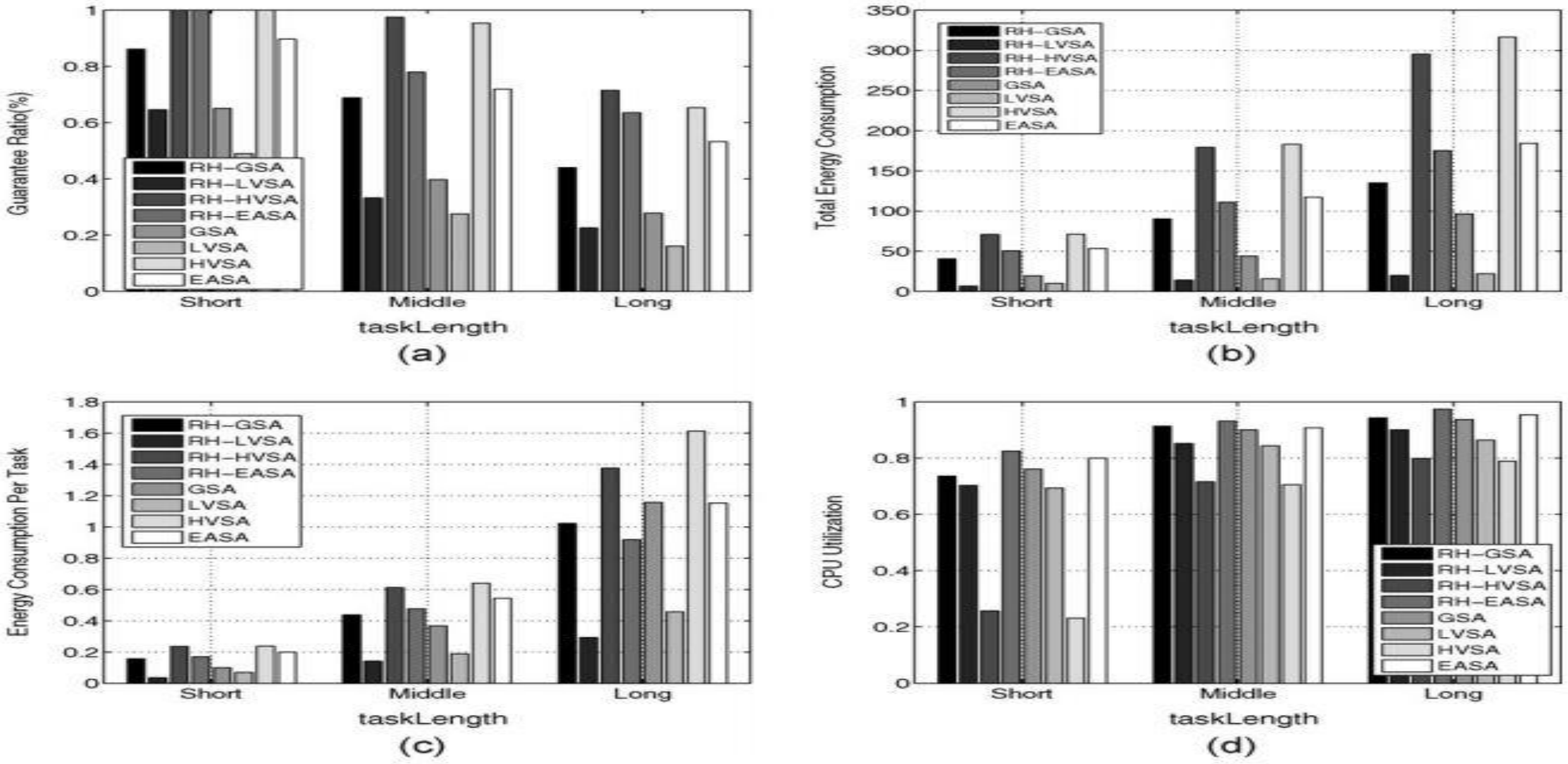

Fig. 7. Performance impact of task length.

Conclusion

- RH can be smoothly integrated into any algorithm.
- RH strategy can achieve a higher guarantee ratio, less energy consumption, and higher CPU utilization
- RH-EASA is best tradeoff between schedulability and energy consumption
- RH can be extended for other design