Energy-aware strategies for reliability-oriented real-time task allocation on heterogeneous platforms
Li Han, Yiqin Gao, Jing Liu, Yves Robert, Frédéric Vivien

To cite this version:
Li Han, Yiqin Gao, Jing Liu, Yves Robert, Frédéric Vivien. Energy-aware strategies for reliability-oriented real-time task allocation on heterogeneous platforms. [Research Report] RR-9324, Univ Lyon, EnsL, UCBL, CNRS, Inria, LIP. 2020. hal-02500381

HAL Id: hal-02500381
https://inria.hal.science/hal-02500381
Submitted on 5 Mar 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Energy-aware strategies for reliability-oriented real-time task allocation on heterogeneous platforms

Li Han, Yiqin Gao, Jing Liu, Yves Robert, Frédéric Vivien
Energy-aware strategies for reliability-oriented real-time task allocation on heterogeneous platforms

Li Han*, Yiqin Gao*, Jing Liu†, Yves Robert*‡, Frédéric Vivien*

Project-Team ROMA

Research Report n° 9324 — February 2020 — 964 pages

* LIP, École Normale Supérieure de Lyon, CNRS & Inria, France
† East China Normal University, Shanghai, China
‡ University of Tennessee Knoxville, USA
Abstract: Low energy consumption and high reliability are widely identified as increasingly relevant issues in real-time systems on heterogeneous platforms. In this paper, we propose a multi-criteria optimization strategy to minimize the expected energy consumption while enforcing the reliability threshold and meeting all task deadlines. The tasks are replicated to ensure a prescribed reliability threshold. The platforms are composed of processors with different (and possibly unrelated) characteristics, including speed profile, energy cost and failure rate. We provide several mapping and scheduling heuristics towards this challenging optimization problem. Specifically, a novel approach is designed to control (i) how many replicas to use for each task, (ii) on which processor to map each replica and (iii) when to schedule each replica on its assigned processor. Different mappings achieve different levels of reliability and consume different amounts of energy. Scheduling matters because once a task replica is successful, the other replicas of that task are cancelled, which calls for minimizing the amount of temporal overlap between any replica pair. The experiments are conducted for a comprehensive set of execution scenarios, with a wide range of processor speed profiles and failure rates. The comparison results reveal that our strategies perform better than the random baseline, with a gain of 40% in energy consumption, for nearly all cases. The absolute performance of the heuristics is assessed by a comparison with a lower bound; the best heuristics achieve an excellent performance, with an average value only 4% higher than the lower bound.

Key-words: real-time systems, independent tasks, stochastic execution times, reliability, scheduling, energy-aware systems, heterogeneous platforms.
Stratégies écoénergétiques pour l’allocation de tâches en temps réel axée sur la fiabilité sur des plateformes hétérogènes

Résumé : La faible consommation d’énergie et la haute fiabilité sont identifiées comme des problèmes de plus en plus pertinents dans les systèmes en temps réel sur des plateformes hétérogènes. Dans cet article, nous proposons une stratégie d’optimisation multicritères pour minimiser la consommation d’énergie attendue tout en respectant le seuil de fiabilité et en respectant toutes les échéances des tâches. Les tâches sont répliquées pour garantir un seuil de fiabilité prescrit. Les plateformes sont composées de processeurs avec des caractéristiques différentes (et éventuellement sans corrélation), y compris la vitesse, le coût énergétique et le taux d’échec. Nous fournissons plusieurs heuristiques de mapping et de planification pour ce problème d’optimisation difficile. Plus précisément, une nouvelle architecture est conçue pour contrôler (i) le nombre de répliques à utiliser pour chaque tâche, (ii) sur quel processeur doit-on mapper chaque réplique et (iii) comment planifier chaque réplique sur le processeur qui lui est affecté. Différents mappings atteignent différents niveaux de fiabilité et consomment différentes quantités d’énergie. La planification est importante car une fois qu’une réplique de tâche réussit, les autres répliques de cette tâche sont annulées, ce qui nécessite de minimiser le chevauchement en temps entre toute paire de répliques. Les expériences sont exécutées pour un grand ensemble de scénarios, avec une large gamme de vitesse et de taux d’échec pour les processeurs. Les résultats révèlent que nos stratégies fonctionnent mieux que la référence aléatoire, avec un gain de 40 % en consommation d’énergie, dans presque tous les cas. La performance absolue de l’heuristique est évaluée en comparant avec une borne inférieure. La meilleure heuristique atteint une excellente performance, avec une valeur moyenne de seulement 4 % supérieure à la borne inférieure.

Mots-clés : systèmes temps-réel, tâches indépendantes, temps d’exécution stochastiques, reliabilité, ordonnancement, économies d’énergie, plates-formes hétérogènes
1 Introduction

Real-time systems are composed of periodic tasks that are regularly input to a parallel computing platform and must complete execution before their deadlines. In many applications, another requirement is reliability: the execution of each task is prone to transient faults, so that several replicas of the same task must be executed in order to guarantee a prescribed level of reliability. Recently, several strategies have been introduced with the objective to minimize the expected energy consumption of the system while matching all deadlines and reliability constraints [10, 9].

This work aims at extending these energy-aware strategies in the context of heterogeneous platforms. Heterogeneous platforms have been used for safety-critical real-time systems for many years [5]. With the advent of multiple hardware resources such as multi-cores, GPUs, and FPGAs, modern computing platforms exhibit a high level of heterogeneity, and the trend is increasing. The multiplicity of hardware resources with very different characteristics in terms of speed profile, reliability level and energy cost, raises an interesting but challenging problem: given several device types, which ones should we keep and which ones should we discard in order to achieve the best possible tri-criteria trade-off (time, energy, reliability)? Needless to say, this optimization problem is NP-hard, even with two identical error-free processors, simply because of matching deadlines.

This work provides several mapping and scheduling heuristics to solve the tri-criteria problem on heterogeneous platforms. The design of these heuristics is much more technical than in the case of identical processors. Intuitively, this is because the reliability of a replica of task \( \tau_i \) depends upon the processor which executes it. More precisely, the reliability \( R(\tau_i, m_k) \) of a replica of \( \tau_i \) mapped on processor \( m_k \) is \( R(\tau_i, m_k) = e^{-\lambda_k c_{i,k}} \), where \( c_{i,k} \) is the execution time of \( \tau_i \) on \( m_k \), and \( \lambda_k \) the failure rate of \( m_k \). The total reliability of \( \tau_i \) is a function of the reliability of all replicas (which we will explicit in Equation 4); hence, it is not known until the end of the mapping process (unless we pre-compute an exponential number of reliability values). Then there are many processors to choose from, and those providing a high reliability, thereby minimizing the number of replicas needed to match the reliability threshold, may also require a high energy cost per replica: in the end, it might be better to use less reliable but also less energy-intensive processors. Furthermore, the reliability is not enough to decide for the mapping: if two processors offer similar reliabilities for a task, it might be better to select the one with smaller execution time, in order to increase the possibility of mapping other tasks without exceeding any deadline. Altogether, we face a complicated decision, and we provide several criteria to guide the mapping process.

Overall, the objective is to minimize the expected energy consumption while matching all deadlines and reliability constraints. The expected en-
Energy consumption is the average energy consumed over all failure scenarios. Consider a sample execution: whenever the execution of a task replica succeeds, all the other replicas are instantaneously deleted; therefore, the actual amount of energy consumed depends both upon the error scenario (which replica is the first successful) and upon the overlap between replicas (some replicas are partially executed and interrupted when the successful one completes). Given a mapping, the scheduling aims at reducing overlap between any two replicas of the same task. Note that having an overlap-free scheduling is not always possible because of utilization constraints. Also, deciding whether an overlap-free scheduling exists for a given mapping is NP-hard [8], even for deterministic tasks.

Finally, in actual real-time systems, tasks often complete before their worst-case execution time, or WCET, so that execution times are routinely modeled as stochastic. For instance, one typically assumes that the execution time of $\tau_i$ on $m_k$ follows a uniform probability distribution in the range $[\beta_{b/w}c_{i,k}, c_{i,k}]$ for some constant $\beta_{b/w} < 1$ (ratio of best case over worst case). In the end, the expected energy consumption must also be averaged over all possible values for execution times in addition to over all failure scenarios.

Our mapping heuristics aim at minimizing energy consumption based upon a lower-bound formula that assumes no overlap between any two replicas of the same task, while our scheduling heuristics aim at minimizing such an overlap. To assess the performance of our heuristics, we use a comprehensive set of execution scenarios, with a wide range of processor speed profiles and failure rates. When the failure rate is low, most heuristics are equivalent, but when the failure rate is higher, only a few heuristics achieve a good performance. Because we have no guarantee on the performance of the global mapping and scheduling process, we analytically derive a lower bound for the expected energy consumption of any mapping. This bound cannot always be met. Nevertheless, we show that the performance of our best heuristics remain quite close to this bound in the vast majority of simulation scenarios.

The main contributions of the paper are the following:

- The formulation of the tri-criteria optimization problem;
- The design of several mapping and scheduling heuristics;
- The characterization of a lower bound for performance;
- An experimental evaluation based on a comprehensive set of simulations scenarios, showing that two of the heuristics always achieve the best performance, and are always very close to the lower bound.

The rest of the paper is organized as follows. Section 2 provides a detailed description of the optimization problem under study, including a few notes on its complexity. The mapping and scheduling heuristics are described in Section 3 and 4 respectively. The performance lower bound is introduced in
Section 5. Section 6 is devoted to a comprehensive experimental comparison of the heuristics. Section 7 presents related work. Finally, Section 8 gives concluding remarks and hints for future work.

Table 1: Key Notations

<table>
<thead>
<tr>
<th>Notation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N$ and $M$</td>
<td>number of tasks and of processors</td>
</tr>
<tr>
<td>$p$</td>
<td>period (deadline) for each task instance</td>
</tr>
<tr>
<td>$c_{i,k}$</td>
<td>WCET for task $\tau_i$ on processor $m_k$</td>
</tr>
<tr>
<td>$u_{i,k} = \frac{c_{i,k}}{p}$</td>
<td>utilization of task $\tau_i$ executing on processor $m_k$</td>
</tr>
<tr>
<td>$u_k$</td>
<td>utilization of $m_k$ (sum of utilization of replicas assigned to $m_k$)</td>
</tr>
<tr>
<td>$R_i$</td>
<td>target reliability threshold for task $\tau_i$</td>
</tr>
<tr>
<td>$\lambda_k$</td>
<td>failure rate of processor $m_k$</td>
</tr>
<tr>
<td>$P(m_k)$</td>
<td>power consumed per time unit on processor $m_k$</td>
</tr>
<tr>
<td>$E_s$</td>
<td>total static energy consumption</td>
</tr>
<tr>
<td>$E_d(\tau_i,m_k)$</td>
<td>dynamic energy cost of task $\tau_i$ on processor $m_k$</td>
</tr>
<tr>
<td>$R(\tau_i,m_k)$</td>
<td>reliability of task $\tau_i$ on processor $m_k$</td>
</tr>
</tbody>
</table>

2 Model

The inputs to the optimization problem are a set of real-time independent tasks, a set of non-identical processors and a reliability target. Key notations are summarized in Table 1.

2.1 Platform and tasks

The platform consists of $M$ heterogeneous processors $m_1, m_2, \ldots, m_M$ and a set of $N$ periodic atomic tasks $\tau_1, \tau_2, \ldots, \tau_N$. Each task $\tau_i$ has WCET $c_{i,k}$ on the processor $m_k$. The WCETs among different processors are not necessarily related. In the experiments, we generate the $c_{i,k}$ values with the method proposed in [2], where we have two parameters to control the correlation among task execution times and processors (see Section 6.1 for details). Each periodic task $\tau_i$ generates a sequence of instances with period $p$, which is equal to its deadline. In this work, we assume that all tasks have the same period $p$, so that a single instance of each task must execute every $p$ seconds. Note that assuming that all tasks are atomic and with same period is the standard assumption for real-time task graphs (or DAGs) [21].

As already mentioned, real-time tasks usually complete execution earlier than their estimated WCET: execution times are assumed to be data-dependent and non-deterministic, randomly sampled from some probability distribution whose support is upper bounded by the WCET. See Section 6.1 for details on the generation of actual execution times from WCET values. The utilization $u_{i,k}$ of task $\tau_i$ executing on processor $m_k$ is defined as
\( u_{i,k} = \frac{c_{i,k}}{p} \). The utilization of a processor is the sum of the utilizations of all tasks that are assigned to it.

### 2.2 Power and energy

The power consumed per time unit on processor \( m_k \) is expressed as

\[
P(m_k) = P_{k,s} + gP_{k,d}
\]

where \( P_{k,s} \) is the static power; \( g \) represents the system state and indicates whether dynamic power \( P_{k,d} \) is currently being consumed by \( m_k \): when \( m_k \) executes a task, \( g = 1 \), otherwise \( g = 0 \). To summarize, we have \( 2M \) input values, \( \{P_{1,s}, P_{2,s}, \ldots, P_{M,s}\} \) for static powers and \( \{P_{1,d}, P_{2,d}, \ldots, P_{M,d}\} \) for dynamic powers.

The dynamic energy consumption \( E_d(\tau_i, m_k) \) of task \( \tau_i \) on processor \( m_k \) is estimated using the WCET:

\[
E_d(\tau_i, m_k) = P_{k,d} \times c_{i,k}
\]

but we use the value derived from the actual execution time in the experiments. The total static energy consumption is simply given by

\[
E_s = \sum_{k \in \text{Used}} P_{k,s} \times p
\]

where \( \text{Used} \) denotes the index set of the processors used by the schedule.

### 2.3 Reliability

We consider transient faults, modeled by an Exponential probability distribution of rate \( \lambda_k \) on processor \( m_k \). Thus, fault rates differ from one processor to another. This is a very natural assumption for a heterogeneous platform made of different-type processors. At the end of the execution of each task, there is an acceptance test to check the occurrence of soft errors induced by the transient faults. It is assumed that acceptance tests are 100% accurate, and that the duration of the test is included within the task WCET [10].

The reliability of a task instance is the probability of executing it successfully, in the absence of software faults. The reliability of task \( \tau_i \) on processor \( m_k \) with WCET \( c_{i,k} \) is \( R(\tau_i, m_k) = e^{-\lambda_k \times c_{i,k}} \). During the mapping phase, task \( \tau_i \) will have several replicas executing on different processors, in order to match some reliability threshold. Let \( \text{alloc}(i) \) denote the index set of the processors executing a replica of \( \tau_i \). The mapping achieves the following reliability \( R(\tau_i) \) for task \( \tau_i \):

\[
R(\tau_i) = 1 - \prod_{k \in \text{alloc}(i)} (1 - R(\tau_i, m_k))
\]
Indeed, the task will succeed if at least one of its replicas does: the success probability is thus equal to 1 minus the probability of all replicas failing, which is the expression given in Equation (4).

Each task $\tau_i$ has a reliability threshold $R_i$, which is an input of the problem and that must be met by the mapping. In other words, the constraint writes $R(\tau_i) \geq R_i$ for $1 \leq i \leq N$. Because the tasks are independent, it is natural to assume that they might have different reliability thresholds: a higher threshold means that more resources should be assigned for the task to complete successfully with a higher probability. In the experiments we use $R_i = R$ for all tasks, but our heuristics are designed to accommodate different thresholds per task.

### 2.4 Optimization Objective

The objective is to determine a set of replicas for each task, a set of processors to execute them, and to build a schedule of length at most $p$, so that expected energy consumption is minimized, while matching the deadline $p$ and reliability threshold $R_i$ for each task $\tau_i$.

As already mentioned in the introduction, the expected energy consumption is an average made over all possible execution times randomly drawn from their distributions, and over all failure scenarios (with every component weighted by its probability to occur). An analytical formula is out of reach, and we use Monte-Carlo sampling in the experiments. However, we stress the following two points:

- To guide the design of the heuristics, we use a simplified objective function: more precisely, we use WCETs instead of (yet unknown) actual execution times, and we conservatively estimate the dynamic energy of a task as the sum of the dynamic energy of all its replicas. Because mapping decisions are based upon WCETs, the number of enrolled processors does not depend upon actual execution times and the static energy is always the same for all scenarios, namely the length of the period times the sum of the static powers of the enrolled processors (see Equation (3)).

- To assess the absolute performance of the heuristics, we derive a lower bound for the dynamic energy. This bound is based upon actual execution times but neglects scheduling constraints and assumes no overlap between any two task replicas, hence it is not reachable in general. However, we show that our best heuristics achieve performance close to this bound.

### 2.5 Complexity

The global optimization problem is obviously NP-hard, since it is a generalization of the makespan minimization problem with a fixed number of
parallel processors [4]. The optimization of the sole scheduling phase is also NP-hard: if the number of replicas has already been decided for each task, and if the assigned processor of each replica has also been decided, the scheduling phase aims at minimizing the expected energy consumption by avoiding overlap between the replicas of a same task [8]. Even if the task deadline was not constraining (very large deadline with respect to the worst-case execution time of tasks), the problem would remain NP-hard. We formally state this latter problem and show that it is NP-hard.

**Definition 1** (*MinEnergyMaxReliability*). Consider an heterogeneous platform composed of $M$ heterogeneous processors, $m_1, ..., m_M$, and $N$ (non-periodic) tasks $\tau_1, \tau_2, ..., \tau_N$. Executing task $\tau_i$ on processor $m_k$ has an energy cost of $E(\tau_i, m_k)$ and has a probability of success of $R(\tau_i, m_k)$. Let $\mathcal{E}$ and $\mathcal{R}$ be two constants. The *MinEnergyMaxReliability* decision problem is: is it possible to schedule the tasks on the processors so that: (i) the total energy consumed does not exceed $\mathcal{E}$; and (ii) the probability that all tasks succeed is at least $\mathcal{R}$?

**Lemma 1.** Problem *MinEnergyMaxReliability* is NP-complete.

*Proof.* We prove this result by a reduction from the 2-PARTITION problem [4]. Let $I_1$ be an instance of 2-PARTITION with $N$ positive integers, $a_1, ..., a_N$. Let $S = \sum_{i=1}^{N} a_i$. The question is: is it possible to find a subset $A$ of $\{1, ..., N\}$ such that

$$\sum_{1 \leq i \leq N; i \notin A} a_i = \sum_{1 \leq i \leq N; i \in A} a_i = \frac{S}{2}.$$ 

From $I_1$ we build an instance $I_2$ of *MinEnergyMaxReliability* as follows. We have $M = 2$ processors. Then we have $N$ tasks each having the same execution times on both processors: $c_{i,1} = c_{i,2} = a_i$. The failure rates are defined by: $\lambda_1 = \frac{1}{S}$ and $\lambda_2 = 1$. The static energy is null, $P_{1,s} = P_{2,s} = 0$, and the dynamic energy is defined by $P_{1,d} = 1$, $P_{2,d} = \frac{1}{S}$. Therefore, we have:

$$\begin{cases} 
E(\tau_i, m_1) = a_i 	ext{ and } R(\tau_i, m_1) = e^{-a_i} \\
E(\tau_i, m_2) = \frac{a_i}{S} \text{ and } R(\tau_i, m_2) = e^{-a_i} 
\end{cases}$$

Finally, we let $\mathcal{E} = \frac{1}{2}(S + 1)$ and $\mathcal{R} = e^{-\frac{1}{2}(S+1)} = e^{-\mathcal{E}}$.

One can easily check that the size of $I_2$ is polynomial in the size of $I_1$, that all the $E(\tau_i, m_k)$’s are positive and that all the $R(\tau_i, m_k)$’s are strictly between 0 and 1.

Let us consider any mapping of the $M$ tasks on the two processors. Let $A$ be the index set of tasks mapped on processor 1 in this mapping, and let
\( \mathcal{A} = \sum_{i \in \mathcal{A}} a_i \). The total energy \( E \) consumed by this mapping is:

\[
E = \left( \sum_{1 \leq i \leq N} E(\tau_i, m_1) \right) + \left( \sum_{1 \leq i \leq N} E(\tau_i, m_2) \right)
\]

\[
= \left( \sum_{1 \leq i \leq N} a_i \right) + \left( \sum_{1 \leq i \leq N} \frac{a_i}{S} \right)
\]

\[
= \mathcal{A} + \frac{1}{S} (S - \mathcal{A})
\]

\[
= \mathcal{A} \left( 1 - \frac{1}{S} \right) + 1 = \mathcal{A} \frac{S - 1}{S} + 1
\]

The reliability \( R \) of the whole set of tasks is:

\[
R = \left( \prod_{1 \leq i \leq N} R(\tau_i, m_1) \right) \times \left( \prod_{1 \leq i \leq N} R(\tau_i, m_2) \right)
\]

Taking logarithms, we obtain:

\[
\ln(R) = \left( \sum_{1 \leq i \leq N} \ln(R(\tau_i, m_1)) \right) + \left( \sum_{1 \leq i \leq N} \ln(R(\tau_i, m_2)) \right)
\]

\[
= \left( \sum_{1 \leq i \leq N} \frac{-a_i}{S} \right) + \left( \sum_{1 \leq i \leq N} (-a_i) \right)
\]

\[
= \left( -\frac{\mathcal{A}}{S} \right) + (- (S - \mathcal{A}))
\]

\[
= -S + \mathcal{A} \left( 1 - \frac{1}{S} \right) = -S + \mathcal{A} \frac{S - 1}{S}
\]
Now let us assume that $\mathcal{I}_2$ has a solution:

\[
\begin{align*}
E &\leq \mathcal{E} & R &\geq \mathcal{R} \\
E &\leq \mathcal{E} & \ln(R) &\geq \ln(\mathcal{R})
\end{align*}
\]

\[
\begin{align*}
A \frac{S-1}{S} + 1 &\leq \frac{1}{2}(S+1) & -S + A \frac{S-1}{S} &\geq -\frac{1}{2}(S+1) \\
A \frac{S-1}{S} &\leq \frac{1}{2}(S-1) & A \frac{S-1}{S} &\geq \frac{1}{2}(S-1)
\end{align*}
\]

Therefore, $\mathcal{I}_2$ has a solution if and only if $\mathcal{I}_1$ has a solution.

\[\square\]

3 Mapping

In the mapping phase, we need to define the number of replicas for each task, as well as the execution processor for every replica, aiming at meeting the reliability target while minimizing the energy cost. One difficulty introduced by platform heterogeneity is that we do not know the number of replicas needed for each task to reach its reliability threshold, before completing the mapping process, because different processors have different failure rates and speeds and, hence, they provide different reliabilities for each replica. Therefore, the simpler three-step method of [10, 8] cannot be applied.

As shown in Algorithm 1, given a set of tasks with their reliability targets and a set of heterogeneous processors, we first order the tasks according to TaskMapCriteria, which includes:

- **deW (inW)**: decreasing (increasing) average work size $\bar{c}_i = \frac{c_{i,1} + c_{i,2} + \cdots + c_{i,M}}{M}$;
- **deMinW (inMinW)**: decreasing (increasing) minimum work size $\bar{c}_i = \min_{1 \leq k \leq M} c_{i,k}$;
- **deMaxW (inMaxW)**: decreasing (increasing) maximum work size $\bar{c}_i = \max_{1 \leq k \leq M} c_{i,k}$;
- **random**: random ordering.
Then, for each task in the ordered list, we order the processors for mapping its replicas according to ProcMapCriteria, which includes:

- \textit{inE}: increasing energy cost;
- \textit{deR}: decreasing reliability;
- \textit{deP}: decreasing ratio of \( \frac{-\log_{10}(1 - R(\tau_i, m_k))}{E(\tau_i, m_k)} \) (explained below);
- \textit{random}: random ordering.

<table>
<thead>
<tr>
<th>( m_k )</th>
<th>( E(\tau_i, m_k) )</th>
<th>( R(\tau_i, m_k) )</th>
<th>( \frac{R(\tau_i, m_k)}{E(\tau_i, m_k)} )</th>
<th>( \frac{-\log_{10}(1 - R(\tau_i, m_k))}{E(\tau_i, m_k)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.9</td>
<td>0.9</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>0.99</td>
<td>0.495</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0.99</td>
<td>0.99</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>0.9</td>
<td>0.45</td>
<td>0.5</td>
</tr>
</tbody>
</table>

We use the example shown in Table 2 to explain how to design a better criteria in ProcMapCriteria. Assume there are four processor sets with different energy and reliability configurations. Considering only the reliability, we cannot distinguish between the second and third sets. Apparently, the third set is better since its processors consume less energy and provide the same level of reliability. The problem is the same when ordering processors only according to energy cost. This gives us a hint that we need to consider energy and reliability interactively. A first idea would be to use the ratio \( \frac{R(\tau_i, m_k)}{E(\tau_i, m_k)} \), which expresses the reliability per energy unit of task \( \tau_i \) executing on processor \( m_k \). But consider a task instance with a reliability target \( R_i = 0.98 \): it requires either one processor from the second set or two processors from the first set. Both solutions match the reliability goal with the same energy cost 4. We aim at a formula that would give the same weight to both solutions. The ratio \( \frac{-\log_{10}(1 - R(\tau_i, m_k))}{E(\tau_i, m_k)} \) is a good candidate, because the total energy cost is the sum of all processors while the reliability is a product. This discussion explains how we have derived the third criteria \textit{deP} in ProcMapCriteria, namely to order processors by decreasing ratio of \( \frac{-\log_{10}(1 - R(\tau_i, m_k))}{E(\tau_i, m_k)} \).

