# Online Semi-Partitioned Multiprocessor Scheduling of Soft Real-Time Periodic Tasks for QoS Optimization

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# *Introduction*

## *The Problem / Motivation*

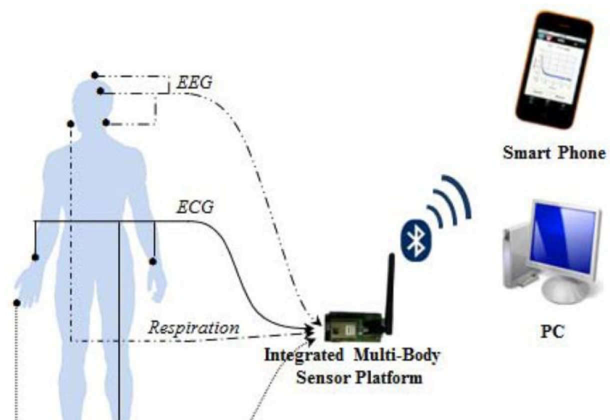
- Maximizing the benefit gained by soft real-time tasks in many applications is highly needed to provide an acceptable QoS
- Existing multiprocessor scheduling policies are mostly proposed for minimizing tardiness, and relatively very few studies on benefit-maximization

## *Objective*

Providing an appropriate strategy for better QoS in highly loaded soft real-time multiprocessor systems with periodic tasks, by maximizing total gained benefit while minimizing tardiness, using approximation algorithms in semi-partitioning of the tasks at job-boundaries

# *Examples of Applications*

- Online (and mobile) banking
- Multimedia applications
- Image and speech processing
- Robot control/navigation systems
- Medical decision making
- Body-sensor networks
- Medical monitoring systems
- Cloud computing, and IoT


By Y.Gil, W.Wu and J. Lee

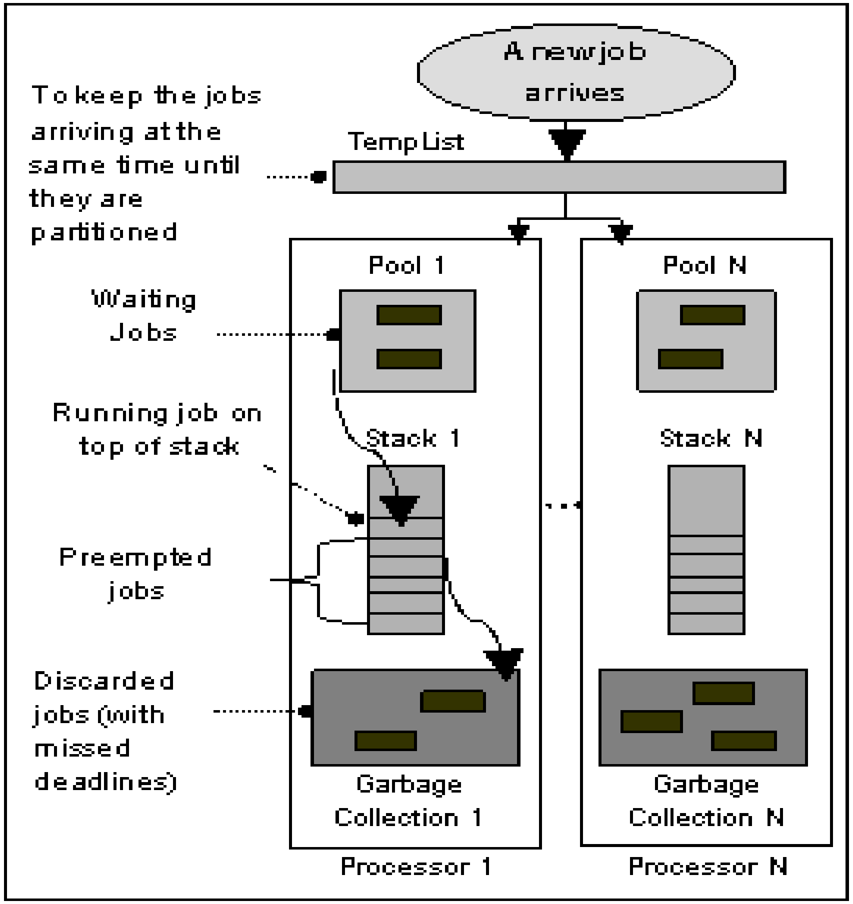
# *Task Model*

- Soft real-time task sets
- Periodic tasks
- Independent in execution

  (No precedence constraints among them)
- Preemption is allowed
- Synchronous and/or Asynchronous
- Each task come with its period, WCET and benefit density function

# System Model

- *m* identical processors
- Three storage areas for each processor:
  1. **Pool:**
     for waiting jobs of any tasks (instead of a shared pool)
  2. **Stack:**
     for the scheduled jobs (preempted or running)
  3. **Garbage collection:**
     for the jobs that miss their deadlines and gain no benefit for the system




**Software Architecture of the System**

# Methodology (1 of 2) – Hybrid Model

**Reward-based Priority Setting**

- ***Variable priority*** assignment over time for ready and waiting jobs
- ***Fixed priority*** assignment for scheduled jobs at their start time