For the mapping phase, we add replicas for task \( \tau_i \) in the order of the processor list until the reliability target \( R_i \) is reached. The algorithm uses the probability of failure \( PoF = 1 - R(\tau_i) = \Pi_{k \in alloc(i)} (1 - R(\tau_i, m_k)) \) (Equation (4)). The mapping process always ensures that: (i) no two replicas of the same task are assigned to the same processor; (ii) the utilization \( u_k \) of each processor does not exceed 1.
Algorithm 1: Replication setting and mapping

Input: A set of tasks $\tau_i$ with reliability targets $R_i$; a set of heterogeneous processors $m_k$

Output: An allocation $\sigma_m$ of all replicas on the processors

begin
1. order all the tasks with TaskMapCriteria and renumber them $\tau_1, \ldots, \tau_N$
2. /* initialize the utilization of all processors to zero */
3. $u \leftarrow [0, \ldots, 0]$
4. /* iterate through the ordered list of tasks */
5. for $i \in [1, \ldots, N]$ do
   6. /* order processors for each task */
   7. order all processors for task $\tau_i$ with ProcMapCriteria and renumber them $\text{proc}_1, \ldots, \text{proc}_M$
   8. /* this ordered list may differ from task to task */
   9. $k = 1$
10. $\text{PoF} = 1$
11. while $1 - \text{PoF} < R_i$ do
12.    $\text{temp} = u_k + u_{i,k}$
13.    if $\text{temp} \leq 1$ then
14.       $u_k = \text{temp}$
15.       $\text{PoF} = \text{PoF} \times (1 - R(\tau_i, m_k))$
16.       add one replica of $\tau_i$ on $\text{proc}_k$
17.       $k++$
18.    if $k > m$ then
19.       return not feasible
20. return $\sigma_m$
4 Scheduling

In the scheduling phase, we aim at ordering the tasks mapped on each processor, with the objective to minimize the energy consumption during execution. Recall that the success of any replica leads to the immediate cancellation of all the remaining replicas, a crucial source of energy saving. Our approach is to identify a primary replica for each task, then all its other replicas become secondaries. The goal of the proposed scheduling is to avoid overlap between the execution of the primary and secondary replicas for each task: the primary must be terminated as soon as possible, while the secondaries must be delayed as much as possible. Whenever a primary replica of a task succeeds, the energy consumption will be minimal for that task if no secondary replica has started executing yet. Our scheduling algorithm uses a layered approach: first we map the first replica of each task, which we call the primary replica; and then, in a round-robin fashion, we map the remaining replicas (if they exist), which we call the secondaries. Here is a detailed description of Algorithm 2:

1. First we order tasks by criterion TaskSchedCriteria, for which we propose:
   - \textit{deNR (inNR)}: decreasing (increasing) number of replicas;
   - \textit{deU (inU)}: decreasing (increasing) total utilization (sum up the utilization of all replicas);
   - \textit{random}: random ordering.

2. Then we process the list of tasks in that order, and select a primary replica for each task, which we execute as soon as possible on its assigned processor, right after already scheduled primary replicas (if any). We use two different criteria PrimarySchedCriteria for selecting primary replicas:
   - \textit{time}: choose the processor that can complete the execution of the replica the earliest (given already made scheduling decisions);
   - \textit{energy}: choose the processor that can execute the replica with smallest dynamic energy.

3. Once primary replicas have all been scheduled, we reverse the order of the list of tasks, and we schedule the remaining replicas (considered in a round-robin fashion in the reversed list) as late as possible on their assigned processor. The idea is to minimize potential overlap between primary and secondaries for each task, hence to delay secondary replicas until the end of the period. The rationale for reverting the task list is that the primary replica of some task \( \tau \) at the end of the list may have been scheduled after some other primary replica \( \tau' \), hence the idea to process the secondary replica of \( \tau' \) before that of \( \tau \) and push it further away at the end of the period.
4. Finally, there only remains to detail which secondary replica of a task is scheduled first (whenever the task has three replicas or more). We also have two criteria `SECONDARY_SCHED_CRITERIA` for choosing secondary replicas:

- **time**: choose the replica whose start-up time can be the latest (given already made scheduling decisions); the idea is to minimize overlap by maximizing slack;
- **energy**: choose the replica whose energy is the highest; the idea is again to minimize overlap, thereby increasing the probability of this costly replica to be cancelled.

As we have two different criteria for both selecting primaries and secondaries, in total, we have four possible combinations, namely **time-time**, **time-energy**, **energy-time** and **energy-energy**. For the baseline scheduling (randomShuffling), we randomly order tasks on each processor and execute them in sequence and as early as possible (no idle time until the end of the period).

**Algorithm 2: Scheduling**

```
Input: An allocation $\sigma_m$ of all replicas on the processors
Output: An order of execution on each processor

1 begin
2     order all the tasks with $\text{TaskSchedCriteria}$ and renumber them $\tau_1, \ldots, \tau_N$
3     /* insert the primary replica for each task at the beginning of each processor schedule */
4     for $i \in [1, \ldots, N]$ do
5         if $\text{PrimarySchedCriteria}$ is "time" then
6             schedule the primary replica of task $\tau_i$ that could finish at the earliest
7         else if $\text{PrimarySchedCriteria}$ is "energy" then
8             schedule the primary replica of task $\tau_i$ that consumes the minimum energy
9     /* insert the secondaries backwards from the end of each processor schedule */
10    reverse the task ordering
11    while there is still at least one replica to be scheduled do
12        for $i \in [1, \ldots, N]$ do
13            if there is still a replica of $\tau_i$ to be scheduled then
14                if $\text{SecondarySchedCriteria}$ is "time" then
15                    schedule the secondary replica of task $\tau_i$ that could start the latest
16                else if $\text{SecondarySchedCriteria}$ is "energy" then
17                    schedule the secondary replica of task $\tau_i$ that consumes the maximum energy
```

RR n° 9324
5 Lower bound

In this section, we explain how to derive a lower bound for the expected energy consumption of a solution to the optimization problem, namely a mapping/scheduling heuristic that uses some of the selection criteria outlined in Sections 3 and 4.

For each problem input, namely $N$ tasks $\tau_i$ with reliability thresholds $R_i$, $M$ processors $m_k$ with failure rates $\lambda_k$, and with all WCET $c_{i,k}$, we compute a solution, i.e., a mapping and ordering of all replicas. We first use Monte-Carlo simulations (see Section 6) and generate several sets of values for the actual execution time $w_{i,k}$ of $\tau_i$ on $m_k$. The values $w_{i,k}$ are drawn uniformly across processors as some fraction of their WCET $c_{i,k}$ (refer to Section 6.1 for details).

Now, for each set of values $w_{i,k}$, we generate a set of failure scenarios, compute the actual energy consumed for each scenario, and report the average of all these values as the expected energy consumption. A failure scenario operates as follows. We call an event the end of the execution of a task replica on some processor. At each event, we flip a biased coin (weighted with the probability of success of the replica on that processor) to decide whether the replica is successful or not. If it is, we delete all other replicas of the same task. At the end of the execution, we record all the dynamic energy that has been actually spent, accounting for all complete and partial executions of replicas, and we add the static energy given by Equation (3). This leads to the energy consumption of the failure scenario. We average the values over all failure scenarios and obtain the expectation, denoted as $E(\{w_{i,k}\})$.

In addition, we also compute a lower bound $LB(\{w_{i,k}\})$ as follows. Our goal is to accurately estimate the energy consumption of an optimal solution. Because the static energy depends upon the subset of processors that are used in the solution (see Equation (3)), we need to try all possible subsets. Given a processor subset $S$, we consider each task $\tau_i$ independently, and try all possible mappings of replicas of $\tau_i$ using only processors in $S$. Thus we explore all subsets $T$ of $S$. A subset $T$ is safe if mapping a replica of $\tau_i$ on each processor of $T$ meets the reliability criteria $R_i$, and if no strict subset of $T$ is safe. Note that safe sets are determined using the WCETs $c_{i,k}$, and not using the $w_{i,k}$, because this is part of the problem specification. Now for each safe subset $T$, we try all possible orderings (there are $k!$ of them if $|T| = k$); for each ordering, we compute the expected value of the dynamic energy consumption as follows: if, say, $T = \{m_1, m_3, m_4\}$ and the ordering is $m_3, m_4, m_1$, then we compute

$$P_{3,dw_{i,3}} + (1 - e^{-\lambda_3 w_{i,3}})P_{4,dw_{i,4}} + (1 - e^{-\lambda_3 w_{i,3}})(1 - e^{-\lambda_4 w_{i,4}})P_{1,dw_{i,1}}.$$

We see that we optimistically assume no overlap between the three repli-
cas, and compute the dynamic energy cost as the energy of the first replica (always spent) plus the energy of the second replica (paid only if the first replica has failed) plus the energy of the third replica (paid only if both the first and second replicas have failed). Note that here we use execution times and failure probabilities based upon the actual execution times \( w_{i,k} \) and not upon the WCETs \( c_{i,k} \). The value of the sum depends upon the ordering of the processors in \( T \), hence we check the 6 orderings and retain the minimal value. We do this for all safe subsets and retain the minimal value. Finally we sum the results obtained for each task and get the lower bound for the original processor subset \( S \). We stress that this bound is not necessarily tight, because our computation assumes no overlap for any replica pair, and does not check the utilization of each processor (which may exceed 1). The final lower bound \( LB(\{w_{i,k}\}) \) is the minimum over all processor subsets. Although the computation has exponential cost, due to the exploration of all processor subsets \( S \), the computation of the expected energy for a given ordering in a subset \( T \) of \( S \) obeys a closed-form formula.

6 Performance evaluation

This section assesses the performance of our different strategies to map and schedule real-time tasks onto heterogeneous platforms. In Section 6.1, we describe the parameters and settings used during the experimental campaign. We present the results in Section 6.2. The algorithms are implemented in C++ and in R. The related code, data and analysis are publicly available in [1].

6.1 Experimental methodology

In the experiments, we have \( M = 10 \) processors and \( N = 20 \) tasks which have all the same period \( p = 100 \). The set of WCETs is generated by the method proposed in [2], as mentioned in Section 2.1. The WCET values are controlled by the correlation factor between the different tasks (\( cor_{\text{task}} \)) and between the different processors (\( cor_{\text{proc}} \)). These two parameters vary between 0 and 1.\(^1\) For example, \( cor_{\text{task}} = 0 \) (resp. \( cor_{\text{proc}} = 0 \)) means that the WCET values between different tasks on one processor (resp. between different processors for one task) are completely randomly generated. Inversely, \( cor_{\text{task}} = 1 \) (resp. \( cor_{\text{proc}} = 1 \)) means that the WCET values between different tasks on one processor (resp. between different processors for one task) are all the same. We also define a parameter \( basic\text{Work} \) as the

\(^1\)We ignored the case when \( cor_{\text{task}} = 0 \) and \( cor_{\text{proc}} = 1 \) for the parameter set with big failure rate, because when tasks are completely unrelated, there (very likely) is a task with very long execution time on all processors (\( cor_{\text{proc}} = 1 \)). The number of replicas needed to meet its reliability goal will exceed the number of available processors.
estimated total utilization of the system with a single replica per task, in order to study the impact of system pressure:

$$\text{basicWork} = \frac{\sum_{i,k} c_{i,k}}{M^2 p} = \frac{\sum_{i,k} u_{i,k}}{M^2}$$  \hspace{1cm} (5)

In Equation (5), we use the average WCETs on the $M$ processors ($\sum_k c_{i,k}$) to estimate the execution time of task $\tau_i$. We have $M$ processors available during period $p$, hence basicWork represent an estimate of the fraction of time processors are used if each task has a single replica. In the experiments, we vary basicWork from 0.1 to 0.3.

To generate the actual execution times of tasks from their WCETs, we use two parameters. The first one, $\beta_{b/w}$, is global to all tasks: $\beta_{b/w}$ is the ratio between the best-case execution time and the worst-case execution time. It is the smallest possible ratio between the actual execution time of a task and its WCET. Therefore, the actual execution time of task $\tau_i$ on processor $m_k$ belongs to $[\beta_{b/w}c_{i,k}, c_{i,k}]$. We consider five possible values of $\beta_{b/w}$: 0.2, 0.4, 0.6, 0.8, and 1. The second parameter, $\beta_i$, is task dependent: $\beta_i$ describes whether the instance of a task is a small one or a large one. $\beta_i$ is randomly drawn in $[0,1]$. A value of $\beta_i = 0$ means that task $\tau_i$ has the shortest execution time possible, and $\beta_i = 1$ means that the actual execution is equal to its worst case execution time. Overall, the actual execution time of task $\tau_i$ on processor $m_k$ is thus defined as: $w_{i,k} = (\beta_{b/w} + (1-\beta_{b/w})\beta_i)c_{i,k}$.

For a processor $m_k$ in the platform, we fix the static power $P_{k,s}$ at 0.001 as in previous papers [21, 20, 24]. But for the dynamic power and the failure rate, we have two sets of parameters. The first set also follows values similar to those of the previous papers [21, 20, 24]. For this set, we have a relatively large power and a very small failure rate. Therefore, the replicas using this first set of parameters succeed in almost all cases. Thus, to evaluate our heuristics in the context when failures occur more frequently, we introduce a second set of parameters where the replicas have a smaller power and a larger failure rate. For the first set, we choose randomly the dynamic power $P_{k,d}$ between 0.8 and 1.2, and the failure rate $\lambda_k$ between 0.0001 and 0.00023. And for the second set, we have $P_{k,d}$ 10 times smaller (between 0.08 and 0.12), and $\lambda_k$ 100 times larger (between 0.01 and 0.023). With the second set of parameters, the actual reliability of one replica ranges from 0.1 to 0.99. To be more realistic, in our experiments, processors with a larger dynamic power $P_{k,d}$ have a smaller failure rate $\lambda_k$. It means that, a more reliable processor costs always more energy than a less reliable one. We guarantee this by ordering inversely the $P_{k,d}$’s and the $\lambda_k$’s after generating the random values.

We vary the local reliability target $R_i$ between 0.9 and 0.98 for the first set and between 0.8 and 0.95 for the second set. This is to give the system a reasonable freedom while mapping and scheduling. The reliability target is
relatively high, implying that tasks need plural replicas to reach it. Therefore, we give more tolerance (smaller reliability threshold) to the second set with a larger failure rate, because otherwise we may not be able to find feasible mappings.

Table 3: Ratio of energy consumption to the baseline of different mapping and scheduling ordering tasks criteria

<table>
<thead>
<tr>
<th>map</th>
<th>sch</th>
<th>deNR</th>
<th>inNR</th>
<th>deU</th>
<th>inU</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>deW</td>
<td>0.5655</td>
<td>0.5662</td>
<td>0.5655</td>
<td>0.5660</td>
<td>0.5663</td>
<td></td>
</tr>
<tr>
<td>inW</td>
<td>0.5631</td>
<td>0.5635</td>
<td>0.5630</td>
<td>0.5635</td>
<td>0.5635</td>
<td></td>
</tr>
<tr>
<td>deMinW</td>
<td>0.5658</td>
<td>0.5662</td>
<td>0.5657</td>
<td>0.5661</td>
<td>0.5665</td>
<td></td>
</tr>
<tr>
<td>inMinW</td>
<td>0.5637</td>
<td>0.5642</td>
<td>0.5637</td>
<td>0.5642</td>
<td>0.5641</td>
<td></td>
</tr>
<tr>
<td>deMaxW</td>
<td>0.5658</td>
<td>0.5664</td>
<td>0.5657</td>
<td>0.5663</td>
<td>0.5665</td>
<td></td>
</tr>
<tr>
<td>inMaxW</td>
<td>0.5629</td>
<td>0.5633</td>
<td>0.5629</td>
<td>0.5633</td>
<td>0.5633</td>
<td></td>
</tr>
<tr>
<td>random</td>
<td>0.5633</td>
<td>0.5639</td>
<td>0.5633</td>
<td>0.5638</td>
<td>0.5639</td>
<td></td>
</tr>
</tbody>
</table>

6.2 Results

In this section, we analyze the impact of the different parameters on the performance of the heuristics. Due to lack of space, we will only analyze in detail a set of representative results in the paper. The comprehensive set of all results is available in the appendix. We choose as default values $\beta_{b/w} = 1$, $\text{basic Work} = 0.3$, $R_i = 0.95$ for the set with big failure rate, and $R_i = 0.98$ for the set with small failure rate. This set of parameters is chosen to constrain the solution so that we can observe the most interesting results. For $\text{cor task}$ and $\text{cor proc}$, we fix them at 0.5 as default value. Each experiment is the average of 10 sets of WCET values. For each set, we generate 10 sets of random $P_{k,d}$ and $\lambda_k$ values. For each $P_{k,d}$ and $\lambda_k$ generated, the final result is the average of 10 executions. Overall, we run 1,000 randomly generated experiments for each set of $\beta_{b/w}$, $\text{basic Work}$, $R_i$, $\text{cor task}$ and $\text{cor proc}$ values. The total number of experiments ran is 3,075,000 for each heuristic. Each result is represented as a ratio to the random baseline method which is defined as follows: for each task, we add replicas randomly on available processors until reaching its reliability target during the mapping phase; for scheduling, we randomly order replicas mapped on each processor and execute them in sequence and as soon as possible. We also compare different strategies with the lower bound proposed in Section 5. We report on these figures the average number of replicas needed in total for 20 tasks (on the left side) and of failures that occur for the 1,000 random trials for each setting (on the right side). These numbers are reported in black above the horizontal axis in each figure.
Energy-aware strategies on heterogeneous platforms

6.2.1 Ordering tasks for mapping and scheduling

In Table 3, we calculated the ratio of combinations of different mapping and scheduling methods to the baseline method, when considering different criteria for ordering tasks. We can see that, in the whole set of experiments, all criteria for ordering tasks perform equally well (around 56%). The difference between the best and the worst performance is only around 0.36%. Hence these criteria do not critically influence energy consumption. In the following results, for the task ordering, we only consider the decreasing average WCET (deW) for the mapping, and the decreasing utilization (deU) for the scheduling, which give priority to the tasks that putting more pressure to the system. We then focus on selecting processors during the mapping phase, and on choosing primary and secondary replicas during the scheduling phase.

6.2.2 Processor correlation

Figures 1 and 2 show results when processor correlation varies, under small and big failure rate respectively. We found that our strategies consume less than 25% of the energy needed by the baseline strategy when cor\textsubscript{proc} = 0, and the result is close to the lower bound. But we can observe that this percentage increases with cor\textsubscript{proc}.

For the mapping phase, in Figure 1a we observe that, in the small failure rate case, ordering the processors by decreasing reliability (deR) has a worse performance than ordering them by increasing energy cost (inE) or decreasing proportion (deP) in nearly all cases. This is reasonable because, in this case, the reliability of all tasks on all processors is relatively high. Therefore, we cannot have significant improvements by using more reliable processors, but these can cost much more energy. Furthermore, inE and deP

Figure 1: Ratio of energy consumption using different mapping and scheduling strategies under small failure rate, when varying cor\textsubscript{proc}, with basicWork = 0.3, β\textsubscript{b/w} = 1, R\textsubscript{i} = 0.98 and cor\textsubscript{task} = 0.5.
Energy-aware strategies on heterogeneous platforms

Figure 2: Ratio of energy consumption using different mapping and scheduling strategies under big failure rate, when varying corproc, with basicWork = 0.3, \(\beta_{l/w} = 1\), \(\mathcal{R}_i = 0.95\) and cortask = 0.5.

perform similarly and have a performance close to that of the lower bound, except when corproc \(\approx 1\). In the big failure rate case (Figure 2a), we see that, when corproc is not equal to 1, inE performs better than deR. But when corproc increases to 1, the performance of deR catches up. And in all cases, deP performs better than, or similarly to the best strategy between deR and inE.

And for the scheduling strategies, Figure 1b and 2b show that, there is little difference between our different criteria, the random one excepted. But we can still observe more difference in the big failure rate case. With corproc \(\neq 1\), we have energy criteria for primary replica choosing slightly better than time, and when corproc = 1, the energy becomes worse than the time.

This is because, for most of the cases, the reliability of our replica is high, so that we can simply choose the replica which costs the least energy as primary, and delete all secondary when it finishes successfully. But in the case of corproc = 1, the WCETs of each task on different processors are the same, so the order of the processors for any task is the same, and is relative to the power and reliability parameters \((P_{k,d} \text{ and } \lambda_k)\). This can result in a few fully used processors, with the other processors being empty. Also, for time criteria, primary replicas will be randomly balanced on different fully used processors, because every replica of a task has the same WCET. But for energy, the processors which cost less energy are the same for all tasks. Then these processors will execute all mapped replicas as primary, and others will execute all mapped replicas as secondary, which increases the overlap. This is why, when corproc = 1, we cannot save as much energy as in other cases, and this is why the energy criteria performs worse than the time criteria.
Energy-aware strategies on heterogeneous platforms

Figure 3: Ratio of energy consumption using different mapping and scheduling strategies under small failure rate when varying $\beta_{b/w}$, with basic Work = 0.3, $R_i = 0.98$ and $cor_{task} = 0.5$.

Figure 4: Ratio of energy consumption using different mapping and scheduling strategies under big failure rate when varying $\beta_{b/w}$, with basic Work = 0.3, $R_i = 0.95$ and $cor_{task} = 0.5$. 
6.2.3 Task variability

Figures 3 and 4 present the results with small and big failure rates when $\beta_{b/w}$ varies. We observe that, for almost all the mapping and scheduling criteria, the results are similar whatever the value of $\beta_{b/w}$. This is because we map and schedule tasks based on their WCETs, so the mapping and scheduling results are independent of the value of $\beta_{b/w}$. Furthermore, each task $i$ has the same $\beta_i$ on the different processors. Therefore the energy consumption ratios tend to be similar. But in the case of $\text{cor}_{\text{proc}} \approx 1$, we can see from Figure 4b (under big failure rate where more than one replica per task needed) that the ratio of all scheduling criteria increases slightly with $\beta_{b/w}$, and the two strategies using $\text{energy}$ as primary replica choosing criteria increase faster than the two others which use $\text{time}$. In fact, when we have a larger value of $\beta_{b/w}$, the actual execution time is closer to the WCET. So that, although the mappings and schedulings are the same for different $\beta_{b/w}$, replicas will take longer time during the actual execution. At the same time, as explained in the previous paragraph, we have a more serious overlap in the case of $\text{cor}_{\text{proc}} = 1$ and for $\text{energy}$ criteria. This is why $\text{cor}_{\text{proc}} = 1$ performs differently when varying $\beta_{b/w}$. However this phenomenon is not obvious ($\approx 5\%$), so we can always conclude that the result is independent of $\beta_{b/w}$. When $\beta_{b/w}$ is small, actual execution times can greatly differ from the WCETs used for mapping and scheduling. However, in this case, our heuristics have a performance similar to that of the lower bound, which shows that they are very robust.
Energy-aware strategies on heterogeneous platforms

1.10 1.80 2.40 20.10 20.30 20.70
1.60 3.00 4.50 20.00 20.80 22.80
0.80 1.40 1.90 20.00 20.00 20.10
1.40 2.70 4.20 20.00 20.00 20.10
0.80 1.50 2.10 20.40 23.40 26.60
1.50 3.30 5.20 23.90 32.90 39.90

\( R = 0.8 \)

\( R = 0.95 \)

\( \text{cor}_{\text{proc}} = 0.5 \)

\( \text{cor}_{\text{proc}} = 1 \)

Basic Work

Ratio to the baseline

(a) Comparing mapping strategies when using time-time as scheduling strategy

(b) Comparing scheduling strategies when using deP as mapping strategy

Figure 6: Ratio of energy consumption using different mapping and scheduling strategies when varying basicWork and \( R_i \), under big failure rate, with \( \beta_{b/w} = 1 \) and \( \text{cor}_{\text{task}} = 0.5 \).

6.2.4 Utilization and reliability threshold

From Figures 5 and 6, we observe the performance of different mapping and scheduling criteria when varying basicWork and \( R_i \).

We remark that the results are similar under big and small failure rates when we have \( \text{cor}_{\text{proc}} \) not close to 1. For example, we can see the case \( \text{cor}_{\text{proc}} = 0.5 \) in the first row of Figures 5 and 6. During the mapping phase, \( \text{deR} \) has a slightly worse performance than \( \text{inE} \) and \( \text{deP} \), which perform similarly to the lower bound. During the scheduling phase, all criteria have similar performance, including the random strategy and the lower bound.

On the contrary, with \( \text{cor}_{\text{proc}} \approx 1 \), the heuristics perform differently with big and low failure rates. For the small failure rate, during the mapping phase, we see from the second row of Figure 5a that \( \text{deR} \) is worse than \( \text{inE} \) and \( \text{deP} \) and has a performance similar to the random case, while \( \text{inE} \) and \( \text{deP} \) provide results similar to the lower bound. During the scheduling phase, in the second line of Figure 5b we can still see similar performance for all criteria. For the big failure rate case, during the mapping phase, the second row of Figure 6a shows that the difference between different criteria becomes smaller when basicWork and \( R_i \) increase. Inversely, the difference with the lower bound becomes larger, but it is still less than 10% (except random), even in the worst case. For small values of basicWork and \( R_i \), \( \text{deR} \) performs worse, but when basicWork and \( R_i \) increase, \( \text{deR} \) becomes similar to \( \text{inE} \), or even better. \( \text{deP} \) has always better or similar performance than \( \text{deR} \) and \( \text{inE} \). For the scheduling phase, from the second row of Figure 6b, we can still find similar performance on all our criteria, but their difference with the lower bound increases to 10% as in the mapping phase. The reason is that with the increase of system load, it becomes harder to map all replicas to
their best processors, while the lower bound is calculated without considering utilization constraints.

6.2.5 Number of failures

We counted the number of replicas that failed during the execution in each experiment. In the set with small failure rate, we have on average 0.44% failed replicas. Thus, in most of the cases, it is enough to have a single replica mapped on the processor that costs the least energy, because failures are scarce. On the contrary, in the set with big failure rate, the average rate of failed replicas increases to 7.57%. We can observe that the deP mapping method used in conjunction with time criterion for choosing primary replica when processors are highly correlated, or with energy criterion in other cases achieves the best performance, or a performance similar to the best observed one, in both cases. This confirms that the performance of our best heuristics is not affected by the failure rate.

6.2.6 Success rate

All the tested heuristics were able to find a valid solution in all tested configurations with small failure rate. And in the big failure rate cases, heuristics were able to build valid solutions for more than 99.94% of the instances. The very high success rate of our experiments shows the robustness of our approach.

6.2.7 Summary

In conclusion, our strategies can save more than 40% of the energy consumed by the baseline, except in the high processor correlation case. The ratio to the baseline can be as low as 20% in the best case.

As for the different criteria used in the heuristics, we find that the deP method is the best processor ordering during the mapping phase.

For scheduling, we can find from the result that, all our primary-secondary choosing criteria have a similar result as the lower bound, except a difference of 10% in the case of cor_{proc} ≈ 1. This means that our primary-secondary choosing heuristic performs well. On the other hand, we point out that strategies with the same method for choosing the primary replica but different methods for choosing secondary replicas, perform similarly. Hence the strategy for choosing the primary replica has much more impact than the one for choosing secondary replicas. We can find that, time-time and time-energy criteria performs better when cor_{proc} ≈ 1, and energy-energy and energy-time have better performance in other cases.

The performance of these best heuristics is only 17.0% higher than the lower bound in the worst case. Furthermore, we report a median value only 3.5% higher than that of the lower bound; and the average value is only
4.3% higher. We can confidently conclude that our best strategies perform remarkably well over the whole experimental setting.

7 Related work

7.1 Scheduling for heterogeneous platforms

There is a huge literature on scheduling for heterogeneous platforms, and even dedicated workshops. Here, we only refer some very recent work closely related to our problem but dealing with non-periodic tasks. [20] maximizes the reliability of an energy-constrained DAG executed on a heterogeneous platform while using DVFS. Conversely, [24] minimizes the energy consumption of a reliability-constrained DAG executed on a heterogeneous platform while using or not DVFS. A group of authors published a book [22] and several articles on the problem of DAG scheduling on heterogeneous platforms. In Chapter 2 of book [22] and in [23] these authors consider the energy minimization when scheduling a DAG with or without DVFS. In [21] they considered the same problem while satisfying some reliability goal. However, these two results do not consider reliability.

Overall, these studies do not consider real-time applications. The deadlines constraining real-time tasks and applications make problems significantly harder to tackle.

7.2 Scheduling of real-time applications on homogeneous platforms

There is a very significant literature on real-time scheduling for multiprocessor systems. However, most work is devoted to homogeneous processor systems, as exemplified by the survey [3] which ignores altogether heterogeneous systems, and by the more recent survey [16] where only 9 of the 78 references deal with heterogeneous platforms. [10] minimizes the energy when scheduling independent tasks with different deadlines on a homogeneous platform while satisfying some threshold on reliability. The study [8] improved the solution from [10] in particular by carefully avoiding overlaps between primary and secondary replicas. [9] considers the same problem; however, it uses checkpointing to cope with failures when all other work consider replication.

We refer the interested reader to [8, 10, 3, 16] for a comprehensive overview of the related work for homogeneous platforms. Heterogeneous platforms make the problem even harder because processors can have different speeds, energy costs, and failure rates. Therefore, the processor preferred for one task by one of the objectives and constraints — deadline satisfaction, energy minimization, reliability threshold satisfaction — may be the worst
processor for another objective or constraint. Heuristics have thus to perform complicated trade-offs in our three-criteria settings.

7.3 Scheduling of real-time applications on heterogeneous platforms

Some related work targets the scheduling of real-time applications on heterogeneous platforms, but without considering fault tolerance. For instance, [27] targets the execution of a DAG, but considering neither energy consumption nor fault-tolerance (when DAGs are scheduled, tasks are always assumed to have the same deadline). [7] targets the execution of independent tasks that access shared resources, the access to resources being exclusive. Their objective is to maximize the number of instances for which a solution is found. [12], [15] and [26] minimize energy consumption by using DVFS, [12] when scheduling independent tasks, [15] a DAG, and [26] a moldable application. [19] considers the scheduling of independent tasks and DAGs under an energy constraint, while [18] considers the scheduling of independent tasks under a thermal constraint. [25] proposes a fully polynomial-time approximation scheme (FPTAS) for minimizing the energy consumption for a set of independent tasks executed on a set of heterogeneous (unrelated) processing elements.

Some of the related work considers the execution of real-time applications on heterogeneous failure-prone platforms but is limited to coping with a single failure per task or per processor. [13] maximizes the reliability of the considered DAG but does not consider energy consumption and follows the primary/backup technique and, thus, is limited to at most one failure per task of the DAG. [14] attempts to maximize resource utilization (and does not consider energy) when scheduling a set of independent tasks. It assumes that at most one processor can fail, which enables the simultaneous scheduling of several backup tasks on the very same processor as at most one of them will need to be executed. [11] minimizes the energy consumed for the execution of a DAG while satisfying a reliability threshold. The proposed solution uses DVFS and Power Mode Management (i.e., the ability to switch off idle processors to low-power inactive state). This solution, however, cannot produce a schedule more reliable than the original one. It also supports at most one fault per processor. [6] minimizes the energy consumed for the execution of a set of independent tasks while satisfying a reliability threshold using DVFS and following a primary-backup approach.

Very few studies consider the execution of real-time applications on heterogeneous failure-prone platforms and can cope with two or more failures per task. [17] minimizes the energy consumed for the execution of a set of independent tasks while satisfying a reliability threshold. The proposed solution uses DVFS. This solution, however, is based on a primary-backup approach that is then extended. This approach, by design, cannot produce
a schedule more reliable than the original one with two replicas per task, strongly relies on DVFS, and schedules several replicas of a same task on the same processor (what most other approaches forbid). [5] targets the execution of a DAG on a heterogeneous platform while satisfying a reliability threshold. However, the objective is not the minimization of energy consumption but the maximization of the utilization of energy consumption, which can be seen as a yield of reliability improvement with respect to increase energy consumption. As a consequence, [5] produces energy greedy schedules (see subplots (a-1), (b-1), and (c-1) of Figure 1 in [5]). In Chapter 3 of the already mentioned book [22], the authors consider cost minimization (which can be energy minimization) when scheduling a DAG under deadline and reliability constraints. Therefore, we consider the same problem but for a set of independent tasks rather than for a DAG. Because of the dependence between tasks and the chosen as-soon-as-possible scheduling of [22], this solution tends to schedule simultaneously the different replicas of a single task. As already pointed out in the studies [8, 10] that this can lead to a significant waste of energy. Therefore, it would have been unfair to compare our solution to that of [22] applied on independent tasks.

From what precedes, we have only identified a single existing solution that enables to schedule real-time tasks on heterogeneous platforms while minimizing energy consumption and satisfying some bound on the overall reliability. However, this solution being dedicated to DAGs lacks the possibility to minimize the overlapping between replicas of a same task, what have been previously proved to be crucial [8] and what we specifically targeted (cf. Section 4).

8 Conclusion

In this work, we have studied the problem of executing periodic real-time tasks on an heterogeneous platform, with several objectives: minimizing the energy consumption, guaranteeing some reliability thresholds, and meeting all deadlines. For each task, we decide how many replicas should be launched, and on which processors to map them. We tagged one replica per task as “primary” replica and the other ones as “secondary” replicas. To obtain an absolute measure for the evaluation of our heuristics, we have computed a theoretical lower bound on energy consumption. Extensive simulations show that our best heuristic always achieve very good performance, very close to the lower bound (on average only 4% higher than this lower bound). This performance was reached by considering processors in the deP order when mapping the replicas of a task (roughly speaking, deP is the ratio of a task failure rate by its energy cost), by executing primary replicas as soon as possible and secondary ones as late as possible, and by tagging replicas as “primary” using an earliest completion time criterion when processors are
highly correlated, using an smallest energy criterion otherwise. Furthermore, while all decisions are taken with the worst-case execution times (WCETs) of tasks as only input, the simulations used the actual execution times; the best heuristic always achieved excellent performance even when the actual execution times were far smaller than the WCETs, showing the robustness of our approach.

Future work will aim at extending the algorithms to periodic graphs of tasks instead of independent task sets. The dependences between tasks will dramatically complicate the mapping and scheduling problems.

Acknowledgments

This paper is partially supported by funding under Chinese National Key Research, Development Project 2017YFB1001800, NSFC 61972150, 61572195, and a JORISS grant from ENS de Lyon and ECNU. The work of Yiqin Gao was supported by the LABEX MILYON (ANR-10-LABX-0070) of Université de Lyon, within the program “Investissements d’Avenir” (ANR-11-IDEX-0007) operated by the French National Research Agency (ANR). Corresponding author is Yiqin GAO.

References


\( \beta_{b/w} \) (Mapping)

The following section presents ratio of energy consumption using different mapping strategies under big failure rate when varying \( \beta_{b/w} \).
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.1; R = 0.8 \)

\( \text{cor}_{\text{proc}} = 0 \)
\( \text{cor}_{\text{proc}} = 0.25 \)
\( \text{cor}_{\text{proc}} = 0.5 \)
\( \text{cor}_{\text{proc}} = 0.75 \)
\( \text{cor}_{\text{proc}} = 1 \)

Ratio to the baseline

\( \beta_{b/w} \)
Energy-aware strategies on heterogeneous platforms
**Energy-aware strategies on heterogeneous platforms**

<table>
<thead>
<tr>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
<td>1.75</td>
</tr>
</tbody>
</table>

**Ratio to the baseline**

<table>
<thead>
<tr>
<th>cor_m=0.25, basicWork = 0.1, R = 0.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR n° 9324</td>
</tr>
</tbody>
</table>
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.25; basicWork = 0.1; R = 0.95
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-time and time-energy trade-offs for different cor proc settings.
Ratio to the baseline.

$\beta_{R,n} = 0.25$, basicWork $= 0.2$, $R = 0.8$.
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \text{basic Work} = 0.2; \mathcal{R} = 0.9 \]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.2; \mathcal{R} = 0.95 \]

\[
\begin{array}{cccccc}
\text{cor}_{\text{proc}} = 0 & \text{cor}_{\text{proc}} = 0.25 & \text{cor}_{\text{proc}} = 0.5 & \text{cor}_{\text{proc}} = 0.75 & \text{cor}_{\text{proc}} = 1 \\
\end{array}
\]

Ratio to the baseline

[Graph showing energy vs. time for different cor values]
Energy-aware strategies on heterogeneous platforms
cor_{task} = 0.25; basicWork = 0.3; R = 0.85

<table>
<thead>
<tr>
<th>cor_{proc} = 0</th>
<th>cor_{proc} = 0.25</th>
<th>cor_{proc} = 0.5</th>
<th>cor_{proc} = 0.75</th>
<th>cor_{proc} = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
<td>1.75</td>
</tr>
</tbody>
</table>

Ratio to the baseline

\( \beta \frac{b}{w} \)

mapping: LowerBound, deP, deR, inE, random
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.25; \ \text{basicWork} = 0.3; \ \mathcal{R} = 0.9 \)

\begin{tabular}{|c|c|c|c|c|}
\hline
\text{cor}_{\text{proc}} & \text{Ratio to the baseline} & \text{Ratio to the baseline} & \text{Ratio to the baseline} & \text{Ratio to the baseline} \\
\hline
0.00 & 0.20 & 0.40 & 0.60 & 0.80 & 1.00 \\
\hline
0.25 & 0.20 & 0.40 & 0.60 & 0.80 & 1.00 \\
\hline
0.50 & 0.20 & 0.40 & 0.60 & 0.80 & 1.00 \\
\hline
0.75 & 0.20 & 0.40 & 0.60 & 0.80 & 1.00 \\
\hline
1.00 & 0.20 & 0.40 & 0.60 & 0.80 & 1.00 \\
\hline
\end{tabular}

\( \text{mapping} \quad \text{LowerBound} \quad \text{deP} \quad \text{deR} \quad \text{inE} \quad \text{random} \)
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.25; \ \text{basicWork} = 0.3; \ \mathcal{R} = 0.95 \)

\( \text{cor}_{\text{proc}} = 0 \)

\( \text{cor}_{\text{proc}} = 0.25 \)

\( \text{cor}_{\text{proc}} = 0.5 \)

\( \text{cor}_{\text{proc}} = 0.75 \)

\( \text{cor}_{\text{proc}} = 1 \)

**Ratio to the baseline**

\[ \frac{\text{energy}}{\text{time}} \]

**LowerBound**

**deP**

**deR**

**inE**

**random**
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

Cor ratio to the baseline mapping lower bound deP deR inE random

\( \beta \) b/w

Task = 0.5, basic work = 0.4, R = 0.85

RR no 9324
Energy-aware strategies on heterogeneous platforms

$cor_{task} = 0.5; basicWork = 0.1; R = 0.9$
$\text{cor}_{\text{task}} = 0.5$; $\text{basicWork} = 0.1$; $R = 0.95$
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 0.5; basicWork = 0.2; R = 0.95

<table>
<thead>
<tr>
<th>cor\textsubscript{proc} = 0</th>
<th>cor\textsubscript{proc} = 0.25</th>
<th>cor\textsubscript{proc} = 0.5</th>
<th>cor\textsubscript{proc} = 0.75</th>
<th>cor\textsubscript{proc} = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>energy-energy</td>
<td>energy-time</td>
<td>randomShuffling</td>
<td>time-energy</td>
<td>time-time</td>
</tr>
</tbody>
</table>

mapping: LowerBound, deP, deR, inE, random
Energy-aware strategies on heterogeneous platforms

corr_{task} = 0.5; basicWork = 0.3; R = 0.8

- corr_{proc} = 0
- corr_{proc} = 0.25
- corr_{proc} = 0.5
- corr_{proc} = 0.75
- corr_{proc} = 1

Mapping: LowerBound, deP, deR, inE, random
Energy-aware strategies on heterogeneous platforms

![Diagram showing energy-energy, energy-time, randomShuffling, time-energy, and time-time scenarios with varying parameters.](image)
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; basicWork = 0.3; R = 0.9

Ratio to the baseline

\( cor_{proc} = 0 \)

\( cor_{proc} = 0.25 \)

\( cor_{proc} = 0.5 \)

\( cor_{proc} = 0.75 \)

\( cor_{proc} = 1 \)

Mapping

- LowerBound
- dP
- dR
- inE
- random

\( \beta_{bw} \)
$cor_{task} = 0.5; \ basicWork = 0.3; \ R = 0.95$
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}\_\text{task} = 0.75; \text{basicWork} = 0.1; \mathcal{R} = 0.8 \]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \quad \text{basicWork} = 0.1; \quad R = 0.85 \]
$cor_{task} = 0.75; basicWork = 0.1; R = 0.9$
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.75; \ basicWork = 0.2; \ R = 0.8
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.2; R = 0.85 \)

\( \text{cor}_{\text{proc}} = 0 \)

\( \text{cor}_{\text{proc}} = 0.25 \)

\( \text{cor}_{\text{proc}} = 0.5 \)

\( \text{cor}_{\text{proc}} = 0.75 \)

\( \text{cor}_{\text{proc}} = 1 \)

Ratio to the baseline

\( \beta_{\text{b/w}} \)

LowerBound  deP  deR  inE  random

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor\text{\_task} = 0.75; \text{\_basicWork} = 0.2; R = 0.9

\begin{figure}
\centering
\begin{tikzpicture}
\begin{axis}[
    width=\textwidth,
    height=\textheight,
    scale only axis,
    xmin=0.2, xmax=1.0,
    ymin=0.0, ymax=1.25,
    xtick={0.2, 0.4, 0.6, 0.8, 1.0},
    ytick={0.0, 0.25, 0.50, 0.75, 1.00, 1.25},
    xlabel=\text{$\beta_{b/w}$},
    ylabel=Ratio to the baseline,
    legend pos=north east,
]
\addplot [red, mark=x] table [y index=0, x index=1] {data.csv};
\addplot [blue, mark=+] table [y index=1, x index=1] {data.csv};
\addplot [green, mark=square*] table [y index=2, x index=1] {data.csv};
\addplot [purple, mark=diamond] table [y index=3, x index=1] {data.csv};
\addplot [orange, mark=triangle*] table [y index=4, x index=1] {data.csv};
\addplot [yellow, mark=star] table [y index=5, x index=1] {data.csv};
\legend{LowerBound, \text{deP}, \text{deR}, \text{inE}, \text{random}}
\end{axis}
\end{tikzpicture}
\end{figure}
### Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>proc</td>
<td>0.25</td>
<td>0.50</td>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>cor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>proc</td>
<td>0.75</td>
<td>0.25</td>
<td>0.75</td>
<td>0.25</td>
</tr>
<tr>
<td>cor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>proc</td>
<td>0.25</td>
<td>0.50</td>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>cor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>proc</td>
<td>0.75</td>
<td>0.25</td>
<td>0.75</td>
<td>0.25</td>
</tr>
<tr>
<td>cor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>proc</td>
<td>0.25</td>
<td>0.50</td>
<td>0.25</td>
<td>0.50</td>
</tr>
</tbody>
</table>

βb/w: Ratio to the baseline

mapping: LowerBound deP deR inE random

basicWork = 0.75, R = 0.05.
$cor_{task} = 0.75$; $basicWork = 0.3$; $R = 0.8$

Energy-aware strategies on heterogeneous platforms

Ratio to the baseline

$eta_{b/w}$

mapping

LowerBound  deP  deR  inE  random
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.3; \ R = 0.85 \)
\( \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.3; \mathcal{R} = 0.9 \)

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_task = 0.75; basicWork = 0.3; R = 0.95

cor_proc = 0

cor_proc = 0.25

cor_proc = 0.5

cor_proc = 0.75

cor_proc = 1

Ratio to the baseline

β

LowerBound deP deR inE random

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 1; basicWork = 0.1; R = 0.8

![Graph showing energy-time comparison](image-url)
Energy-aware strategies on heterogeneous platforms

corr\text{task} = 1; basicWork = 0.1; R = 0.85
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 1; \text{basicWork} = 0.1; \ R = 0.9 \)

\( \text{cor}_{\text{proc}} = 0 \)

\( \text{cor}_{\text{proc}} = 0.25 \)

\( \text{cor}_{\text{proc}} = 0.5 \)

\( \text{cor}_{\text{proc}} = 0.75 \)

\( \text{cor}_{\text{proc}} = 1 \)

\( \beta_{b/w} \)

\( \text{Ratio to the baseline} \)

\( \text{mapping} \)  LowerBound  deP  deR  inE  random

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \; \text{basicWork} = 0.2; \; R = 0.85 \]

\[ \text{cor}_{\text{proc}} = 0 \]

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]

**Ratio to the baseline**

- LowerBound
- deP
- deR
- inE
- random

**Time-energy**

**Time-time**

**Energy-energy**

**Energy-time**

**Random Shuffling**

**DeP**

**DeR**

**InE**

**Baseline**

**Energy-aware strategies on heterogeneous platforms**
### Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Correlation Matrix</th>
<th>Basic Work</th>
<th>Basic Work</th>
<th>Random Shuffling</th>
<th>Basic Work</th>
<th>Basic Work</th>
<th>Random Shuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
</tr>
<tr>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
</tr>
<tr>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
<td>Correlation Matrix</td>
</tr>
</tbody>
</table>

**Correlation Coefficients:**
- Cor = 0.75
- Cor = 0.5
- Cor = 0.25

**Basic Work:**
- Basic Work = 0.2
- Basic Work = 0.4
- Basic Work = 0.6
- Basic Work = 0.8

**Random Shuffling:**
- Random Shuffling = 0.0
- Random Shuffling = 0.2
- Random Shuffling = 0.4
- Random Shuffling = 0.6
- Random Shuffling = 0.8

**Locality:**
- Locality = 0.0
- Locality = 0.2
- Locality = 0.4
- Locality = 0.6
- Locality = 0.8

**Mapping:**
- Mapping = 0.0
- Mapping = 0.2
- Mapping = 0.4
- Mapping = 0.6
- Mapping = 0.8

**RR n° 9324**
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 1; \ basicWork = 0.2; \ R = 0.95

![Graph showing energy-time and time-energy relationships]

(mapping -- LowerBound, deP, deR, inE, random)
Energy-aware strategies on heterogeneous platforms

![Graph showing energy and time ratios for different scenarios.](image)
$cor_{\text{task}} = 1; \ basicWork = 0.3; \ R = 0.85$
Energy-aware strategies on heterogeneous platforms

\[ cor_{\text{task}} = 1; \quad basicWork = 0.3; \quad R = 0.9 \]

\[ cor_{\text{proc}} = 0 \]

\[ cor_{\text{proc}} = 0.25 \]

\[ cor_{\text{proc}} = 0.5 \]

\[ cor_{\text{proc}} = 0.75 \]

\[ cor_{\text{proc}} = 1 \]

\[ \beta \]

\[ b/w \]

\[ \text{Ratio to the baseline} \]

\[ \text{Mapping} \]

\[ \text{LowerBound} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]
$\text{cor}_{\text{task}} = 1; \text{basicWork} = 0.3; \mathcal{R} = 0.95$

Energy-aware strategies on heterogeneous platforms
$\beta_{b/w}$ (Scheduling)

The following section presents ratio of energy consumption using different scheduling strategies under big failure rate when varying $\beta_{b/w}$.
\( \text{cor}_\text{task} = 0.25; \text{basicWork} = 0.1; R = 0.8 \)

<table>
<thead>
<tr>
<th>( \text{cor}_\text{proc} )</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.90</td>
</tr>
<tr>
<td>0.50</td>
<td>0.80</td>
</tr>
<tr>
<td>0.75</td>
<td>0.70</td>
</tr>
<tr>
<td>1.00</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>cor params</th>
<th>deP</th>
<th>deR</th>
<th>mA</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor params 1</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>cor params 0</td>
<td>0.1</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>cor params -0.25</td>
<td>0.0</td>
<td>0.1</td>
<td>0.25</td>
<td>0.50</td>
</tr>
</tbody>
</table>