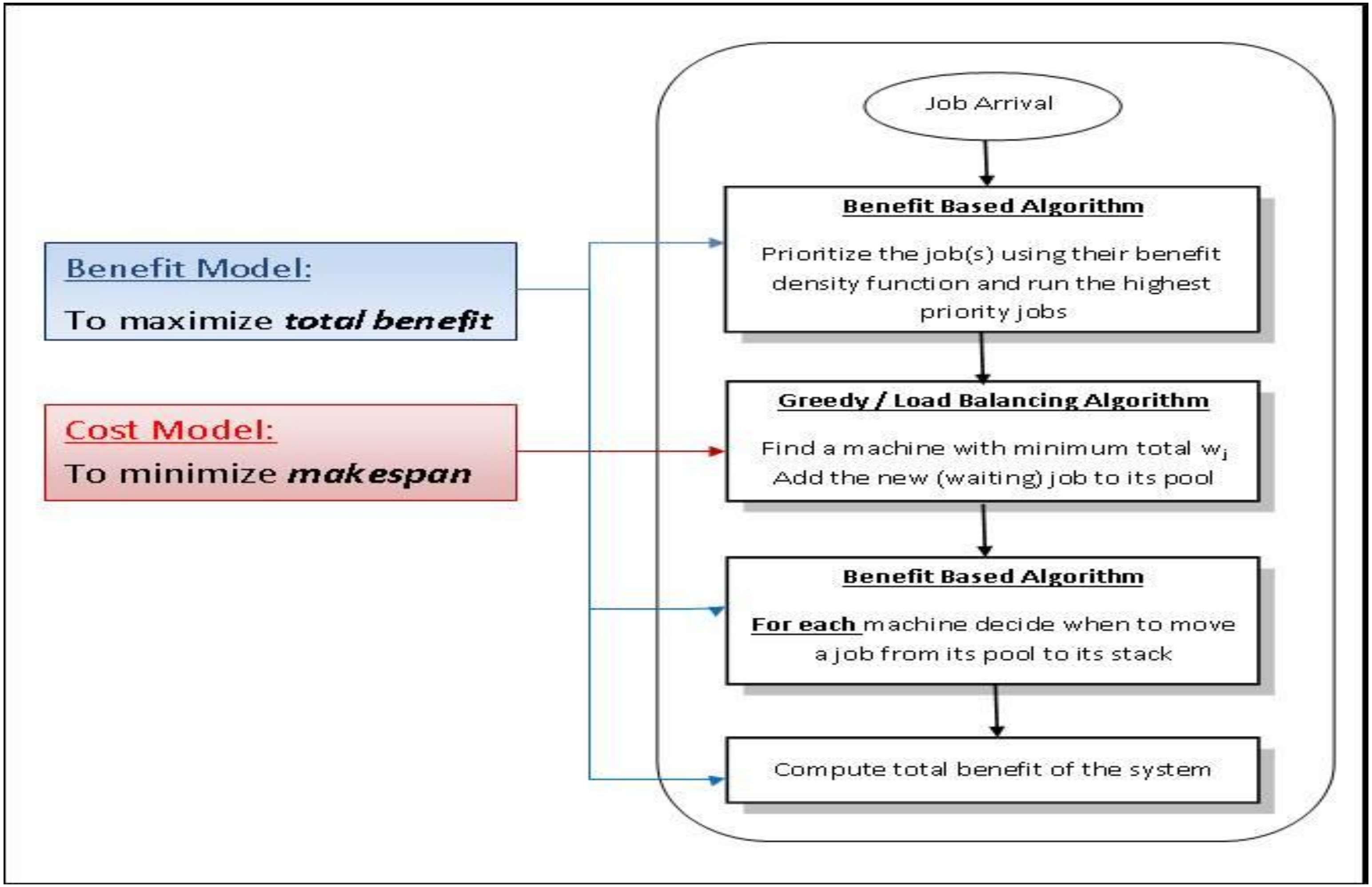
**Hybrid Scheduling**

- ***Reward Model:*** Schedule high priority jobs
- ***Cost Model:*** Gready/Load-balancing Approx. for Partitioning low priority jobs

**Reward Calculation**

- No reward for incomplete jobs
- Calculate gained reward by each completed job and add it to the total reward

# Methodology (2 of 2) – Hybrid Model



# *Objective Functions and Solutions*

- Benefit Maximization
  - *The main goal in a benefit-aware, soft real-time system*
  - *To gain maximum total value or benefit for the system by the jobs that complete their execution*
  - *An approximate solution due to multiprocessor scheduling being an NP hard problem*
- Reducing Tardiness

  *Semi-partitioning approach (Migration at job-boundary)*
- Overhead Reduction
  - *Reducing Number of Preemptions*
  - *Limiting Migrations*

# *Summary of Advantages toward QoS Optimization*

- **more conservative CPU cycles consumption** (less idle time)
- **Reduces the makespan** without compromising on benefit maximization
- **Increases the total benefit** gained, specially on systems with higher work load, by
- Applicable to **broader scope of tasks models**, i.e. synchronous and/or asynchronous
- **No off-line phase**, and **no limit on the number of processors** for migrating jobs of each task (unlike other semi-partitioning techniques)
- The NP hard problem of **multiprocessor scheduling is reduced into uniprocessor scheduling** problem by partitioning the tasks at their arrival time (no dualization is needed as in RUN)

# *Thank You*

Questions

or

Comments?