β/b/w Ratio to the baseline
$\text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.1; R = 0.9$
<table>
<thead>
<tr>
<th>$corr_{\text{prev}}$</th>
<th>$dtP$</th>
<th>$dtR$</th>
<th>$taE$</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
<td><img src="image3" alt="Graph" /></td>
<td><img src="image4" alt="Graph" /></td>
</tr>
<tr>
<td>0.75</td>
<td><img src="image5" alt="Graph" /></td>
<td><img src="image6" alt="Graph" /></td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
</tr>
<tr>
<td>0.5</td>
<td><img src="image9" alt="Graph" /></td>
<td><img src="image10" alt="Graph" /></td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graph" /></td>
</tr>
<tr>
<td>0.25</td>
<td><img src="image13" alt="Graph" /></td>
<td><img src="image14" alt="Graph" /></td>
<td><img src="image15" alt="Graph" /></td>
<td><img src="image16" alt="Graph" /></td>
</tr>
<tr>
<td>0</td>
<td><img src="image17" alt="Graph" /></td>
<td><img src="image18" alt="Graph" /></td>
<td><img src="image19" alt="Graph" /></td>
<td><img src="image20" alt="Graph" /></td>
</tr>
</tbody>
</table>

- $\beta_{bw}$: LowerBound
- $\beta_{de}$: energy-energy
- $\beta_{de}$: energy-time
- $\beta_{de}$: time-energy
- $\beta_{sh}:$ randomShuffling

$R_{\text{lower}} = 0.1, R_{\text{upper}} = 0.95$
Energy-aware strategies on heterogeneous platforms

$\text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.2; \mathcal{R} = 0.8$

![Graph showing energy-aware strategies on heterogeneous platforms with various parameters.]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Schedule</th>
<th>( \text{cor}_{\text{proc}} = 1 )</th>
<th>( \text{cor}_{\text{proc}} = 0.75 )</th>
<th>( \text{cor}_{\text{proc}} = 0.5 )</th>
<th>( \text{cor}_{\text{proc}} = 0.25 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{deP} )</td>
<td>( \begin{array}{c</td>
<td>c</td>
<td>c</td>
<td>c</td>
</tr>
<tr>
<td>( \text{deR} )</td>
<td>( \begin{array}{c</td>
<td>c</td>
<td>c</td>
<td>c</td>
</tr>
<tr>
<td>( \text{neE} )</td>
<td>( \begin{array}{c</td>
<td>c</td>
<td>c</td>
<td>c</td>
</tr>
<tr>
<td>( \text{random} )</td>
<td>( \begin{array}{c</td>
<td>c</td>
<td>c</td>
<td>c</td>
</tr>
</tbody>
</table>

\( \beta_{\text{cor}} = 0.25 \), \( \text{basicWork} = 0.2 \); \( R = 0.85 \), \( \text{RR} = 0 \).
cor\_task = 0.25; basic\_Work = 0.2; R = 0.9

<table>
<thead>
<tr>
<th>cor_proc</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>cor_proc</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>R</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>cor_proc</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>R</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \text{ basicWork} = 0.2; R = 0.95 \]

<table>
<thead>
<tr>
<th>( \beta_{bw} )</th>
<th>( \text{cor}_{\text{proc}} = 0 )</th>
<th>( \text{cor}_{\text{proc}} = 0.25 )</th>
<th>( \text{cor}_{\text{proc}} = 0.5 )</th>
<th>( \text{cor}_{\text{proc}} = 0.75 )</th>
<th>( \text{cor}_{\text{proc}} = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0.4</td>
<td>0.6</td>
<td>0.8</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

- \( \text{LowerBound} \)
- \( \text{energy-energy} \)
- \( \text{time-energy} \)
- \( \text{randomShuffling} \)
Energy-aware strategies on heterogeneous platforms

$cor_{task} = 0.25; basicWork = 0.3; R = 0.8$
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.3; \mathcal{R} = 0.85 \]

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.4</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.6</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.8</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>1.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]

\[ \text{ratio to the baseline} \]

\[ \text{LowerBound} \]

\[ \text{energy-energy} \]

\[ \text{energy-time} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]

\[ \text{randomShuffling} \]

scheduling

- LowerBound
- energy-energy
- energy-time
- time-energy
- randomShuffling
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0.25; \ \text{basicWork} = 0.3; \ \mathcal{R} = 0.9

cor\text{proc} = 0

cor\text{proc} = 0.25

cor\text{proc} = 0.5

cor\text{proc} = 0.75

cor\text{proc} = 1

\text{Ratio to the baseline}

\begin{tabular}{cccc}
\text{LowerBound} & \text{energy-energy} & \text{energy-time} & \text{time-energy} & \text{time-time} \\
\text{randomShuffling} & \text{scheduling} & \text{time-energy} & \text{energy-energy} & \text{randomShuffling} \\
\end{tabular}

scheduling

\text{LowerBound} \quad \text{energy-energy} \quad \text{time-time} \\
\text{randomShuffling} \\

RR n° 9221
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.3; R = 0.95 \)

\[
\begin{array}{cccc}
\text{cor}_{\text{proc}} & 0.00 & 0.25 & 0.50 \\
\text{basicWork} & 0.00 & 0.25 & 0.50 \\
R & 0.00 & 0.25 & 0.50 \\
\end{array}
\]
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 0.5; basicWork = 0.1; R = 0.8

<table>
<thead>
<tr>
<th>cor\textsubscript{proc}</th>
<th>0</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(\beta_{bw}\) Ratio to the baseline

LowerBound  energy-energy  time-energy  randomShuffling
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.5; \ \text{basicWork} = 0.1; \ \mathcal{R} = 0.85 \)

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>energy</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>time</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>random</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\[ \text{scheduling: LowerBound} \] \[ \text{energy-energy} \] \[ \text{time-energy} \] \[ \text{randomShuffling} \]
Energy-aware strategies on heterogeneous platforms

cor_task = 0.5; basicWork = 0.1; \( R = 0.9 \)
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0.5; \text{basicWork} = 0.2; \mathcal{R} = 0.8

<table>
<thead>
<tr>
<th>cor\text{proc}</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor\text{proc}</td>
<td>0</td>
<td>0.25</td>
<td>0.5</td>
<td>0.75</td>
<td>1</td>
</tr>
<tr>
<td>cor\text{proc}</td>
<td>0</td>
<td>0.25</td>
<td>0.5</td>
<td>0.75</td>
<td>1</td>
</tr>
</tbody>
</table>

\text{Ratio to the baseline}

\text{LowerBound}

\text{energy-energy}

\text{energy-time}

\text{time-energy}

\text{time-time}

\text{randomShuffling}

\text{scheduling}

- LowerBound
- energy-energy
- energy-time
- time-energy
- time-time
- randomShuffling
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; basicWork = 0.2; R = 0.85
Energy-aware strategies on heterogeneous platforms

cor_task = 0.5; basicWork = 0.2; R = 0.9

Ratio to the baseline

cor_proc = 0

cor_proc = 0.25

cor_proc = 0.5

cor_proc = 0.75

cor_proc = 1

\( \beta' \) / \( \beta \)

deP

dE

deR

scheduling

LowerBound energy-time time-energy energy-energy time-time randomShuffling

RR n 9221

Energy-aware strategies on heterogeneous platforms

100
Energy-aware strategies on heterogeneous platforms

corr_{task} = 0.5; basicWork = 0.2; R = 0.95
Energy-aware strategies on heterogeneous platforms

cor\text{\_task} = 0.5;\ basicWork = 0.3;\ R = 0.8
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Parameter</th>
<th>deP</th>
<th>deR</th>
<th>inE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor proc</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>cor proc</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
<td>1.75</td>
</tr>
<tr>
<td>cor proc</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>cor proc</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
<td>1.75</td>
</tr>
</tbody>
</table>

Ratio to the baseline scheduling

LowerBound energy-energy energy-time time-energy time-time

randomShuffling

βbw

RR n° 9324
cor\textsubscript{task} = 0.5; basic\textit{Work} = 0.3; \mathcal{R} = 0.9

\begin{align*}
\text{cor\textsubscript{proc} = 0} & \quad \text{cor\textsubscript{proc} = 0.25} & \quad \text{cor\textsubscript{proc} = 0.5} & \quad \text{cor\textsubscript{proc} = 0.75} & \quad \text{cor\textsubscript{proc} = 1} \\
\text{Ratio to the baseline} & \quad \text{scheduling} & \quad \text{energy-energy} & \quad \text{energy-time} & \quad \text{time-energy} & \quad \text{time-time} \\
\beta_{bw} & \quad 0.00 & \quad 0.25 & \quad 0.50 & \quad 0.75 & \quad 1.00 \\
\text{Random Shuffling} & \quad \text{basicWork} = 0.3 & \quad \text{R} = 0.9 & \quad \text{randomShuffling} & \quad \text{randomShuffling}
\end{align*}
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0.5; \text{basicWork} = 0.3; \mathcal{R} = 0.95
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.1; R = 0.8 \]

<table>
<thead>
<tr>
<th>\text{cor}_{\text{proc}} = 0</th>
<th>\text{cor}_{\text{proc}} = 0.25</th>
<th>\text{cor}_{\text{proc}} = 0.5</th>
<th>\text{cor}_{\text{proc}} = 0.75</th>
<th>\text{cor}_{\text{proc}} = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{ratio to the baseline}</td>
<td>\text{ratio to the baseline}</td>
<td>\text{ratio to the baseline}</td>
<td>\text{ratio to the baseline}</td>
<td>\text{ratio to the baseline}</td>
</tr>
</tbody>
</table>

\( \beta \) is the weight factor in the objective function.

\( \text{LowerBound} \)

\( \text{energy-energy} \)

\( \text{time-energy} \)

\( \text{randomShuffling} \)
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>deP</th>
<th>deR</th>
<th>inE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Graph deP" /></td>
<td><img src="image2" alt="Graph deR" /></td>
<td><img src="image3" alt="Graph inE" /></td>
<td><img src="image4" alt="Graph random" /></td>
</tr>
<tr>
<td><img src="image1" alt="Graph deP" /></td>
<td><img src="image2" alt="Graph deR" /></td>
<td><img src="image3" alt="Graph inE" /></td>
<td><img src="image4" alt="Graph random" /></td>
</tr>
<tr>
<td><img src="image1" alt="Graph deP" /></td>
<td><img src="image2" alt="Graph deR" /></td>
<td><img src="image3" alt="Graph inE" /></td>
<td><img src="image4" alt="Graph random" /></td>
</tr>
<tr>
<td><img src="image1" alt="Graph deP" /></td>
<td><img src="image2" alt="Graph deR" /></td>
<td><img src="image3" alt="Graph inE" /></td>
<td><img src="image4" alt="Graph random" /></td>
</tr>
<tr>
<td><img src="image1" alt="Graph deP" /></td>
<td><img src="image2" alt="Graph deR" /></td>
<td><img src="image3" alt="Graph inE" /></td>
<td><img src="image4" alt="Graph random" /></td>
</tr>
<tr>
<td><img src="image1" alt="Graph deP" /></td>
<td><img src="image2" alt="Graph deR" /></td>
<td><img src="image3" alt="Graph inE" /></td>
<td><img src="image4" alt="Graph random" /></td>
</tr>
</tbody>
</table>

**Ratio to the baseline**

- deP
- deR
- inE
- random

**Lower Bound**

- energy-energy
- energy-time
- time-energy
- time-time

**Scheduling**

- LowerBound
- energy-energy
- energy-time
- time-energy
- time-time

β [0.0, 0.1]

RR n° 9324
$cor_{task} = 0.75; \ basicWork = 0.1; \ R = 0.9$

![Graph showing energy-efficiency ratios for different cor_{proc} values](image_url)

- $cor_{proc} = 0$
- $cor_{proc} = 0.25$
- $cor_{proc} = 0.5$
- $cor_{proc} = 0.75$
- $cor_{proc} = 1$

Legend:
- LowerBound
- energy-energy
- time-energy
- randomShuffling

Energy-aware strategies on heterogeneous platforms
cor_task = 0.75; basicWork = 0.1; R = 0.95

<table>
<thead>
<tr>
<th>cor_proc</th>
<th>0.00</th>
<th>0.00</th>
<th>0.00</th>
<th>0.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

R = 0.95; cor_task = 0.75; basicWork = 0.1

- LowerBound
- energy-time
- time-energy
- randomShuffling

Energy-aware strategies on heterogeneous platforms
cor\_{\text{task}} = 0.75; \quad \text{basicWork} = 0.2; \quad R = 0.8
$\text{cor}_{\text{task}} = 0.75$; $\text{basicWork} = 0.2$; $R = 0.85$
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0.75; basicWork = 0.2; R = 0.9
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.2; R = 0.95 \)

\[ \frac{\text{cor}_{\text{proc}}}{0.2} \text{ to the baseline} \]

\[ \frac{\text{basicWork}}{0.2} \]

\[ \frac{R}{0.95} \]

\( \text{randomShuffling} \)

\( \text{LowerBound} \)

\( \text{energy-energy} \)

\( \text{energy-time} \)

\( \text{time-energy} \)

\( \text{time-time} \)
cor\textsubscript{task} = 0.75; basic\textsubscript{Work} = 0.3; \mathcal{R} = 0.8
Energy-aware strategies on heterogeneous platforms

cor\_task = 0.75; basic\_Work = 0.3; \( R = 0.85 \)

<table>
<thead>
<tr>
<th>cor_proc</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
</tbody>
</table>

cor\_proc = 0.75; basic\_Work = 0.3; \( R = 0.85 \)

<table>
<thead>
<tr>
<th>cor_proc</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
</tbody>
</table>

cor\_proc = 1; basic\_Work = 0.3; \( R = 0.85 \)

<table>
<thead>
<tr>
<th>cor_proc</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\( \beta_{bw} \)
cor_{task} = 0.75; basicWork = 0.3; R = 0.9

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>1.25</td>
<td>1.00</td>
<td>0.75</td>
<td>0.50</td>
<td>0.25</td>
</tr>
<tr>
<td>0.4</td>
<td>1.00</td>
<td>0.75</td>
<td>0.50</td>
<td>0.25</td>
<td>0.10</td>
</tr>
<tr>
<td>0.6</td>
<td>0.75</td>
<td>0.50</td>
<td>0.25</td>
<td>0.10</td>
<td>0.00</td>
</tr>
<tr>
<td>0.8</td>
<td>0.50</td>
<td>0.25</td>
<td>0.10</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>1.0</td>
<td>0.25</td>
<td>0.10</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Ratio to the baseline

scheduling
- LowerBound
- energy-time
- time-energy
- randomShuffling
Energy-aware strategies on heterogeneous platforms

cor\_task = 0.75; basicWork = 0.3; R = 0.95

cor\_proc = 0

cor\_proc = 0.25

cor\_proc = 0.5

cor\_proc = 0.75

cor\_proc = 1

<table>
<thead>
<tr>
<th>βbw</th>
<th>LowerBound</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>time-time</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
<td>1.40</td>
</tr>
<tr>
<td>0.20</td>
<td>0.40</td>
<td>0.60</td>
<td>0.80</td>
<td>1.00</td>
<td>1.20</td>
<td>1.40</td>
</tr>
<tr>
<td>0.40</td>
<td>0.60</td>
<td>0.80</td>
<td>1.00</td>
<td>1.20</td>
<td>1.40</td>
<td>1.60</td>
</tr>
<tr>
<td>0.60</td>
<td>0.80</td>
<td>1.00</td>
<td>1.20</td>
<td>1.40</td>
<td>1.60</td>
<td>1.80</td>
</tr>
<tr>
<td>0.80</td>
<td>1.00</td>
<td>1.20</td>
<td>1.40</td>
<td>1.60</td>
<td>1.80</td>
<td>2.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.20</td>
<td>1.40</td>
<td>1.60</td>
<td>1.80</td>
<td>2.00</td>
<td>2.20</td>
</tr>
</tbody>
</table>

Correlations and scheduling metrics for different scenarios.
Energy-aware strategies on heterogeneous platforms

corr_{task} = 1; basicWork = 0.1; \mathcal{R} = 0.8

\begin{align*}
corr_{proc} &= 0 \\
corr_{proc} &= 0.25 \\
corr_{proc} &= 0.5 \\
corr_{proc} &= 0.75 \\
corr_{proc} &= 1
\end{align*}

\begin{align*}
\text{Ratio to the baseline} = 1 &; \\
\text{basicWork} = 0.1; \\
\mathcal{R} = 0.8 &; \\
\text{randomShuffling} = 1
\end{align*}

\begin{align*}
\text{scheduling} &; \\
\text{energy-energy} &; \\
\text{time-energy} &; \\
\text{time-time} &;
\end{align*}
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \ \text{basicWork} = 0.1; \ \mathcal{R} = 0.85 \]

\[ \text{cor}_{\text{proc}} = 0 \]

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]

\[ \beta_{b/w} \]

\[ \text{Ratio to the baseline} \]

\[ \text{LowerBound} \]

\[ \text{energy-time} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]

\[ \text{randomShuffling} \]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \text{basicWork} = 0.1; R = 0.9 \]

\[ \text{cor}_{\text{proc}} = 0 \]

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]

\( \beta_{b/w} \)

Ratio to the baseline

- LowerBound
- energy-time
- time-energy
- randomShuffling

0.2 0.4 0.6 0.8 1.0

0.2 0.4 0.6 0.8 1.0
Energy-aware strategies on heterogeneous platforms
cor\textsubscript{task} = 1; basicWork = 0.2; R = 0.8
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
</tr>
<tr>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Figure:**

- **Task:** BasicWork = 0.2, R = 0.85
- **Scheduling:** RandomShuffling

**Legend:**
- Energy
- Time
- Random
- Scheduling
- LowerBound
- Energy
- Time
- Random
- Scheduling

**Notes:**
- $\alpha$ and $\beta$ are parameters affecting task and scheduling decisions.
- The figure compares the performance of different strategies with varying $\alpha$ and $\beta$ values.
$\text{cor}_{\text{task}} = 1$; $\text{basicWork} = 0.2$; $R = 0.9$

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{proc}}$</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

$\beta_{b/w}$

- LowerBound: Red
- energy-time: Green
- time-energy: Blue
- randomShuffling: Purple
$cor_{task} = 1; basicWork = 0.2; R = 0.95$
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_\text{task} = 1; \ \text{basicWork} = 0.3; \ \mathcal{R} = 0.8 \)

\[
\begin{array}{cccc}
\text{cor}_\text{proc} = 0 & \text{cor}_\text{proc} = 0.25 & \text{cor}_\text{proc} = 0.5 & \text{cor}_\text{proc} = 0.75 \\
\text{cor}_\text{proc} = 1 & \text{cor}_\text{proc} = 1 & \text{cor}_\text{proc} = 1 & \text{cor}_\text{proc} = 1
\end{array}
\]
### Energy-aware strategies on heterogeneous platforms

#### Table 1: Performance Comparison

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Energy-Energy</th>
<th>Energy-Time</th>
<th>Time-Energy</th>
<th>Time-Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>doP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>doR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>random</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Figure 1: Graphical Representation

- **Baseline**
- **Energy**
- **Time**
- **Energy-Time**
- **Time-Energy**

**Legend:**
- BasicWork
- RandomSubShuffling
- LowerBound

**Correlations:**
- $\rho_{\text{cor}} = 0$
- $\rho_{\text{cor}} = 0.25$
- $\rho_{\text{cor}} = 0.5$
- $\rho_{\text{cor}} = 0.75$
- $\rho_{\text{cor}} = 1$

**Task Set:** $n^\text{task} = 1$

**Workload:** $\text{BasicWork} = 0.3$, $R = 0.85$
energy-aware strategies on heterogeneous platforms
$cor_{task} = 1; basicWork = 0.3; R = 0.95$

Energy-aware strategies on heterogeneous platforms
Correlation (Mapping)

The following section presents ratio of energy consumption using different mapping strategies under big failure rate, when varying $cor_{proc}$ and $cor_{task}$. 
<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>LowerBound</th>
<th>deP</th>
<th>deR</th>
<th>inE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>energy-energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>energy-time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>randomShuffling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time-energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time-time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( \beta_{\text{in}} = 0.2; \beta_{\text{Work}} = 0.1; R = 0.9 \)

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.2; \text{ basicWork} = 0.1; \mathcal{R} = 0.95 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{b/w}} = 0.2; \text{basic workload} = 0.2; \text{R} = 0.8 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.2; \ basicWork = 0.2; \ R = 0.85 \]

![Graph showing the ratio of energy to baseline for different processor correlations and mapping strategies.](image-url)

- **mapping**: LowerBound, deP, deR, incE, random
Energy-aware strategies on heterogeneous platforms

\[ \beta = 0.2; \text{ basicWork } = 0.3; \quad \mathcal{R} = 0.8 \]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>LowerBound</th>
<th>deP</th>
<th>deR</th>
<th>inE</th>
<th>random</th>
<th>Processor correlation</th>
<th>LowerBound</th>
<th>deP</th>
<th>deR</th>
<th>inE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.25</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>

$\beta_{\text{bw}} = 0.2$, basic work $e = 0.3$, $R = 0.85$

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>LowerBound</th>
<th>deP</th>
<th>deR</th>
<th>inE</th>
<th>random</th>
<th>deP</th>
<th>deR</th>
<th>inE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>energy-energy</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>energy-time</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>randomShuffling</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>time-energy</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>time-time</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Ratio to the baseline

RR n° 9324
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>β</th>
<th>0.4</th>
<th>0.2</th>
<th>0.2</th>
<th>0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation</td>
<td>0.75</td>
<td>0.5</td>
<td>0.25</td>
<td>0.0</td>
</tr>
<tr>
<td>Task correlation</td>
<td>0.75</td>
<td>0.5</td>
<td>0.25</td>
<td>0.0</td>
</tr>
<tr>
<td>Energy correlation</td>
<td>0.75</td>
<td>0.5</td>
<td>0.25</td>
<td>0.0</td>
</tr>
<tr>
<td>Work correlation</td>
<td>0.75</td>
<td>0.5</td>
<td>0.25</td>
<td>0.0</td>
</tr>
</tbody>
</table>

![Graph showing energy-time, randomShuffling, time-energy, time-time correlations]
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

LowerBound

deP

deR

random

deShuffling

time-energy

time-time

energy-energy

energy-time

1.0

0.0

0.25

0.50

0.75

1.00

β_{b/w} = 0.4; basicWork = 0.2; R = 0.85

RR n° 9324
\( \beta_{b/w} = 0.4; \) \( basicWork = 0.2; \) \( R = 0.95 \)
<table>
<thead>
<tr>
<th>Correlation</th>
<th>Energy-Energy</th>
<th>Energy-Time</th>
<th>Random Shuffling</th>
<th>Time-Energy</th>
<th>Time-Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor = 1</td>
<td>0.80</td>
<td>1.10</td>
<td>1.90</td>
<td>2.70</td>
<td>3.60</td>
</tr>
<tr>
<td>cor = 0.75</td>
<td>20.40</td>
<td>20.50</td>
<td>21.20</td>
<td>22.50</td>
<td>24.10</td>
</tr>
<tr>
<td>cor = 0.5</td>
<td>1.00</td>
<td>1.40</td>
<td>1.80</td>
<td>2.60</td>
<td>3.40</td>
</tr>
<tr>
<td>cor = 0.25</td>
<td>1.10</td>
<td>1.60</td>
<td>2.10</td>
<td>2.60</td>
<td>3.30</td>
</tr>
</tbody>
</table>

Processor correlation: Ratio to the baseline

\[ \beta_{\text{corr}} = 0.4; \text{basicWork} = 0.3; R = 0.8 \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

$\beta_{wb} = 0.4$; $\text{basicWork} = 0.3$; $R = 0.85$

![Graph showing processor correlation and ratio to the baseline for different $\text{CORrank}$ values](chart.png)

**Legend:**
- LowerBound
- deP
- deR
- inE
- random
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.4$; $\texttt{basicWork} = 0.3$; $\mathcal{R} = 0.9$

$\texttt{cor}\_\texttt{task} = 0.25$

$\texttt{cor}\_\texttt{task} = 0.5$

$\texttt{cor}\_\texttt{task} = 0.75$

$\texttt{cor}\_\texttt{task} = 1$

$\mathbf{Ratio to the baseline}

Processor correlation

mapping $\texttt{LowerBound}$ $\texttt{deP}$ $\texttt{deR}$ $\texttt{inE}$ $\texttt{random}$
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{io}} = 0.4; \, \text{basicWork} = 0.3; \, R = 0.95 \]
$\beta_{b/w} = 0.6$; $basicWork = 0.1$; $R = 0.8$
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.6; \text{ basicWork} = 0.1; R = 0.85 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{eq}} = 0.6; \text{ basicWork} = 0.1; R = 0.9 \]

\[ \text{Processor correlation} \]

\[ \text{LowerBound} \]

\[ \text{Ratio to the baseline} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{randomShuffling} \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>corr = 1</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>corr = 0.75</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>corr = 0.5</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>corr = 0.25</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>corr = 0</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>

β_b/w = 0.6; basicWork = 0.2; R = 0.8
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms](image-url)
Energy-aware strategies on heterogeneous platforms

\[
\beta_{b/w} = 0.6; \quad basicWork = 0.2; \quad R = 0.9
\]

<table>
<thead>
<tr>
<th>Correlation</th>
<th>( COR_{task} = 0.25 )</th>
<th>( COR_{task} = 0.5 )</th>
<th>( COR_{task} = 0.75 )</th>
<th>( COR_{task} = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy-Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time-Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time-Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>random</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Processor correlation

Ratio to the baseline

\( \beta_{b/w} \) vs. \( COR_{task} \) for different correlation types.

Mapping:
- LowerBound
- deP
- deR
- inE
- random
Energy-aware strategies on heterogeneous platforms

Processor correlation
Ratio to the baseline
lowerBound
deP
deR
random

$\beta_{n_0} = 0.6; \text{basicWork} = 0.2; R = 0.95$
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

mapping

LowerBound

deP
deR

inE

randomShuffling

time-energy
time-time

energy-energy
energy-time

cor	= 0.9

cor	= 0.75
cor	= 0.5

cor	= 0.25

β\text{b/w} = 0.6

basicWork = 0.3

R = 0.8

RR n° 9324
Energy-aware strategies on heterogeneous platforms

Correlation task $= 0.25$.

$\beta_{bw} = 0.6; \text{basicWork} = 0.3; \mathcal{R} = 0.85$.

Ratio to the baseline mapping.
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{ave}} = 0.6, \quad \text{basicVck} = 0.3, \quad R = 0.9 \]

Processor correlation

Ratio to the baseline
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.6$; basicWork = 0.3; $R = 0.95$

![Graph showing energy-time and time-energy ratios for different processor correlations and COF values. The graphs compare the performance of different mapping algorithms, including LowerBound, deP, deR, inE, and random.](image)
Processor correlation

Ratio to the baseline

\[ \frac{\text{basicWork}}{\text{basicWork}} = 0.1; \ R = 0.8 \]

\[ \beta_{V_b} = 0.8; \ \beta_{V_b} = 1; \ R = 0.8 \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.8; \, basicWork = 0.1; \, R = 0.85 \]

\[ \text{mapping} \quad \text{LowerBound} \quad \text{deP} \quad \text{deR} \quad \text{inE} \quad \text{random} \]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Energy-Energy</th>
<th>Energy-Time</th>
<th>RandomShuffling</th>
<th>Time-Energy</th>
<th>Time-Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.80</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
</tr>
<tr>
<td>0.75</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
</tr>
<tr>
<td>0.50</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
</tr>
<tr>
<td>0.25</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
<td>[Graph]</td>
</tr>
</tbody>
</table>

Correlation = \( \beta \) with basic work = 0.1, \( R = 0.9 \)

\[ \beta_{bar} = 0.8, \text{ basic work } = 0.1, R = 0.9 \]
Energy-aware strategies on heterogeneous platforms

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.8; \ basicWork = 0.2; \ R = 0.85 \]

<table>
<thead>
<tr>
<th>( \text{Core Correlation} )</th>
<th>( \text{Time Correlation} )</th>
<th>( \text{Lower Bound} )</th>
<th>( \text{deP} )</th>
<th>( \text{deR} )</th>
<th>( \text{random} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mapping: Lower Bound, deP, deR, inE, random
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.8; \ basicWork = 0.2; \ R = 0.9 \]
Energy-aware strategies on heterogeneous platforms

Processor correlation
Ratio to the baseline
mapping
LowerBound
deP
deR
inE
random

$\beta_{x,y} = 0.8$, basicWorkRate $= 0.2$; $\mathcal{R} = 0.95$

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 1; \ \text{basicWork} = 0.1; \ \mathcal{R} = 0.8 \)
Energy-aware strategies on heterogeneous platforms

- Processor correlation
- Ratio to the baseline
- Lower Bound
- deP
- deR
- inE
- random

- \( \beta_{\text{w}} = 1 \), \( \text{basicWork} = 0.1 \), \( R = 0.85 \)

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 1; \text{basicWork} = 0.1; R = 0.95 \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 1; \text{ basicWork} = 0.2; \mathcal{R} = 0.85 \]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Ratio to the baseline</th>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>energy-energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>energy-time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>randomShuffling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time-energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>time-time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the table, the values for the ratio to the baseline, processor correlation, and the mapping are shown. The processor correlation is shown for different values of \( \beta_{bn} = 1 \) and \( \beta_{bn} = 0.3 \). The mapping is represented with different colors for each processor.
Energy-aware strategies on heterogeneous platforms

1. Energy-energy
2. Energy-time
3. RandomShuffling
4. Time-energy
5. Time-time

Correlation: 0, 0.25, 0.50, 0.75, 1.00

Ratio to the baseline

Processor correlation

β_{b/w} = 1, basicWork = 0.3, R = 0.85
Energy-aware strategies on heterogeneous platforms
Correlation (Scheduling)

The following section presents ratio of energy consumption using different scheduling strategies under big failure rate, when varying $cor_{proc}$ and $cor_{task}$. 
Energy-aware strategies on heterogeneous platforms

![Graph showing energy correlation and time correlation on different processors]

**Processor correlation**
- Ratio to the baseline

**Scheduling**
- Lower bound

**Energy-time**
- Random Shuffling

**Lower bound**

\[ \beta_{\text{L}} = 0.2; \text{ basicWork} = 0.1; R = 0.8 \]

**Comparative Analysis**
- deP
- deR
- inE
- random

**RR n° 9324**
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

scheduling

LowerBound energy-energy
time-energy
time-time
randomShuffling

β_{0,w} = 0.2; basicWork = 0.1; R = 0.85

RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Graph showing processor correlation with varying correlation and ratio to baseline.]

- $\beta_{\text{int}} = 0.2, \beta_{\text{basic}} = 0.1, R = 0.9$
- $\beta_{\text{int}} = 0.1, \beta_{\text{basic}} = 0.1, R = 0.9$
- $\beta_{\text{int}} = 0.0, \beta_{\text{basic}} = 0.1, R = 0.9$

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.2; \text{ basicWork} = 0.1; R = 0.95 \]

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Correlation coefficient</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation coefficient</td>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>Correlation coefficient</td>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>Correlation coefficient</td>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>Correlation coefficient</td>
<td>0.25</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Legend:**
- LowerBound
- energy-time
- time-energy
- randomShuffling

**Note:**
- Processor correlation with \( \beta_{b/w} = 0.2 \);
- basicWork = 0.1;
- \( R = 0.95 \).
$\beta_{b/w} = 0.2$; basicWork = 0.2; $R = 0.8$

Processor correlation

Ratio to the baseline

Energy-aware strategies on heterogeneous platforms
\( \beta_{b/w} = 0.2; \ \text{basicWork} = 0.2; \ \mathcal{R} = 0.85 \)

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>LowerBound</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Processor correlation vs. Ratio to the baseline for different cost functions.

Energy-aware strategies on heterogeneous platforms.
Energy-aware strategies on heterogeneous platforms

![Graph showing process correlation and energy-time ratio]

- Processor correlation
- Ratio to the baseline
- scheduling
- LowerBound
- energy-energy
- energy-time
- time-energy
- time-energy
- random

**Parameters:**
- $\beta_{0, 0.2}$, basicWork = 0.2; $R = 0.9$
- $\beta_{0, 0.2}$, basicWork = 0.2; $R = 0.9$

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>doP</td>
<td>1.25</td>
</tr>
<tr>
<td>doR</td>
<td>1.00</td>
</tr>
<tr>
<td>iaE</td>
<td>1.25</td>
</tr>
<tr>
<td>random</td>
<td>1.00</td>
</tr>
</tbody>
</table>

β_{eff} = 0.2; basic\text{Work} = 0.2; R = 0.95

RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms]

Processor correlation

Ratio to the baseline

scheduling

energy-time

time-energy

time-time

randomShuffling

LowerBound

energy-energy


cor\_task = 0.25\; , basicWork\_work = 0.33\; , R = 0.8

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/\text{loc}} = 0.2; \text{basicWork} = 0.3; R = 0.85 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.2; \text{ basicWork} = 0.3; R = 0.9 \]
Energy-aware strategies on heterogeneous platforms

![Graph showing processor correlation and scheduling for different values of correlation task and correlation ratio to baseline.](image-url)

- \( \beta_{t,a} = 0.2 \); basicWork = 0.3; \( R = 0.95 \)
- \( \beta_{t,a} = 0.75 \); basicWork = 0.3; \( R = 0.95 \)
- \( \beta_{t,a} = 1.0 \); basicWork = 0.3; \( R = 0.95 \)

**Legend:**
- LowerBound
- energy-energy
- time-energy
- energy-time
- randomShuffling
- basicWork
Energy-aware strategies on heterogeneous platforms

---

**Processor correlation**

Ratio to the baseline

- \( \beta_{\text{mix}} = 0.4; \text{basicWork} = 0.1; \text{R} = 0.8 \)

---

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{vec}} = 0.4; \text{basicWork} = 0.1; \ R = 0.85 \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.4; \text{basicWork} = 0.1; R = 0.9 \]

\[ \text{energy-energy, energy-time, time-energy, randomShuffling} \]
$\beta_{b/w} = 0.4; \text{basicWork} = 0.2; R = 0.8$

**Processor correlation**

Ratio to the baseline

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>$\text{cor}_{\text{task}} = 0.25$</th>
<th>$\text{cor}_{\text{task}} = 0.5$</th>
<th>$\text{cor}_{\text{task}} = 0.75$</th>
<th>$\text{cor}_{\text{task}} = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1.10</td>
<td>1.20</td>
<td>1.30</td>
<td>1.40</td>
</tr>
<tr>
<td>0.25</td>
<td>1.20</td>
<td>1.30</td>
<td>1.40</td>
<td>1.50</td>
</tr>
<tr>
<td>0.50</td>
<td>1.30</td>
<td>1.40</td>
<td>1.50</td>
<td>1.60</td>
</tr>
<tr>
<td>0.75</td>
<td>1.40</td>
<td>1.50</td>
<td>1.60</td>
<td>1.70</td>
</tr>
<tr>
<td>1.00</td>
<td>1.50</td>
<td>1.60</td>
<td>1.70</td>
<td>1.80</td>
</tr>
</tbody>
</table>

**Scheduling**

- LowerBound
- energy-energy
- time-energy
- randomShuffling

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

scheduling

LowerBound

time	 energy
time	 energy
time-time
time-energy
energy-energy
energy-time

β = 0.4; basicork = 0.2; R = 0.85

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{u/c} = 0.4; \ \text{basicWork} = 0.2; \ \mathcal{R} = 0.9 \]

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>( \text{energy-energy} )</th>
<th>( \text{energy-time} )</th>
<th>( \text{time-energy} )</th>
<th>( \text{time-time} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Scheduling methods:
- LowerBound
- energy-time
- time-energy
- randomShuffling

Processor correlation to the baseline

\[ \text{random} \]
Energy-aware strategies on heterogeneous platforms

Processor correlation
Ratio to the baseline
LowerBound energy-energy
time-energy
time-time
randomShuffling

\[ \beta_{\text{corr}} = 0.4; \text{basicWork} = 0.2; R = 0.95 \]
Energy-aware strategies on heterogeneous platforms

Correlation to the baseline

Processor correlation

βₜ/ₘ = 0.4; basicWork = 0.3; R = 0.8

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{Processor correlation} \]
\[ \text{Ratio to the baseline} \]

\[ \beta_{\text{bw}} = 0.4; \text{basicWork} = 0.3; \text{R} = 0.85 \]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
<th>scheduling</th>
<th>LowerBound energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>time-time</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
</tr>
<tr>
<td>0.75</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
</tr>
<tr>
<td>0.25</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>0.00</td>
<td>0.25</td>
</tr>
</tbody>
</table>

β_{bw} = 0.4; basicWork = 0.3; R = 0.9
Energy-aware strategies on heterogeneous platforms

[Graphical representation of data showing processor correlation ratios to the baseline for different scheduling methods and correlation values.]

**Legend**: Processor correlation, energy-time, time-energy, energy-energy, random shuffling.

- **Processor correlation**
- **Energy-time**
- **Time-energy**
- **Energy-energy**
- **Random shuffling**

**Graphs**
- **doP**
- **doR**
- **inE**
- **random**
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

LowerBound energy-energy time-energy time-time randomShuffling

scheduling

Processor correlation

LowerBound energy-energy time-energy time-time randomShuffling

β_{b/w} = 0.6; basicWork = 0.1; R = 0.8

RR n° 9324
Energy-aware strategies on heterogeneous platforms

Processor correlation
Ratio to the baseline

scheduling
energy-energy
time-energy
energy-time
time-time
randomShuffling

\[ \beta_{\text{net}} = 0.6; \text{basicWork} = 0.1; R = 0.85 \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Graph showing processor correlation to the baseline for different methods and correlation levels.](image-url)
\( \beta_{b/w} = 0.6; \) basicWork = 0.2; \( R = 0.8 \)
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{b/w}} = 0.6; \ \text{basicWork} = 0.2; \ \mathcal{R} = 0.85 \]

![Graph showing energy-aware strategies on heterogeneous platforms with processor correlation and ratio to the baseline on the x and y axes, respectively. The graph includes different scheduling strategies such as LowerBound, energy-time, time-energy, energy-energy, and randomShuffling.]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>( \beta_{d_R} )</th>
<th>( \beta_{d_P} )</th>
<th>( \beta_{d_E} )</th>
<th>( \beta_{r} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
<td>1.75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( \beta_{d_R} )</th>
<th>( \beta_{d_P} )</th>
<th>( \beta_{d_E} )</th>
<th>( \beta_{r} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
<td>1.75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
</tr>
</tbody>
</table>
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>LowerBound</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>time-time</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>deP</td>
<td>0</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>deR</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>intE</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>random</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

β_int = 0.6; basicWork = 0.2; R = 0.95

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{b/w}} = 0.6; \text{basicWork} = 0.3; R = 0.8 \]

![Graph comparing processor correlation ratio to the baseline for various scheduling strategies and energy consumption models for different correlation factors.](image-url)
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

Processor correlation
Ratio to the baseline
scheduling
LowerBound
energy-energy
energy-time
time-energy
time-time
randomShuffling

\[ \beta_{b,w} = 0.6; \text{ basicVor} = 0.3; \ R = 0.9 \]
\[ \beta_{b/w} = 0.6; \ basicWork = 0.3; \ R = 0.95 \]
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.8; \text{basicWork} = 0.1; R = 0.8 \)
**Energy-aware strategies on heterogeneous platforms**

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
<th>scheduling</th>
<th>LowerBound</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{\text{work}} = 0.8; \text{basicWork} = 0.1; \mathcal{R} = 0.85$</td>
<td>$\sigma_{\text{p}} = 1$</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
<tr>
<td>$\sigma_{\text{p}} = 0.75$</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
</tr>
<tr>
<td>$\sigma_{\text{p}} = 0.5$</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
</tr>
<tr>
<td>$\sigma_{\text{p}} = 0.3$</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
</tr>
<tr>
<td>$\sigma_{\text{p}} = 0.1$</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
</tr>
</tbody>
</table>

RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Graph showing processor correlation ratio to the baseline for different correlation coefficients and scheduling methods.]
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

energy-energy

time-energy

time-time

randomShuffling

βw,b = 0.8; basicWork = 0.1; R = 0.95

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.8; \ basicWork = 0.2; \ R = 0.8 \)
Energy-aware strategies on heterogeneous platforms

\[ \beta_{kn} = 0.8; \text{basicWork} = 0.2; R = 0.85 \]

\[ \text{cor}_{1} = 0.25 \]

\[ \text{cor}_{2} = 0.5 \]

\[ \text{cor}_{3} = 0.75 \]

\[ \text{cor}_{4} = 1.0 \]

\[ \text{cor}_{5} = 1.25 \]

\[ \text{cor}_{6} = 1.5 \]

\[ \text{cor}_{7} = 1.75 \]

\[ \text{cor}_{8} = 2.0 \]

\[ \text{cor}_{9} = 2.25 \]

\[ \text{cor}_{10} = 2.5 \]

\[ \text{cor}_{11} = 2.75 \]

\[ \text{cor}_{12} = 3.0 \]

\[ \text{cor}_{13} = 3.25 \]

\[ \text{cor}_{14} = 3.5 \]

\[ \text{cor}_{15} = 3.75 \]

\[ \text{cor}_{16} = 4.0 \]

\[ \text{cor}_{17} = 4.25 \]

\[ \text{cor}_{18} = 4.5 \]

\[ \text{cor}_{19} = 4.75 \]

\[ \text{cor}_{20} = 5.0 \]

\[ \text{cor}_{21} = 5.25 \]

\[ \text{cor}_{22} = 5.5 \]

\[ \text{cor}_{23} = 5.75 \]

\[ \text{cor}_{24} = 6.0 \]

\[ \text{cor}_{25} = 6.25 \]

\[ \text{cor}_{26} = 6.5 \]

\[ \text{cor}_{27} = 6.75 \]

\[ \text{cor}_{28} = 7.0 \]

\[ \text{cor}_{29} = 7.25 \]

\[ \text{cor}_{30} = 7.5 \]

\[ \text{cor}_{31} = 7.75 \]

\[ \text{cor}_{32} = 8.0 \]

\[ \text{cor}_{33} = 8.25 \]

\[ \text{cor}_{34} = 8.5 \]

\[ \text{cor}_{35} = 8.75 \]

\[ \text{cor}_{36} = 9.0 \]

\[ \text{cor}_{37} = 9.25 \]

\[ \text{cor}_{38} = 9.5 \]

\[ \text{cor}_{39} = 9.75 \]

\[ \text{cor}_{40} = 10.0 \]
### Energy-aware strategies on heterogeneous platforms

#### Processor correlation

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>dsP</strong></td>
<td><img src="image1" alt="Graph" /></td>
</tr>
<tr>
<td><strong>dsR</strong></td>
<td><img src="image2" alt="Graph" /></td>
</tr>
<tr>
<td><strong>ubE</strong></td>
<td><img src="image3" alt="Graph" /></td>
</tr>
<tr>
<td><strong>random</strong></td>
<td><img src="image4" alt="Graph" /></td>
</tr>
</tbody>
</table>

**Notes:**
- \( \beta_{h/w} = 0.8; \) basicWork = 0.2; \( \mathcal{R} = 0.9 \)
- Correlation values: 1, 0.75, 0.5, 0.25

---

**RR n° 9324**
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{b/w}} = 0.8; \ \text{basicWork} = 0.2; \ \mathcal{R} = 0.95 \]
$\beta_{b/w} = 0.8; \ basicWork = 0.3; \ R = 0.8$
Energy-aware strategies on heterogeneous platforms
### Energy-aware strategies on heterogeneous platforms

#### Processor correlation

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>deP</td>
<td>deR</td>
</tr>
<tr>
<td>error = 1</td>
<td>error = 0.75</td>
</tr>
<tr>
<td>( \beta_{\text{in}} = 0.8 )</td>
<td>basicWork = 0.3; ( R = 0.9 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>deP</td>
<td>deR</td>
</tr>
<tr>
<td>error = 1</td>
<td>error = 0.75</td>
</tr>
<tr>
<td>( \beta_{\text{in}} = 0.8 )</td>
<td>basicWork = 0.3; ( R = 0.9 )</td>
</tr>
</tbody>
</table>

**Legend:**
- LowerBound
- energy-energy
- energy-time
- time-energy
- randomShuffling
- time-time
- lowerBound

**Notes:**
- \( \beta_{\text{in}} = 0.8 \)
- basicWork = 0.3
- \( R = 0.9 \)

**References:**
- RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 1; \ basicWork = 0.1; \ R = 0.8 \]
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 1; \ basicWork = 0.1; \ \mathcal{R} = 0.85 \)

- \( \text{COR}_{\text{task}} = 0.25 \)
- \( \text{COR}_{\text{task}} = 0.5 \)
- \( \text{COR}_{\text{task}} = 0.75 \)
- \( \text{COR}_{\text{task}} = 1 \)

\[ \begin{array}{cccccc}
0.00 & 0.25 & 0.50 & 0.75 & 1.00 & 1.25 \\
0.00 & 0.25 & 0.50 & 0.75 & 1.00 & 1.25 \\
0.00 & 0.25 & 0.50 & 0.75 & 1.00 & 1.25 \\
0.00 & 0.25 & 0.50 & 0.75 & 1.00 & 1.25 \\
\end{array} \]
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline
\( \beta b/w = 1; \ \text{basicWork} = 0.1; \ R = 0.95 \)
Energy-aware strategies on heterogeneous platforms

![Graph showing processor correlation and ratio to the baseline for different scenarios](image)

- Processor correlation
- Ratio to the baseline

**Scheduling strategies**
- Energy-energy
- Energy-time
- Time-energy
- RandomShuffling

**Beta values**
- $\beta_{bw} = 1$
- $\beta_{bs} = 0.2$
- $\beta = 0.9$

**Baseline values**
- $R = 0.2$
- $R = 0.9$

**Energy consumption**
- Processor correlation
- Ratio to the baseline

**Legend**
- LowerBound
- energy-energy
- energy-time
- time-energy
- RandomShuffling

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>cor task</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>deP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>deR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iaE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>random</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ratio to the baseline

- LowerBound
- Energy-energy
- Energy-time
- Time-energy
- RandomShuffling

Processor correlation

\[ \beta_{\text{bw}} = 1, \text{ basicWork} = 0.2, R = 0.95 \]
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

scheduling

LowerBound

energy-energy

time-energy

time-time

energy-energy

RandomShuffling

β_{b/w} = 1; basicWork = 0.3; R = 0.8

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>LowerBound</td>
<td>energy-energy</td>
</tr>
</tbody>
</table>

- Processor correlation: $\beta_{bb} = 1$, basicWork = 0.3, $R = 0.9$
- Ratio to the baseline: $\beta_{bb} = 1$, basicWork = 0.3, $R = 0.9$

RR n° 9324
basicWork and $\mathcal{R}$ (Mapping)

The following section presents ratio of energy consumption using different mapping strategies under big failure rate, when varying basicWork and $\mathcal{R}$. 
Energy-aware strategies on heterogeneous platforms

For 

\[ R = 0.85 \]

\[ R = 0.9 \]

\[ R = 0.95 \]

\[ R = 1 \]

\[ \text{cor} \text{ task} = 0.25, \beta \text{uw} = 0.2 \]

\[ \text{Scheduling criteria: time-time} \]

Basic Work

LowerBound
deP
deR
inE
random

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_\text{task} = 0.25; \ \beta_{b/w} = 0.2; \ \text{Scheduling criteria: time-energy} \)

<table>
<thead>
<tr>
<th>R</th>
<th>\text{Ratio to the baseline}</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>0.95</td>
<td></td>
</tr>
</tbody>
</table>

**Basic Work**

<table>
<thead>
<tr>
<th>R</th>
<th>\text{Mapping}</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>LowerBound</td>
</tr>
<tr>
<td>0.85</td>
<td>deP</td>
</tr>
<tr>
<td>0.9</td>
<td>deR</td>
</tr>
<tr>
<td>0.95</td>
<td>inE</td>
</tr>
<tr>
<td></td>
<td>random</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>coR</th>
<th>RR</th>
<th>coR</th>
<th>RR</th>
<th>coR</th>
<th>RR</th>
<th>coR</th>
<th>RR</th>
<th>coR</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0.25</td>
<td>0.25</td>
<td>0.5</td>
<td>0.5</td>
<td>0.75</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

R = 0.95

R = 0.9

R = 0.85

R = 0.8

Basic Work

Mapping

LowerBound

deP

deR

inE

random

β

β

β

β

β

β

β

β

β
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{cost}_{\text{pre}}$</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R = 0.95$</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
<td><img src="image3.png" alt="Graph" /></td>
<td><img src="image4.png" alt="Graph" /></td>
<td><img src="image5.png" alt="Graph" /></td>
</tr>
<tr>
<td>$R = 0.9$</td>
<td><img src="image6.png" alt="Graph" /></td>
<td><img src="image7.png" alt="Graph" /></td>
<td><img src="image8.png" alt="Graph" /></td>
<td><img src="image9.png" alt="Graph" /></td>
<td><img src="image10.png" alt="Graph" /></td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td><img src="image11.png" alt="Graph" /></td>
<td><img src="image12.png" alt="Graph" /></td>
<td><img src="image13.png" alt="Graph" /></td>
<td><img src="image14.png" alt="Graph" /></td>
<td><img src="image15.png" alt="Graph" /></td>
</tr>
<tr>
<td>$R = 0.8$</td>
<td><img src="image16.png" alt="Graph" /></td>
<td><img src="image17.png" alt="Graph" /></td>
<td><img src="image18.png" alt="Graph" /></td>
<td><img src="image19.png" alt="Graph" /></td>
<td><img src="image20.png" alt="Graph" /></td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

LowerBound

dP

dR

$\text{cor}_{\text{task}} = 0.25$, $\beta_{\text{inE}} = 0.2$, Scheduling criteria: energy-energy

RR n° 9324
$cor_{task} = 0.25; \beta_{b/w} = 0.2; \text{Scheduling criteria: randomShuffling}$
$cor_{task} = 0.25; \; \beta_{b/w} = 0.4; \text{Scheduling criteria: time-time}$
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\alpha_{\text{proc}}$</th>
<th>R = 0.95</th>
<th>R = 0.85</th>
<th>R = 0.8</th>
<th>R = 0.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>0.40</td>
<td>0.35</td>
<td>0.40</td>
<td>0.45</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

Mapping

LowerBound

deP

deR

inE

random

Scheduling criteria: time-energy

RR

$n$
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{proc}}$</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R$</td>
<td>0.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R$</td>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R$</td>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R$</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Basic Work**

- Ratio to the baseline
- Mapping
- Lower Bound
dP
- Random
dR
- Task

**Scheduling criteria: energy-time**

- $\text{cor}_{\text{proc}} = 0.25$, $\beta_{\text{w}} = 0.4$
- $\text{cor}_{\text{proc}} = 0.75$
- $\text{cor}_{\text{proc}} = 1$

RR n° 9324
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms
\(\text{cor}_{\text{task}} = 0.25; \beta_{b/w} = 0.6; \) Scheduling criteria: \(\text{time-time}\)

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

![Graph with multiple bars and lines representing different scenarios and parameters.](image)
Energy-aware strategies on heterogeneous platforms

\[ R = \beta \cdot \gamma \]

Basic Work

\[ \text{Ratio to the baseline} \]

Mapping

\[ \text{LowerBound} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]

\[ \text{cor} \]

\[ \text{task} \]

\[ \text{cor}_{\text{task}} = 0.25; \beta_{\text{cor}} = 0.6 \]

\[ \text{Scheduling criteria: energy-time} \]

\[ R = 0.95 \]

\[ R = 0.9 \]

\[ R = 0.85 \]

\[ R = 0.8 \]

\[ \text{Radios to the base} \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Correlation coefficient</th>
<th>Correlation coefficient</th>
<th>Correlation coefficient</th>
<th>Correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.25</td>
<td>0.5</td>
<td>0.75</td>
</tr>
<tr>
<td>Basic Work</td>
<td>Lower Bound</td>
<td>deP</td>
<td>deR</td>
</tr>
</tbody>
</table>

- Correlation coefficient: \( cor_{corr} = 0.25 \), \( \beta_{ll}/u = 0.6 \), Scheduling criteria: energy-energy

RR n° 9324
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{pre}}$</th>
<th>$R$ = 0.95</th>
<th>$R$ = 0.9</th>
<th>$R$ = 0.85</th>
<th>$R$ = 0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{\text{fs}}$ = 0.25</td>
<td>$\beta_{\text{fs}}$ = 0.8</td>
<td>$\beta_{\text{fs}}$ = 0.8</td>
<td>$\beta_{\text{fs}}$ = 0.8</td>
<td>$\beta_{\text{fs}}$ = 0.8</td>
</tr>
<tr>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
</tr>
<tr>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
</tr>
<tr>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
</tr>
<tr>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
<td>$\beta_{\text{bw}}$ = 0.8</td>
</tr>
</tbody>
</table>

Basic Work

Mapping

Lower bound

$R = 0.85$

$R = 0.8$

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\cos \theta_{pr} = 0$</th>
<th>$\cos \theta_{pr} = 0.25$</th>
<th>$\cos \theta_{pr} = 0.5$</th>
<th>$\cos \theta_{pr} = 0.75$</th>
<th>$\cos \theta_{pr} = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R = 0.05$</td>
<td>$R = 0.05$</td>
<td>$R = 0.05$</td>
<td>$R = 0.05$</td>
<td>$R = 0.05$</td>
</tr>
<tr>
<td>$R = 0.10$</td>
<td>$R = 0.10$</td>
<td>$R = 0.10$</td>
<td>$R = 0.10$</td>
<td>$R = 0.10$</td>
</tr>
<tr>
<td>$R = 0.15$</td>
<td>$R = 0.15$</td>
<td>$R = 0.15$</td>
<td>$R = 0.15$</td>
<td>$R = 0.15$</td>
</tr>
<tr>
<td>$R = 0.20$</td>
<td>$R = 0.20$</td>
<td>$R = 0.20$</td>
<td>$R = 0.20$</td>
<td>$R = 0.20$</td>
</tr>
<tr>
<td>$R = 0.25$</td>
<td>$R = 0.25$</td>
<td>$R = 0.25$</td>
<td>$R = 0.25$</td>
<td>$R = 0.25$</td>
</tr>
</tbody>
</table>

Scheduling criteria: energy-time

$\text{cor}_{\text{task}} = 0.25, \beta_{\text{de}} = 0.8, S\text{cheduling criteria: energy-time}$

RR n° 9324
cor_{task} = 0.25; \beta_{b/w} = 0.8; Scheduling criteria: energy-energy
Energy-aware strategies on heterogeneous platforms

\[ R = 0.8, R = 0.9, R = 0.85, R = 0.8 \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ \text{mapping} \]

\[ \text{LowerBound} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]

\[ \beta_{\text{baseline}} = 0.25, \beta_{\text{inE}} = 0.8, \text{Scheduling criteria: randomShuffling} \]

\[ \text{RR} n^9324 \]
Energy-aware strategies on heterogeneous platforms

RR n° 9324
cor_{task} = 0.25; \beta_{b/w} = 1; Scheduling criteria: energy-time

Energy-aware strategies on heterogeneous platforms
\( \text{cor}_{\text{task}} = 0.25; \beta_{b/w} = 1 \); Scheduling criteria: energy-energy

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

[Table or Diagram]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

$cor_{task} = 0.5; \beta_{f,w} = 0.2; Scheduling criteria: time-energy$

Basic Work

Ratio to the baseline

mapping

LowerBound  deP  deR  inE  random
Energy-aware strategies on heterogeneous platforms

RR n° 9324
Energy-aware strategies on heterogeneous platforms
\( cor_{task} = 0.5; \beta_{bw} = 0.2; \) Scheduling criteria: randomShuffling
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\alpha = 0$</th>
<th>$\alpha = 0.25$</th>
<th>$\alpha = 0.5$</th>
<th>$\alpha = 0.75$</th>
<th>$\alpha = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R = 0.8$</td>
<td>$R = 0.85$</td>
<td>$R = 0.9$</td>
<td>$R = 0.95$</td>
<td>$R = 0.97$</td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

Mapping

LowerBound

deP

deR

inE

random

Scheduling criteria: time-time

$\gamma = 0.5$, $\beta^{\frac{1}{3}} = 0.4$
Energy-aware strategies on heterogeneous platforms

\( R = 0.85 \)

\( R = 0.75 \)

\( R = 0.6 \)

\( R = 0.5 \)

\( R = 0.4 \)

\( R = 0.3 \)

\( R = 0.2 \)

\( R = 0.1 \)

Basic Work

Ratio to the baseline

\( \text{cor}_{\text{proc}} = 0 \)

\( \beta_t = 0.5 \)

\( \beta_{t,w} = 0.4 \)

Scheduling criteria: time-energy

\( \text{cor}_{\text{proc}} = 0.25 \)

\( \text{cor}_{\text{proc}} = 0.5 \)

\( \text{cor}_{\text{proc}} = 0.75 \)

\( \text{cor}_{\text{proc}} = 1 \)
\[ \text{Scheduling criteria: energy-time} \]
Energy-aware strategies on heterogeneous platforms

**Diagram Description:**

The diagram presents various scenarios for energy-aware strategies on heterogeneous platforms. Each scenario is represented by a set of data points and lines, indicating different performance metrics such as energy consumption, scheduling criteria, and task allocation. The parameters and metrics used include:

- \( R \) (possibly representing a specific ratio or threshold)
- \( \alpha \), \( \beta \), and \( \gamma \) (coefficients or weights)
- Scheduling criteria: energy-energy

Each scenario is labeled with a different \( \alpha \) value, ranging from 0 to 1, with specific values indicated for each graph. The horizontal axis represents probability, while the vertical axis shows the corresponding performance metrics.

**Key Points:**

- **\( R = 0.95 \):**
- **\( R = 0.9 \):**
- **\( R = 0.85 \):**
- **\( R = 0.8 \):**

The graphs are color-coded, with different shades indicating various experimental conditions or results. The legend at the bottom right corner provides a key for interpreting the data points and lines, with labels such as "Basic Work," "LowerBound," and "Mapping."
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{task}} = 0.5$</th>
<th>$\beta_{\text{w}} = 0.6$</th>
<th>Scheduling criteria: time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{cor}_{\text{pre}} = 0$</td>
<td>$\text{cor}_{\text{pre}} = 0.25$</td>
<td>$\text{cor}_{\text{pre}} = 0.5$</td>
</tr>
<tr>
<td>$\text{cor}_{\text{pre}} = 0.75$</td>
<td>$\text{cor}_{\text{pre}} = 1$</td>
<td>$\text{cor}_{\text{pre}} = 1$</td>
</tr>
</tbody>
</table>

Basic Work: LowerBound, $\text{ach} \text{P}$, $\text{app} \text{L}$}
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{proc}}$</th>
<th>0</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R$</td>
<td>0.95</td>
<td>0.85</td>
<td>0.85</td>
<td>0.85</td>
<td>0.85</td>
</tr>
</tbody>
</table>

**Basic Work**

- $\text{cor}_{\text{task}} = 0.5$, $\beta_{b/w} = 0.6$
- Scheduling criteria: energy-time

- LowerBound
- deP
- deR
- random

RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms](image-url)
Energy-aware strategies on heterogeneous platforms

Basic Work
cor task = 0.5, β_{w} = 0.6, Scheduling criteria: randomShuffling

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ r = 0.8 \]

\[ R_{\text{task}} = 0.5; \beta_{j,w} = 0.8; \text{Scheduling criteria: time-time} \]
Energy-aware strategies on heterogeneous platforms

![Graphical representation of energy-aware strategies on heterogeneous platforms]

- Correlation mapping: $\rho = 0.8$, $\beta_{w} = 0.8$, Scheduling criteria: randomShuffling
- Correlation mapping: $\rho = 0.8$, $\beta_{w} = 0.8$, Scheduling criteria: randomShuffling

RR n° 9324
$corr_{task} = 0.5; \beta_{j,w} = 1$; Scheduling criteria: time-time

![Graph showing energy-aware strategies on heterogeneous platforms](image)

- **Correlation**
- **Baseline Ratio**
- **Mapping**
- **DeP**
- **DeR**
- **InE**
- **Random**
Energy-aware strategies on heterogeneous platforms

Basic Work

Ratio to the baseline

LowerBound
deP
deR
inE
random

cor_
task = 0.5, \beta_{lw} = 1; Scheduling criteria: time-energy

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \beta_{b/w} = 0.2; \text{Scheduling criteria: time-time} \]

![Graph showing energy-aware strategies on heterogeneous platforms]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \; \beta_{b/w} = 0.2; \; \text{Scheduling criteria: energy-energy} \]
Energy-aware strategies on heterogeneous platforms

![Graphical representation of energy-aware strategies on heterogeneous platforms](image)

- $R = 0.85$
- $R = 0.9$
- $R = 0.95$

**Basic Work**

- Task ratio to the baseline
- LowerBound
- deP
- deR
- inE
- random

**Scheduling criteria**

- randomShuffling

**Parameters**

- $\alpha_{\text{task}} = 0.75$
- $\beta_{\text{uw}} = 0.2$

**Mapping**

- Localization

**Reference**

- RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Diagram showing energy-aware strategies on heterogeneous platforms]
$corr_{task} = 0.75$; $\beta_{b/w} = 0.4$; Scheduling criteria: time-energy

<table>
<thead>
<tr>
<th>$R$</th>
<th>0.8</th>
<th>0.85</th>
<th>0.9</th>
<th>0.95</th>
</tr>
</thead>
<tbody>
<tr>
<td>$corr_{proc}$</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>$\beta_{b/w}$</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Scheduling criteria: time-energy
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.75; \ \beta_{\text{b/w}} = 0.4; \ \text{Scheduling criteria: randomShuffling} \)
Energy-aware strategies on heterogeneous platforms

Correlation coefficient between the baseline and the proposed strategy:

- \( R = 0.8 \) for \( \text{cor}_{\text{prev}} = 0 \)
- \( R = 0.9 \) for \( \text{cor}_{\text{prev}} = 0.25 \)
- \( R = 0.95 \) for \( \text{cor}_{\text{prev}} = 0.75 \)
- \( R = 1 \) for \( \text{cor}_{\text{prev}} = 1 \)

Basic Work

Ratio to the baseline

Mapping criteria: time-time

\( R = 0.85 \) for \( \text{cor}_{\text{prev}} = 0.75 \), \( \beta_{\text{bw}} = 0.6 \). Scheduling criteria: time-time
Energy-aware strategies on heterogeneous platforms

\( cor_{task} = 0.75; \beta_{b/w} = 0.6; \) Scheduling criteria: time-energy
Energy-aware strategies on heterogeneous platforms

![Graph showing energy consumption and time for different correlation values and mapping strategies.]

- $r_{corr} = 0.95$
- $r_{corr} = 0.9$
- $r_{corr} = 0.85$
- $r_{corr} = 0.8$

For $r_{corr} = 0.75$, $\beta_{w} = 0.6$, scheduling criteria: energy-time.

Basic Work

LowerBound

dP

dR

$\text{cor}_{\text{task}} = 0.75$
Energy-aware strategies on heterogeneous platforms

\[ R = 0.8 \]

\[ R = 0.9 \]

\[ R = 0.95 \]

\[ \text{cor}_{\text{proc}} = 0 \]

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ \text{mapping} \]

\[ \text{LowerBound} \]

\[ \text{dP} \]

\[ \text{dR} \]

\[ \text{a.R.}, \text{a.S.} \]

\[ \text{task} \]

\[ \text{RR} \]

\[ \text{n} = 9324 \]
energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

![Graph](image-url)
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$cor_{pre} = 0$</th>
<th>$cor_{pre} = 0.25$</th>
<th>$cor_{pre} = 0.5$</th>
<th>$cor_{pre} = 0.75$</th>
<th>$cor_{pre} = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
<tr>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
<td>$R = 0.85$</td>
</tr>
</tbody>
</table>
\[ \text{cor}_{\text{task}} = 0.75; \ \beta_{b/w} = 0.8; \text{Scheduling criteria: energy-energy} \]
Energy-aware strategies on heterogeneous platforms

\[ c_{or, taks} = 0.75; \beta_{b/w} = 0.8; \text{Scheduling criteria: randomShuffling} \]
### Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$R_p$ = 0.05</th>
<th>$R_p$ = 0.10</th>
<th>$R_p$ = 0.20</th>
<th>$R_p$ = 0.25</th>
<th>$R_p$ = 0.30</th>
<th>$R_p$ = 0.35</th>
<th>$R_p$ = 0.40</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{cor}_{\text{map}}$ = 0</td>
<td><img src="image1.png" alt="Graph1" /></td>
<td><img src="image2.png" alt="Graph2" /></td>
<td><img src="image3.png" alt="Graph3" /></td>
<td><img src="image4.png" alt="Graph4" /></td>
<td><img src="image5.png" alt="Graph5" /></td>
<td><img src="image6.png" alt="Graph6" /></td>
<td><img src="image7.png" alt="Graph7" /></td>
</tr>
<tr>
<td>$\text{cor}_{\text{map}}$ = 0.25</td>
<td><img src="image8.png" alt="Graph8" /></td>
<td><img src="image9.png" alt="Graph9" /></td>
<td><img src="image10.png" alt="Graph10" /></td>
<td><img src="image11.png" alt="Graph11" /></td>
<td><img src="image12.png" alt="Graph12" /></td>
<td><img src="image13.png" alt="Graph13" /></td>
<td><img src="image14.png" alt="Graph14" /></td>
</tr>
<tr>
<td>$\text{cor}_{\text{map}}$ = 0.5</td>
<td><img src="image15.png" alt="Graph15" /></td>
<td><img src="image16.png" alt="Graph16" /></td>
<td><img src="image17.png" alt="Graph17" /></td>
<td><img src="image18.png" alt="Graph18" /></td>
<td><img src="image19.png" alt="Graph19" /></td>
<td><img src="image20.png" alt="Graph20" /></td>
<td><img src="image21.png" alt="Graph21" /></td>
</tr>
<tr>
<td>$\text{cor}_{\text{map}}$ = 0.75</td>
<td><img src="image22.png" alt="Graph22" /></td>
<td><img src="image23.png" alt="Graph23" /></td>
<td><img src="image24.png" alt="Graph24" /></td>
<td><img src="image25.png" alt="Graph25" /></td>
<td><img src="image26.png" alt="Graph26" /></td>
<td><img src="image27.png" alt="Graph27" /></td>
<td><img src="image28.png" alt="Graph28" /></td>
</tr>
<tr>
<td>$\text{cor}_{\text{map}}$ = 1</td>
<td><img src="image29.png" alt="Graph29" /></td>
<td><img src="image30.png" alt="Graph30" /></td>
<td><img src="image31.png" alt="Graph31" /></td>
<td><img src="image32.png" alt="Graph32" /></td>
<td><img src="image33.png" alt="Graph33" /></td>
<td><img src="image34.png" alt="Graph34" /></td>
<td><img src="image35.png" alt="Graph35" /></td>
</tr>
</tbody>
</table>

**Note:** The graphs represent the performance of various scheduling strategies under different conditions. The x-axis represents the ratio to the baseline, while the y-axis shows the basic work. The legend includes different strategies such as Basic Work, LowerBound, deP, deR, inE, and random.
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms]

- $R = 0.85$
- $R = 0.9$
- $R = 0.95$
- $R = 0.8$

**Scheduling criteria:** energy-time

**Mapping:**
- Basic Work
- deP
- deR
- inE
- random

**Task Correlation:**
- $cor_{task} = 0.75$
- $\beta_{wu} = 1$

**Correlation Coefficient:**
- $cor_{proc} = 0$
- $cor_{proc} = 0.25$
- $cor_{proc} = 0.5$
- $cor_{proc} = 0.75$
- $cor_{proc} = 1$

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \quad \beta_{b/w} = 1; \] Scheduling criteria: energy-energy

<table>
<thead>
<tr>
<th>R</th>
<th>\text{cor}_{\text{proc}}</th>
<th>\beta_{b/w}</th>
<th>Scheduling criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>0.8</td>
<td>1</td>
<td>energy-energy</td>
</tr>
<tr>
<td>0.9</td>
<td>0.95</td>
<td>1</td>
<td>energy-energy</td>
</tr>
</tbody>
</table>

**Basic Work Ratio to the Baseline**

Mapping:
- LowerBound
- deP
- deR
- inE
- random
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms](image-url)
Energy-aware strategies on heterogeneous platforms

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$cor_{pre}$</th>
<th>$R = 0.5$</th>
<th>$R = 0.9$</th>
<th>$R = 0.85$</th>
<th>$R = 0.8$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$cor_{task} = 0.2$</td>
<td><img src="image1.png" alt="Plot" /></td>
<td><img src="image2.png" alt="Plot" /></td>
<td><img src="image3.png" alt="Plot" /></td>
<td><img src="image4.png" alt="Plot" /></td>
</tr>
<tr>
<td>$cor_{task} = 0.4$</td>
<td><img src="image5.png" alt="Plot" /></td>
<td><img src="image6.png" alt="Plot" /></td>
<td><img src="image7.png" alt="Plot" /></td>
<td><img src="image8.png" alt="Plot" /></td>
</tr>
</tbody>
</table>

$cor_{proc} = 0.10$; $\beta_{bw} = 0.2$; Scheduling criteria: energy-time

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \beta_{b/w} = 0.2; \text{Scheduling criteria: energy-energy} \]
Energy-aware strategies on heterogeneous platforms

\( c_{\text{task}} = 1; \beta_{b/w} = 0.2; \) Scheduling criteria: randomShuffling
Energy-aware strategies on heterogeneous platforms

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|}
\hline
\textbf{cor}_{	ext{pre}} & 0 & 0.25 & 0.5 & 0.75 & 1 \\
\hline
\textbf{R} & 0.85 & 0.85 & 0.85 & 0.85 & 0.85 \\
\hline
\textbf{cor}_{	ext{proc}} & 0 & 0 & 0 & 0 & 0 \\
\hline
\end{tabular}
\end{table}

\textbf{Basic Work}

\textbf{Ratio to the baseline}

\textbf{mapping}

\textbf{LowerBound}

\textbf{deP}

\textbf{deR}

\textbf{inE}

\textbf{random}

\textbf{cor}

\textbf{task} = 1; \beta_{0,n} = 0.4.

Scheduling criteria: time-time

RR n° 9324
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

![Graph showing energy awareness on heterogeneous platforms]

- $R = 0.8$
- $R = 0.9$
- $R = 0.85$
- $R = 0.8$

Scheduling criteria: energy-time

$\text{cor}_{\text{task}} = 1; \beta_{\text{bw}} = 0.4$
### Energy-aware strategies on heterogeneous platforms

#### Table: Basic Work Ratio to the baseline

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{true}}$</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R$</td>
<td>0.8</td>
<td>0.9</td>
<td>0.95</td>
<td>0.85</td>
<td>0.8</td>
</tr>
</tbody>
</table>

#### Diagram: LowerBound, deP, deR, inE, random

- LowerBound (Lower Bound) (red diamonds)
- deP (deferred Processing) (green squares)
- deR (deferred Response) (blue triangles)
- inE (intra-Entity) (purple circles)
- random (random assignment) (black crosses)

- Mapping to the baseline (Baseline Work) (black circles)

#### Scheduling criteria: energy-energy

- $\text{cor}_{\text{true}} = 1$, $\beta_{\text{true}} = 0.4$
- $\text{cor}_{\text{true}} = 1$, $\beta_{\text{true}} = 0.4$
- $\text{cor}_{\text{true}} = 1$, $\beta_{\text{true}} = 0.4$

RR n° 9324
Energy-aware strategies on heterogeneous platforms

RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms with various parameters and metrics.]

*Note*: The graph illustrates the performance of energy-aware strategies across different parameters and metrics, focusing on the ratio of energy consumption to baseline and scheduling criteria such as time-energy balance. The metrics vary with different values of parameters, highlighting the effectiveness of the strategies in various scenarios.
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Correlated Tasks</th>
<th>Correlated Workload</th>
<th>Correlated Mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>R = 0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R = 0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R = 0.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R = 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scheduling criteria: energy-time

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ R = 0.8 \]

\[ cor_{\text{proc}} = 0 \]

\[ cor_{\text{proc}} = 0.25 \]

\[ cor_{\text{proc}} = 0.5 \]

\[ cor_{\text{proc}} = 0.75 \]

\[ cor_{\text{proc}} = 1 \]

Basic Work

\[ \text{Ratio to the baseline} \]

\[ \text{LowerBound} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]

\[ \text{cor}_{\text{task}} = 1; \beta_{\text{bw}} = 0.6; \text{Scheduling criteria: energy-energy} \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 1; \ \beta_{b/w} = 0.6; \text{ Scheduling criteria: randomShuffling} \)

<table>
<thead>
<tr>
<th>K</th>
<th>Mapping</th>
<th>LowerBound</th>
<th>deP</th>
<th>deR</th>
<th>inE</th>
<th>Random</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

Mapping
cor_task = 1; \beta_{b/w} = 0.6; Scheduling criteria: randomShuffling
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \ \beta_{b/w} = 0.8; \text{ Scheduling criteria: time-time} \]

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

- **LowerBound**
- **deP**
- **deR**
- **inE**
- **random**
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{corr}_{\text{proc}}$</th>
<th>$R = 0.85$</th>
<th>$R = 0.9$</th>
<th>$R = 0.95$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{corr}<em>{\text{task}} = 1$, $\beta</em>{0,\text{uw}} = 0.8$, Scheduling criteria: time-energy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RR n° 9324
Energy-aware strategies on heterogeneous platforms

0.90 1.00 1.10 1.30 20.00 20.20 20.30
1.00 1.50 2.10 20.00 20.10 20.30
1.20 2.20 2.90 20.00 20.10 20.40
1.40 2.50 3.60 20.00 20.00 20.80
1.50 2.80 4.00 20.00 20.00 21.50

R = 0.85

cor.proc = 0.25
β.b/w = 0.8; Scheduling criteria: energy-time

cor.proc = 1
β.b/w = 0.8; Scheduling criteria: energy-time

Basic Work

cor.proc = 0.25
β.b/w = 0.8; Scheduling criteria: energy-time

RR n° 9324
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ R = 0.8 \]

\[ R = 0.9 \]

\[ R = 0.95 \]

\[ \text{cor}_{\text{task}} = 1; \ \beta_{0_u} = 0.8; \text{Scheduling criteria: randomShuffling} \]

Basic Work

Mapping LOCALMAPPING

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ R = 0.85 \]

\[ R = 0.8 \]

\[ R = 0.5 \]

\[ R = 0.1 \]

\[ R = 0.05 \]

Correlation to the baseline mapping: \( \beta_{inE} = 1 \), \( \beta_{inE} = 1 \), Scheduling criteria: energy-time

RR n° 9324
basicWork and $\mathcal{R}$ (Scheduling)

The following section presents ratio of energy consumption using different scheduling strategies under big failure rate, when varying basicWork and $\mathcal{R}$. 
$\text{cor}_{\text{task}} = 0.25$; $\beta_{b/w} = 0.2$; Mapping criteria: inE
Energy-aware strategies on heterogeneous platforms

\[ R = 0.8 \]

\[ \text{cor}_{\text{proc}} = 0 \]

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]

\[ \text{cor}_{\text{proc}} = 0 \]
**Energy-aware strategies on heterogeneous platforms**

<table>
<thead>
<tr>
<th>$cor_{pre}$</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R = 0.05$</td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
<td><img src="image3" alt="Graph" /></td>
<td><img src="image4" alt="Graph" /></td>
<td><img src="image5" alt="Graph" /></td>
</tr>
<tr>
<td>$R = 0.10$</td>
<td><img src="image6" alt="Graph" /></td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
<td><img src="image9" alt="Graph" /></td>
<td><img src="image10" alt="Graph" /></td>
</tr>
<tr>
<td>$R = 0.15$</td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graph" /></td>
<td><img src="image13" alt="Graph" /></td>
<td><img src="image14" alt="Graph" /></td>
<td><img src="image15" alt="Graph" /></td>
</tr>
<tr>
<td>$R = 0.20$</td>
<td><img src="image16" alt="Graph" /></td>
<td><img src="image17" alt="Graph" /></td>
<td><img src="image18" alt="Graph" /></td>
<td><img src="image19" alt="Graph" /></td>
<td><img src="image20" alt="Graph" /></td>
</tr>
</tbody>
</table>

Basic Work Ratio to the baseline scheduling

LowerBound energy-energy LowerBound time-energy LowerBound time-time randomShuffling

$\text{cor}_{\text{task}} = 0.25, \beta_{d/u} = 0.2, \text{Mapping criteria: deP}$
Energy-aware strategies on heterogeneous platforms

\[ R = 0.85 \]

\[ R = 0.9 \]

\[ R = 0.95 \]

\[ cor_{p_{\text{max}}} = 0 \]

\[ cor_{p_{\text{max}}} = 0.25 \]

\[ cor_{p_{\text{max}}} = 0.5 \]

\[ cor_{p_{\text{max}}} = 0.75 \]

\[ cor_{p_{\text{max}}} = 1 \]
$\text{cor}_{\text{task}} = 0.25$; $\beta_{b/w} = 0.4$; Mapping criteria: in

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{proc}} = 0.30, 0.40, 0.50, 0.80, 1.00, 1.50, 1.90, 2.30, 2.80, 3.10, 3.30 \]

\[ \text{cor}_{\text{proc}} = 0.85, 0.9, 0.95 \]

\[ \text{cor}_{\text{proc}} = 1 \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ \text{scheduling} \]

\[ \text{LowerBound} \]

\[ \text{energy-energy} \]

\[ \text{energy-time} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]

\[ \text{randomShuffling} \]

\[ \text{cor}_{\text{task}} = 0.25, \beta_{\text{R}} = 0.4 \]

\[ \text{Mapping criteria: deR} \]

\[ \text{RR n}^9 \]

\[ \text{cor}_{\text{proc}} = 0, 0.25, 0.5, 0.75, 1 \]

\[ \text{cor}_{\text{proc}} = 0.25, 0.5, 0.75, 1 \]

\[ \text{cor}_{\text{proc}} = 0.5, 0.75, 1 \]

\[ \text{cor}_{\text{proc}} = 0.75, 1 \]

\[ \text{cor}_{\text{proc}} = 1 \]

\[ \text{cor}_{\text{proc}} = 0.8 \]

\[ \text{cor}_{\text{proc}} = 0.85 \]

\[ \text{cor}_{\text{proc}} = 0.9 \]

\[ \text{cor}_{\text{proc}} = 0.95 \]

\[ \text{cor}_{\text{proc}} = 1 \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

### Table

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$R$</th>
<th>$\text{Basic Work}$</th>
<th>$\text{Ratio to the baseline}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Diagram

The diagrams illustrate the impact of $\text{cor}_{\text{proc}}$ on the energy consumption and efficiency for different values of $R$. Each graph represents a specific value of $\text{cor}_{\text{proc}}$ and $R$, showing the ratio to the baseline in terms of energy and time. The x-axis represents the ratio to the baseline, while the y-axis shows the energy consumption.

### Correlation

- $\text{cor}_{\text{task}} = 0.25$, $\beta_{\text{w}} = 0.4$, Mapping criteria: random
- $\text{cor}_{\text{proc}} = 0, 0.25, 0.5, 0.75, 1$
- $R = 0.5, 0.5, 0.8, 0.85$
Energy-aware strategies on heterogeneous platforms

\[ R = 0.8 \]

\[ R = 0.9 \]

\[ R = 0.85 \]

\[ R = 0.95 \]

Basic Work

\[ \text{Ratio to the baseline} \]

scheduling

LowerBound

energy-energy

time-energy

time-time

randomShuffling

Mapping criteria: inE
Energy-aware strategies on heterogeneous platforms

\[ R = 0.85 \]

\[ \text{cor}_{	ext{proc}} = 0 \]

\[ \text{cor}_{	ext{proc}} = 0.25 \]

\[ \text{cor}_{	ext{proc}} = 0.5 \]

\[ \text{cor}_{	ext{proc}} = 0.75 \]

\[ \text{cor}_{	ext{proc}} = 1 \]

\[ \text{cor}_{\text{task}} = 0.25, \beta_{\text{bw}} = 0.6 \]

\[ \text{Mapping criteria: dep} \]

RR n° 9324
$cor_{task} = 0.25; \beta_{b/w} = 0.6$; Mapping criteria: random

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms]

- $\text{cor}_{\text{proc}} = 0$
- $\text{cor}_{\text{proc}} = 0.25$
- $\text{cor}_{\text{proc}} = 0.5$
- $\text{cor}_{\text{proc}} = 0.75$
- $\text{cor}_{\text{proc}} = 1$

- $R = 0.95$
- $R = 0.9$
- $R = 0.85$
- $R = 0.8$

- Mapping criteria: in $E$

- Correlation of task $\text{cor}_{\text{task}} = 0.25$, $\beta_{\text{inv}} = 0.8$

RR n° 9324
\( \text{cor}_{\text{task}} = 0.25; \beta_{b/w} = 0.8; \text{Mapping criteria: deR} \)

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>\text{Ratio to the baseline}</th>
<th>\text{LowerBound}</th>
<th>\text{energy-energy}</th>
<th>\text{energy-time}</th>
<th>\text{time-energy}</th>
<th>\text{time-time}</th>
<th>\text{randomShuffling}</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>1.25</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.20</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
<td>0.00</td>
</tr>
<tr>
<td>0.50</td>
<td>1.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
<td>0.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.10</td>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
<td>0.45</td>
<td>0.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.05</td>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
<td>0.45</td>
<td>0.50</td>
<td>0.00</td>
</tr>
<tr>
<td>1.25</td>
<td>1.00</td>
<td>0.35</td>
<td>0.40</td>
<td>0.45</td>
<td>0.50</td>
<td>0.55</td>
<td>0.00</td>
</tr>
</tbody>
</table>

\( R = 0.8 \)

\( R = 0.85 \)

\( R = 0.9 \)

\( R = 0.95 \)
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \beta_{b/w} = 0.8; \text{Mapping criteria: random} \]

- \( R = 0.8 \)
- \( R = 0.85 \)
- \( R = 0.9 \)
- \( R = 0.95 \)

\( \text{Basic Work} \)

\( \text{Ratio to the baseline} \)

\[ \text{scheduling} \]

- LowerBound
- energy-energy
- time-time
- energy-time
- time-energy
- randomShuffling
$cor_{task} = 0.25$; $\beta_{b/w} = 1$; Mapping criteria: inE

<table>
<thead>
<tr>
<th>$K$</th>
<th>$cor_{task} = 0.80$</th>
<th>$cor_{task} = 0.85$</th>
<th>$cor_{task} = 0.90$</th>
<th>$cor_{task} = 0.95$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.10</td>
<td>0.20</td>
<td>0.30</td>
<td>0.40</td>
</tr>
<tr>
<td>0.15</td>
<td>0.15</td>
<td>0.25</td>
<td>0.35</td>
<td>0.45</td>
</tr>
<tr>
<td>0.20</td>
<td>0.20</td>
<td>0.30</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
<td>0.35</td>
<td>0.45</td>
<td>0.55</td>
</tr>
<tr>
<td>0.30</td>
<td>0.30</td>
<td>0.40</td>
<td>0.50</td>
<td>0.60</td>
</tr>
<tr>
<td>0.35</td>
<td>0.35</td>
<td>0.45</td>
<td>0.55</td>
<td>0.65</td>
</tr>
<tr>
<td>0.40</td>
<td>0.40</td>
<td>0.50</td>
<td>0.60</td>
<td>0.70</td>
</tr>
<tr>
<td>0.45</td>
<td>0.45</td>
<td>0.55</td>
<td>0.65</td>
<td>0.75</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
<td>0.60</td>
<td>0.70</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms

- LowerBound
- energy-energy
- time-time
- randomShuffling

$R = 0.80$; $R = 0.85$; $R = 0.90$; $R = 0.95$
$cor_{\text{task}} = 0.25; \; \beta_{b/w} = 1; \; \text{Mapping criteria: deR}$

Energy-aware strategies on heterogeneous platforms
### Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$cor_{prex}$</th>
<th>$R = 0.85$</th>
<th>$R = 0.9$</th>
<th>$R = 0.95$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$cor_{task} = 0.25$, $\beta_{w} = 1$; Mapping criteria: deP</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
<td><img src="image3.png" alt="Graph" /></td>
</tr>
</tbody>
</table>

### Basic Work

- Ratio to the baseline

- LowerBound: energy-energy, energy-time, time-energy, randomShuffling

### RR n° 9324
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; \beta_{h,w} = 0.2; Mapping criteria: inE

scheduling

LowerBound  energy-time  time-energy

energy-energy  time-energy  randomShuffling

Basic Work

Ratio to the baseline

LowerBound

energy-time

time-energy

energy-energy

cor_{proc} = 0.25; cor_{proc} = 0.5; cor_{proc} = 0.75; cor_{proc} = 1.0

RR n = 924
### Energy-aware strategies on heterogeneous platforms

Table: 

<table>
<thead>
<tr>
<th>$R_{corr}$</th>
<th>$0.0$</th>
<th>$0.25$</th>
<th>$0.50$</th>
<th>$0.75$</th>
<th>$1.00$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{b/w}$</td>
<td>0.05</td>
<td>0.50</td>
<td>1.00</td>
<td>1.50</td>
<td>2.00</td>
</tr>
</tbody>
</table>

**Mapping criteria:**
- $\alpha = 0.5$
- $\beta_{b/w} = 0.2$

*Task set: $n \leq 9324$*
### Energy-aware strategies on heterogeneous platforms

![Graphs showing energy-aware strategies on heterogeneous platforms](image)

**Table: Basic Work Ratio to the baseline**

<table>
<thead>
<tr>
<th>Mapping criteria: random</th>
<th>cor_{prev} = 0</th>
<th>cor_{prev} = 0.25</th>
<th>cor_{prev} = 0.5</th>
<th>cor_{prev} = 0.75</th>
<th>cor_{prev} = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>R = 0.05</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>R = 0.19</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>R = 0.65</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>R = 0.8</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Diagram:**

- Correlation between energy-time and energy-energy.
- Correlation between energy-time and time-energy.
- Correlation between energy-energy and time-energy.

**Legend:**

- Basic Work
- Ratio to the baseline
- Mapping criteria: random

**Mapping Criteria:**

- Random
- Correlation: 0.5, β_{0,w} = 0.2

**Parameters:**

- corr_shuffling = 0.5, β_{0,w} = 0.2
- corr_{prev} = 0, 0.25, 0.5, 0.75, 1
- R = 0.05, 0.19, 0.65, 0.8
Energy-aware strategies on heterogeneous platforms

\[ R = 0.85 \]

\[ R = 0.9 \]

\[ R = 0.8 \]

\[ \text{cor}_{\text{task}} = 0.5, \beta_b = 0.4 \]

\[ \text{Mapping criteria: inE} \]

\[ \text{Base Work} \]

\[ \text{scheduling} \]

\[ \text{LowerBound} \]

\[ \text{energy-energy} \]

\[ \text{energy-time} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]

\[ \text{randomShuffling} \]

\[ \text{energy-consumption} \]

\[ \text{time-consumption} \]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$cor_{proc} = 0$</th>
<th>$cor_{proc} = 0.25$</th>
<th>$cor_{proc} = 0.5$</th>
<th>$cor_{proc} = 0.75$</th>
<th>$cor_{proc} = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{1} = 0.85$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{2} = 0.85$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{3} = 0.85$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{4} = 0.85$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mapping criteria: $d_{eR}$

RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Graph showing energy efficiency with varying correlation and scheduling strategies.](image-url)
Energy-aware strategies on heterogeneous platforms

![Graph showing energy consumption under different correlation factors and scheduling algorithms.]

- $R_{corr} = 0.95$
- $R_{corr} = 0.9$
- $R_{corr} = 0.85$
- $R_{corr} = 0.8$

- Mapping criteria: random

- Correlation coefficient: 0.5, $\beta_0 = 0.4$

- Baseline Work

- Ratio to the baseline

- LowerBound

- energy-energy

- energy-time

- time-energy

- time-time

- randomShuffling

- lowerBound

- energy-energy

- energy-time

- time-energy

- time-time

- randomShuffling

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.5; \beta_{\text{b/w}} = 0.6; \text{Mapping criteria: inE} \]

<table>
<thead>
<tr>
<th>R</th>
<th>0.8</th>
<th>0.85</th>
<th>0.9</th>
<th>0.95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Work</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
</tr>
<tr>
<td>Task Ratio to the baseline</td>
<td>1.25</td>
<td>1.20</td>
<td>1.15</td>
<td>1.10</td>
</tr>
</tbody>
</table>

\[ R = 0.8 \]
\[ R = 0.85 \]
\[ R = 0.9 \]
\[ R = 0.95 \]

\[ \text{scheduling} \]
- LowerBound
- energy-time
- time-energy
- randomShuffling
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.5; \ \beta_{\text{bw}} = 0.6; \ \text{Mapping criteria: deR} \]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>( R = 0.05 )</th>
<th>( R = 0.15 )</th>
<th>( R = 0.45 )</th>
<th>( R = 0.85 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( corr_{pre} = 0 )</td>
<td>( corr_{pre} = 0.25 )</td>
<td>( corr_{pre} = 0.5 )</td>
<td>( corr_{pre} = 0.75 )</td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

scheduling

LowerBound

energy-energy

time-energy

time-time

randomShuffling

\( corr_{task} = 0.5, \beta_{\text{cr}} = 0.6 \), Mapping criteria: \( \text{deP} \)
$cor_{task} = 0.5; \beta_{j,w} = 0.8; $ Mapping criteria: inE

<table>
<thead>
<tr>
<th>$R$</th>
<th>0.8</th>
<th>0.85</th>
<th>0.9</th>
<th>0.95</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{\text{Basic Work}}{\text{Ratio to the baseline}}$</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms
$\text{cor}_{\text{task}} = 0.5; \beta_{b/w} = 0.8; \text{Mapping criteria: deR}$

<table>
<thead>
<tr>
<th>$R$</th>
<th>$0.8$</th>
<th>$0.85$</th>
<th>$0.9$</th>
<th>$0.95$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{Basic Work}$</td>
<td>$0.10$</td>
<td>$0.15$</td>
<td>$0.20$</td>
<td>$0.25$</td>
</tr>
</tbody>
</table>

$\text{scheduling}$

- LowerBound
- energy-energy
- time-energy
- randomShuffling
$corr_{task} = 0.5; \beta_{b/w} = 0.8$; Mapping criteria: deP
Energy-aware strategies on heterogeneous platforms

\[ r_{task} = 0.5; \beta_{b/w} = 0.8; \text{Mapping criteria: random} \]
Energy-aware strategies on heterogeneous platforms

$\text{cor}_{\text{task}} = 0.5; \beta_{b/w} = 1; \text{Mapping criteria: inE}$
Energy-aware strategies on heterogeneous platforms

$cor_{task} = 0.5; \beta_{b/w} = 1; $ Mapping criteria: deR

![Graph showing energy-aware strategies on heterogeneous platforms](image-url)
cor_{task} = 0.5; \beta_{j,w} = 1; \text{Mapping criteria: } \text{deP}
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

| cor$_{mean}$ | cor$_{var}$ | cor$_{max}$ | cor$_{min}$ | cor$_{p}$
|-------------|-------------|-------------|-------------|-------
| $0.50$      | $0.50$      | $0.70$      | $20.00$     | $20.00$
| $0.50$      | $0.90$      | $1.20$      | $20.00$     | $20.00$
| $0.70$      | $1.30$      | $1.80$      | $20.00$     | $20.10$
| $0.90$      | $1.60$      | $2.20$      | $20.00$     | $20.40$
| $1.20$      | $2.30$      | $3.40$      | $20.00$     | $22.20$
| $20.00$     | $20.00$     | $20.00$     | $20.00$     | $20.00$

$r = 0.85$

$schedulings$

| cor$_{mean}$ | cor$_{var}$ | cor$_{max}$ | cor$_{min}$ | cor$_{p}$
|-------------|-------------|-------------|-------------|-------
| $0.50$      | $0.50$      | $0.70$      | $20.00$     | $20.00$
| $0.50$      | $0.90$      | $1.20$      | $20.00$     | $20.00$
| $0.70$      | $1.30$      | $1.80$      | $20.00$     | $20.10$
| $0.90$      | $1.60$      | $2.20$      | $20.00$     | $20.40$
| $1.20$      | $2.30$      | $3.40$      | $20.00$     | $22.20$
| $20.00$     | $20.00$     | $20.00$     | $20.00$     | $20.00$

$r = 0.85$

$schedulings$

| cor$_{mean}$ | cor$_{var}$ | cor$_{max}$ | cor$_{min}$ | cor$_{p}$
|-------------|-------------|-------------|-------------|-------
| $0.50$      | $0.50$      | $0.70$      | $20.00$     | $20.00$
| $0.50$      | $0.90$      | $1.20$      | $20.00$     | $20.00$
| $0.70$      | $1.30$      | $1.80$      | $20.00$     | $20.10$
| $0.90$      | $1.60$      | $2.20$      | $20.00$     | $20.40$
| $1.20$      | $2.30$      | $3.40$      | $20.00$     | $22.20$
| $20.00$     | $20.00$     | $20.00$     | $20.00$     | $20.00$

$r = 0.85$

$schedulings$

| cor$_{mean}$ | cor$_{var}$ | cor$_{max}$ | cor$_{min}$ | cor$_{p}$
|-------------|-------------|-------------|-------------|-------
| $0.50$      | $0.50$      | $0.70$      | $20.00$     | $20.00$
| $0.50$      | $0.90$      | $1.20$      | $20.00$     | $20.00$
| $0.70$      | $1.30$      | $1.80$      | $20.00$     | $20.10$
| $0.90$      | $1.60$      | $2.20$      | $20.00$     | $20.40$
| $1.20$      | $2.30$      | $3.40$      | $20.00$     | $22.20$
| $20.00$     | $20.00$     | $20.00$     | $20.00$     | $20.00$

$r = 0.85$

$schedulings$

| cor$_{mean}$ | cor$_{var}$ | cor$_{max}$ | cor$_{min}$ | cor$_{p}$
|-------------|-------------|-------------|-------------|-------
| $0.50$      | $0.50$      | $0.70$      | $20.00$     | $20.00$
| $0.50$      | $0.90$      | $1.20$      | $20.00$     | $20.00$
| $0.70$      | $1.30$      | $1.80$      | $20.00$     | $20.10$
| $0.90$      | $1.60$      | $2.20$      | $20.00$     | $20.40$
| $1.20$      | $2.30$      | $3.40$      | $20.00$     | $22.20$
| $20.00$     | $20.00$     | $20.00$     | $20.00$     | $20.00$

$r = 0.85$

$schedulings$

| cor$_{mean}$ | cor$_{var}$ | cor$_{max}$ | cor$_{min}$ | cor$_{p}$
|-------------|-------------|-------------|-------------|-------
| $0.50$      | $0.50$      | $0.70$      | $20.00$     | $20.00$
| $0.50$      | $0.90$      | $1.20$      | $20.00$     | $20.00$
| $0.70$      | $1.30$      | $1.80$      | $20.00$     | $20.10$
| $0.90$      | $1.60$      | $2.20$      | $20.00$     | $20.40$
| $1.20$      | $2.30$      | $3.40$      | $20.00$     | $22.20$
| $20.00$     | $20.00$     | $20.00$     | $20.00$     | $20.00$

$r = 0.85$

$schedulings$
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\rho_{\text{proc}}$</th>
<th>0.0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R = 0.85$</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
<td><img src="image3.png" alt="Graph" /></td>
<td><img src="image4.png" alt="Graph" /></td>
<td><img src="image5.png" alt="Graph" /></td>
</tr>
<tr>
<td>$R = 0.9$</td>
<td><img src="image6.png" alt="Graph" /></td>
<td><img src="image7.png" alt="Graph" /></td>
<td><img src="image8.png" alt="Graph" /></td>
<td><img src="image9.png" alt="Graph" /></td>
<td><img src="image10.png" alt="Graph" /></td>
</tr>
<tr>
<td>$R = 0.95$</td>
<td><img src="image11.png" alt="Graph" /></td>
<td><img src="image12.png" alt="Graph" /></td>
<td><img src="image13.png" alt="Graph" /></td>
<td><img src="image14.png" alt="Graph" /></td>
<td><img src="image15.png" alt="Graph" /></td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

scheduling

LowerBound

energy-energy

time-energy

time-time

Mapping criteria: deR

$\rho_{\text{task}} = 0.75$, $\beta_{\text{pr}} = 0.2$

RR n° 9324
$cor_{task} = 0.75; \beta_{b/w} = 0.2$; Mapping criteria: deP
## Energy-aware strategies on heterogeneous platforms

### Basic Work

<table>
<thead>
<tr>
<th>Task to baseline</th>
<th>Scheduling</th>
<th>LowerBound energy-time</th>
<th>LowerBound energy-energy</th>
<th>LowerBound time-energy</th>
<th>LowerBound time-time</th>
<th>RandomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>0.25</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>0.50</td>
<td>0.25</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.25</td>
<td>0.75</td>
</tr>
<tr>
<td>0.75</td>
<td>0.25</td>
<td>0.25</td>
<td>0.00</td>
<td>0.50</td>
<td>0.25</td>
<td>0.75</td>
</tr>
</tbody>
</table>

### Correlation

- $\text{cor}_{\text{proc}} = 0.85$
- $\text{cor}_{\text{proc}} = 0.75$
- $\text{cor}_{\text{proc}} = 0.65$
- $\text{cor}_{\text{proc}} = 0.55$
- $\text{cor}_{\text{proc}} = 0.45$

### Mapping criteria

- $\text{inE}$
- $\text{mE}$

### Parameters

- $R_n = 0.95$
- $R_n = 0.9$
- $R_n = 0.85$
- $R_n = 0.8$
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.75; \ \beta_{\text{b/w}} = 0.4; \ \text{Mapping criteria: deR} \)

![Graph showing energy and time metrics for different scenarios]

<table>
<thead>
<tr>
<th>R</th>
<th>Schedule</th>
<th>Energy-time</th>
<th>Time-energy</th>
<th>Energy-energy</th>
<th>RandomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>LowerBound</td>
<td>0.50</td>
<td>0.60</td>
<td>0.80</td>
<td>20.00</td>
</tr>
<tr>
<td>0.85</td>
<td></td>
<td>0.40</td>
<td>0.50</td>
<td>0.70</td>
<td>20.10</td>
</tr>
<tr>
<td>0.9</td>
<td></td>
<td>0.30</td>
<td>0.40</td>
<td>0.60</td>
<td>20.20</td>
</tr>
<tr>
<td>0.95</td>
<td></td>
<td>0.20</td>
<td>0.30</td>
<td>0.50</td>
<td>20.30</td>
</tr>
</tbody>
</table>

Basic Work Ratio to the baseline
\( \text{cor}_\text{task} = 0.75; \ \beta_{b/w} = 0.4; \ \text{Mapping criteria: random} \)
Energy-aware strategies on heterogeneous platforms

corr_{task} = 0.75; \beta_{b/w} = 0.6; \text{Mapping criteria: inE}

Basic Work

Ratio to the baseline
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.75; \beta_{b/w} = 0.6; Mapping criteria: deR

![Graph showing energy-efficiency comparison with varying cor_{task} values (R = 0.8, 0.85, 0.9, 0.95).]

- LowerBound
- energy-energy
- time-energy
- randomShuffling

Basic Work Ratio to the baseline
Energy-aware strategies on heterogeneous platforms

\( \rho_{\text{task}} = 0.75; \ \bar{\beta}_{b/w} = 0.6; \) Mapping criteria: deP

<table>
<thead>
<tr>
<th>( R )</th>
<th>( \rho_{\text{corr}} )</th>
<th>( \beta_{\text{b/w}} )</th>
<th>Mapping criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>0.85</td>
<td>0.9</td>
<td>0.95</td>
</tr>
<tr>
<td>( \beta_{\text{b/w}} )</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
</tbody>
</table>

**Basic Work**

- LowerBound
- energy-time
- time-energy
- randomShuffling

**Ratio to the baseline**

- time-energy
- energy-energy
- time-time
- randomShuffling
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \; \beta_{h/w} = 0.6; \; \text{Mapping criteria: random} \]
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 0.75; \beta_{b/w} = 0.8; Mapping criteria: inE
Energy-aware strategies on heterogeneous platforms

\[ cor_{\text{task}} = 0.75; \beta_{b/w} = 0.8; \text{Mapping criteria: deR} \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{Basic Work} = \frac{\text{Ratio to the baseline}}{\text{LowerBound}} \]

- **Task Correlation** ($r_{\text{task}} = 0.75$)
- **Bandwidth** ($\beta_{b/w} = 1$)
- **Mapping Criteria** in $E$

### Diagram

- **Scheduling**
  - LowerBound
  - Energy-Time
  - Time-Time
  - Energy-Energy
  - Time-Energy
  - Random Shuffling

### Table

<table>
<thead>
<tr>
<th>$R$</th>
<th>$\sigma_{\text{proc}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>0.85</td>
<td>0.85</td>
</tr>
<tr>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>0.95</td>
<td>0.95</td>
</tr>
</tbody>
</table>
$\text{cor}_{\text{task}} = 0.75$; $\beta_{b/w} = 1$; Mapping criteria: deP

Energy-aware strategies on heterogeneous platforms
## Energy-aware strategies on heterogeneous platforms

### Table

<table>
<thead>
<tr>
<th>cor prev</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>R = 0.05</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>R = 0.10</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>R = 0.15</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>R = 0.20</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
</tbody>
</table>

### Diagram

[Graph showing energy consumption across different scenarios]
Energy-aware strategies on heterogeneous platforms

\[ cor_{task} = 1; \beta_{b/w} = 0.2; \text{Mapping criteria: inE} \]

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>Scheduling</th>
<th>LowerBound</th>
<th>Energy-Time</th>
<th>Time-Energy</th>
<th>RandomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.10</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>0.10</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>0.20</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>0.30</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>0.40</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>

cor proc = 0.25; cor proc = 0.5; cor proc = 0.75; cor proc = 1.0
Energy-aware strategies on heterogeneous platforms

\( cor_{task} = 1; \beta_{b/w} = 0.2; \) Mapping criteria: deR

![Graph showing energy-aware strategies on heterogeneous platforms](image-url)

- LowerBound
- energy-energy
- time-energy
- randomShuffling

Basic Work Ratio to the baseline

task \( = 1; \beta_{b/w} = 0.2; \) Mapping criteria: deR

\( \mathcal{R} = 0.8 \)  \( \mathcal{R} = 0.85 \)  \( \mathcal{R} = 0.9 \)  \( \mathcal{R} = 0.95 \)
$\text{cor}_{\text{task}} = 1; \beta_{b/w} = 0.2; \text{Mapping criteria: deP}$
Energy-aware strategies on heterogeneous platforms

![Graphs showing energy-time and time-energy trade-offs for different values of \( \rho_{\text{proc}} \) and mapping criteria]

- \( \rho_{\text{proc}} = 0 \)
- \( \rho_{\text{proc}} = 0.25 \)
- \( \rho_{\text{proc}} = 0.5 \)
- \( \rho_{\text{proc}} = 0.75 \)
- \( \rho_{\text{proc}} = 1 \)

**Mapping criteria:** random

**R**: Rate of the baseline

**Task**: Basic Work

**Scheduling**
- LowBound
- EnergyTime
- RandomShuffling

**LowerBound energy-time**

**Time-energy**

**Energy-time**

**Time-time**

**RandomShuffling**

**Baseline**

**Ratio to the baseline**

\[ R = \text{cor}_{\text{proc}} = \beta_{\text{bw}} = 0.2; \text{Mapping criteria: random} \]

\[ R = 0.5 \]

\[ R = 0.8 \]

**RR n° 9324**
cor_task = 1; \beta_{b/w} = 0.4; Mapping criteria: deR

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ R = 0.85 \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ s_{\text{lower bound}} \]

\[ \text{energy-energy} \]

\[ \text{energy-time} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]

\[ \text{randomShuffling} \]

\[ \text{Mapping criteria: deP} \]

\[ \text{cor}_{\text{prex}} = 0 \]

\[ \text{cor}_{\text{prex}} = 0.25 \]

\[ \text{cor}_{\text{prex}} = 0.5 \]

\[ \text{cor}_{\text{prex}} = 0.75 \]

\[ \text{cor}_{\text{prex}} = 1 \]

\[ \text{cor}_{\text{ex}} = 1; \beta_{\text{var}} = 0.4; \text{Mapping criteria: deP} \]

\[ R = 0.95 \]

\[ R = 0.9 \]

\[ R = 0.8 \]

\[ R = 0.75 \]

\[ R = 0.5 \]

\[ R = 0.4 \]

\[ R = 0.3 \]

\[ R = 0.2 \]

\[ R = 0.1 \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ s_{\text{lower bound}} \]

\[ \text{energy-energy} \]

\[ \text{energy-time} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]

\[ \text{randomShuffling} \]

\[ \text{Mapping criteria: deP} \]

\[ \text{cor}_{\text{prex}} = 0 \]

\[ \text{cor}_{\text{prex}} = 0.25 \]

\[ \text{cor}_{\text{prex}} = 0.5 \]

\[ \text{cor}_{\text{prex}} = 0.75 \]

\[ \text{cor}_{\text{prex}} = 1 \]

\[ \text{cor}_{\text{ex}} = 1; \beta_{\text{var}} = 0.4; \text{Mapping criteria: deP} \]

\[ R = 0.95 \]

\[ R = 0.9 \]

\[ R = 0.8 \]

\[ R = 0.75 \]

\[ R = 0.5 \]

\[ R = 0.4 \]

\[ R = 0.3 \]

\[ R = 0.2 \]

\[ R = 0.1 \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ s_{\text{lower bound}} \]

\[ \text{energy-energy} \]

\[ \text{energy-time} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]

\[ \text{randomShuffling} \]

\[ \text{Mapping criteria: deP} \]

\[ \text{cor}_{\text{prex}} = 0 \]

\[ \text{cor}_{\text{prex}} = 0.25 \]

\[ \text{cor}_{\text{prex}} = 0.5 \]

\[ \text{cor}_{\text{prex}} = 0.75 \]

\[ \text{cor}_{\text{prex}} = 1 \]

\[ \text{cor}_{\text{ex}} = 1; \beta_{\text{var}} = 0.4; \text{Mapping criteria: deP} \]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>cor_{prex} = 0</th>
<th>cor_{prex} = 0.25</th>
<th>cor_{prex} = 0.5</th>
<th>cor_{prex} = 0.75</th>
<th>cor_{prex} = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>R = 0.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor_{post} = 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor_{task} = 1; β_{bw} = 0.4</td>
<td>Mapping criteria: random</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work: scheduling, energy-time, energy-energy, time-energy, task-shuffling.

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \ \beta_{b/w} = 0.6; \ \text{Mapping criteria: inE} \]

...
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 1; \beta_{b/w} = 0.6; Mapping criteria: deR

Basic Work

Ratio to the baseline

scheduling
LowerBound  energy-time  time-energy
energy-energy  time-energy  randomShuffling
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \beta_{b/w} = 0.6; \text{Mapping criteria: random} \]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>( \text{corr}_{\text{proc}} = 0 )</th>
<th>( \text{corr}_{\text{proc}} = 0.25 )</th>
<th>( \text{corr}_{\text{proc}} = 0.5 )</th>
<th>( \text{corr}_{\text{proc}} = 0.75 )</th>
<th>( \text{corr}_{\text{proc}} = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R = 0.05 )</td>
<td>( R = 0.05 )</td>
<td>( R = 0.05 )</td>
<td>( R = 0.05 )</td>
<td>( R = 0.05 )</td>
</tr>
<tr>
<td>( R = 0.10 )</td>
<td>( R = 0.10 )</td>
<td>( R = 0.10 )</td>
<td>( R = 0.10 )</td>
<td>( R = 0.10 )</td>
</tr>
<tr>
<td>( R = 0.15 )</td>
<td>( R = 0.15 )</td>
<td>( R = 0.15 )</td>
<td>( R = 0.15 )</td>
<td>( R = 0.15 )</td>
</tr>
<tr>
<td>( R = 0.20 )</td>
<td>( R = 0.20 )</td>
<td>( R = 0.20 )</td>
<td>( R = 0.20 )</td>
<td>( R = 0.20 )</td>
</tr>
<tr>
<td>( R = 0.25 )</td>
<td>( R = 0.25 )</td>
<td>( R = 0.25 )</td>
<td>( R = 0.25 )</td>
<td>( R = 0.25 )</td>
</tr>
<tr>
<td>( R = 0.30 )</td>
<td>( R = 0.30 )</td>
<td>( R = 0.30 )</td>
<td>( R = 0.30 )</td>
<td>( R = 0.30 )</td>
</tr>
</tbody>
</table>

\( \text{corr}_{\text{task}} = 1; \beta_{0} = 0.8; \text{Mapping criteria: inE} \)

Basic Work

Ratio to the baseline

scheduling

Lower Bound

time-energy

time-energy

time-energy

time-energy

\( \text{Basic Work} \)
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 1; \beta_{b/w} = 0.8; Mapping criteria: deR
energy-aware strategies on heterogeneous platforms

cost = 1; \beta_{b/w} = 0.8; Mapping criteria: deP

scheduling

LowerBound  energy-energy  time-energy
energy-time  time-time  randomShuffling
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms. The graph includes several plots with varying correlation coefficients (\(R = 0.95\), \(R = 0.9\), \(R = 0.85\), \(R = 0.8\)) and mapping criteria (random, random, random, random). Each plot compares different scheduling strategies (Best Work, LowerBound, energy-time, time-energy, randomShuffling) against a baseline. The x-axis represents the ratio to the baseline, while the y-axis shows the energy consumption or time. The correlation parameters are denoted as \(corr_{task} = 1\), \(\beta_{wu} = 0.8\).]
Energy-aware strategies on heterogeneous platforms

$cor_{task} = 1; \beta_{b/w} = 1; \text{Mapping criteria: } inE$

Basic Work

Ratio to the baseline

LowerBound  energy-time  time-energy

energy-energy  time-energy  randomShuffling

$R = 0.8$

$R = 0.85$

$R = 0.9$

$R = 0.95$

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

![Graph](image-url)
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 1; \ \beta_{b/w} = 1; \ \text{Mapping criteria: deP} \)

<table>
<thead>
<tr>
<th>cor_{task}</th>
<th>0.8</th>
<th>0.85</th>
<th>0.9</th>
<th>0.95</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.8</td>
<td>0.85</td>
<td>0.9</td>
<td>0.95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
<th>1.25</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Ratio to the baseline</th>
<th>0.10</th>
<th>0.15</th>
<th>0.20</th>
<th>0.25</th>
<th>0.30</th>
<th>0.35</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>scheduling</th>
<th>LowerBound</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>randomShuffling</th>
</tr>
</thead>
</table>
$\beta_{b/w}$ (Mapping)

The following section presents ratio of energy consumption using different mapping strategies under small failure rate when varying $\beta_{b/w}$. 
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0; \text{basicWork} = 0.1; R = 0.9 \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

corr_{task} = 0; basicWork = 0.1; R = 0.94
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\( cor_{\text{task}} = 0; \) basicWork = 0.2; \( R = 0.9 \)

- \( cor_{\text{proc}} = 0 \)
- \( cor_{\text{proc}} = 0.25 \)
- \( cor_{\text{proc}} = 0.5 \)
- \( cor_{\text{proc}} = 0.75 \)
- \( cor_{\text{proc}} = 1 \)

Ratio to the baseline

\( \beta_{b/w} \)

mapping
- LowerBound
- deP
- deR
- inE
- random
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th></th>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_{\text{proc}}$ = 1</td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
<td><img src="image3" alt="Graph" /></td>
<td><img src="image4" alt="Graph" /></td>
<td><img src="image5" alt="Graph" /></td>
</tr>
<tr>
<td>$\alpha_{\text{proc}}$ = 0.75</td>
<td><img src="image6" alt="Graph" /></td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
<td><img src="image9" alt="Graph" /></td>
<td><img src="image10" alt="Graph" /></td>
</tr>
<tr>
<td>$\alpha_{\text{proc}}$ = 0.5</td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graph" /></td>
<td><img src="image13" alt="Graph" /></td>
<td><img src="image14" alt="Graph" /></td>
<td><img src="image15" alt="Graph" /></td>
</tr>
<tr>
<td>$\alpha_{\text{proc}}$ = 0.25</td>
<td><img src="image16" alt="Graph" /></td>
<td><img src="image17" alt="Graph" /></td>
<td><img src="image18" alt="Graph" /></td>
<td><img src="image19" alt="Graph" /></td>
<td><img src="image20" alt="Graph" /></td>
</tr>
</tbody>
</table>

- $\beta_{\text{b/w}}$: Ratio to the baseline
- $\text{mapping}$: LowerBound, $\text{deP}$, $\text{deR}$, $\text{inE}$, random

$\text{cor} = 0, \text{basicWork} = 0.2; R = 0.92$
$\text{cor}_{\text{task}} = 0; \text{basicWork} = 0.2; R = 0.94$

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

Cor

Proc

= 0

BasicWork

= 0.2, R = 0.96

RR n° 9324
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0; basicWork = 0.2; R = 0.98

\[ \text{Ratio to the baseline} \]

\[ \beta_{w} \]

mapping

LowerBound  deP  deR  inE  random
cor_{task} = 0; basicWork = 0.3; R = 0.9
Energy-aware strategies on heterogeneous platforms
$\text{cor}_{\text{task}} = 0$; $\text{basicWork} = 0.3$; $R = 0.94$
$cor_{task} = 0; basicWork = 0.3; R = 0.98$
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0.25; basicWork = 0.1; \mathcal{R} = 0.9
$\text{cor}_{\text{task}} = 0.25$; $\text{basicWork} = 0.1$; $\mathcal{R} = 0.92$
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.25; basicWork = 0.1; \mathcal{R} = 0.98
Energy-aware strategies on heterogeneous platforms

$cor_{task} = 0.25; basicWork = 0.2; R = 0.9$
$cor_{task} = 0.25; \ basicWork = 0.2; \ R = 0.92$

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_task = 0.25; basicWork = 0.2; R = 0.94

cor_proc = 0  

cor_proc = 0.25  

cor_proc = 0.5  

cor_proc = 0.75  

cor_proc = 1  

deP mapping
$\text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.2; \mathcal{R} = 0.96$

mapping
  - LowerBound
  - deP
  - deR
  - inE
  - random
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_\text{task} = 0.25; \text{basicWork} = 0.2; \mathcal{R} = 0.98 \)
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \quad \text{basicWork} = 0.3; \quad R = 0.92 \]

\[ \text{cor}_{\text{proc}} = 0; \quad \text{cor}_{\text{proc}} = 0.25; \quad \text{cor}_{\text{proc}} = 0.5; \quad \text{cor}_{\text{proc}} = 0.75; \quad \text{cor}_{\text{proc}} = 1 \]

Ratio to the baseline

\[ \beta_{b/w} \]

LowerBound, deR, inE, random
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.25 \); \( \text{basicWork} = 0.3 \); \( \mathcal{R} = 0.94 \)
Energy-aware strategies on heterogeneous platforms

cor_task = 0.25; basicWork = 0.3; \( R = 0.96 \)
\[ \text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.3; R = 0.98 \]

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Ratio to the baseline</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>energy-energy</td>
<td>energy-time</td>
<td>randomShuffling</td>
<td>time-energy</td>
<td>time-time</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\beta$</th>
<th>$b/w$</th>
<th>$\Delta$</th>
<th>$\Delta_{deP}$</th>
<th>$\Delta_{deR}$</th>
<th>$\Delta_{inE}$</th>
<th>$\Delta_{random}$</th>
<th>$\Delta_{task}$</th>
<th>$\Delta_{basicWork}$</th>
<th>$\Delta_{R}$</th>
<th>$\Delta_{R'}$</th>
<th>$\Delta_{RR_n}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
<td>1.50</td>
<td>1.75</td>
<td>2.00</td>
<td>2.25</td>
<td>2.50</td>
<td>2.75</td>
</tr>
</tbody>
</table>

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.5; \text{basicWorking} = 0.1; R = 0.92 \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.5; \text{basicWork} = 0.1; R = 0.96 \)

<table>
<thead>
<tr>
<th>( \text{cor}_{\text{proc}} )</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
<th>1.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ratio to the baseline**

mapping: LowerBound, deP, deR, inE, random

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; basicWork = 0.1; R = 0.98
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.5; \text{basicWork} = 0.2; \mathcal{R} = 0.9 \)

<table>
<thead>
<tr>
<th>cor_{proc} = 0</th>
<th>cor_{proc} = 0.25</th>
<th>cor_{proc} = 0.5</th>
<th>cor_{proc} = 0.75</th>
<th>cor_{proc} = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1.25</td>
<td>1.25</td>
<td>1.25</td>
<td>1.25</td>
<td>1.25</td>
</tr>
</tbody>
</table>

\( \beta_{bw} \)

Ratio to the baseline

Energy-energy

Energy-time

randomShuffling

time-energy

time-time

1

mapping

LowerBound  deP  deR  inE  random
Energy-aware strategies on heterogeneous platforms

$\text{cor}_{\text{task}} = 0.5; \text{basicWork} = 0.2; \mathcal{R} = 0.92$
energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.5; \; \text{basicWork} = 0.2; \; R = 0.94 \]
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; basicWork = 0.2; R = 0.96
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Mapping</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor proc = 1</td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
<td><img src="image3" alt="Graph" /></td>
<td><img src="image4" alt="Graph" /></td>
<td><img src="image5" alt="Graph" /></td>
</tr>
<tr>
<td>cor proc = 0.75</td>
<td><img src="image6" alt="Graph" /></td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
<td><img src="image9" alt="Graph" /></td>
<td><img src="image10" alt="Graph" /></td>
</tr>
<tr>
<td>cor proc = 0.5</td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graph" /></td>
<td><img src="image13" alt="Graph" /></td>
<td><img src="image14" alt="Graph" /></td>
<td><img src="image15" alt="Graph" /></td>
</tr>
<tr>
<td>cor proc = 0.25</td>
<td><img src="image16" alt="Graph" /></td>
<td><img src="image17" alt="Graph" /></td>
<td><img src="image18" alt="Graph" /></td>
<td><img src="image19" alt="Graph" /></td>
<td><img src="image20" alt="Graph" /></td>
</tr>
<tr>
<td>cor proc = 0</td>
<td><img src="image21" alt="Graph" /></td>
<td><img src="image22" alt="Graph" /></td>
<td><img src="image23" alt="Graph" /></td>
<td><img src="image24" alt="Graph" /></td>
<td><img src="image25" alt="Graph" /></td>
</tr>
</tbody>
</table>

Ratio to the baseline

- $\beta_{b/w}$
- LowerBound
- $\beta_{R}$
- $\beta_{R_{n}}$
- $\beta_{R_{n}}$

BasicWork $= 0.2$, $R = 0.98$

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th></th>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>corproc = 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>corproc = 0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>corproc = 0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>corproc = 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ratio to the baseline

- 1.25
- 1.00
- 0.75
- 0.50
- Lower Bound

β

b/w mapping

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor proc = 0</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>cor proc = 0.25</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>cor proc = 0.5</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>cor proc = 0.75</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Ratio to the baseline

- lowerBound
- deP
- deR
- inE
- random

$\beta_{b/w}$

RR n° 9324
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

[Graph showing energy-time and time-energy mappings with varying parameters]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.1; R = 0.92 \]

\[ \text{cor}_{\text{proc}} = 0 \]
\[ \text{cor}_{\text{proc}} = 0.25 \]
\[ \text{cor}_{\text{proc}} = 0.5 \]
\[ \text{cor}_{\text{proc}} = 0.75 \]
\[ \text{cor}_{\text{proc}} = 1 \]

Ratio to the baseline

\[ \beta_{\text{b/w}} \]

mapping
- LowerBound
- deP
- deR
- minE
- random

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.1; R = 0.94 \]

**Diagram:**
- \( \text{cor}_{\text{proc}} = 0 \)
- \( \text{cor}_{\text{proc}} = 0.25 \)
- \( \text{cor}_{\text{proc}} = 0.5 \)
- \( \text{cor}_{\text{proc}} = 0.75 \)
- \( \text{cor}_{\text{proc}} = 1 \)

**Legend:**
- LowerBound
- deP
- deR
- inE
- random

**Note:**
- \( \beta \) is a parameter related to performance.
- \( R \) represents the efficiency of energy management.
- The diagram illustrates the ratio to the baseline for different mapping strategies.
$corr_{task} = 0.75; basicWork = 0.1; \mathcal{R} = 0.98$
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \ \text{basicWork} = 0.2; \ R = 0.9 \]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \; \text{basicWork} = 0.2; \; R = 0.92 \]

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
<tr>
<td>b/w</td>
<td>0.00</td>
<td>0.20</td>
<td>0.40</td>
<td>0.60</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Legend:
- LowerBound
- dP
- deR
- inE
- random
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[
cor_{task} = 0.75; \quad basicWork = 0.2; \quad R = 0.96
\]

<table>
<thead>
<tr>
<th>cor_{proc} = 0</th>
<th>cor_{proc} = 0.25</th>
<th>cor_{proc} = 0.5</th>
<th>cor_{proc} = 0.75</th>
<th>cor_{proc} = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>[\beta_{b/w}]</td>
<td>[\beta_{b/w}]</td>
<td>[\beta_{b/w}]</td>
<td>[\beta_{b/w}]</td>
<td>[\beta_{b/w}]</td>
</tr>
</tbody>
</table>

Ratio to the baseline

Mapping: LowerBound, deP, deR, inE, random
$cor_{task} = 0.75$; $basicWork = 0.2$; $R = 0.98$
\( \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.3; R = 0.9 \)
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 0.75; basicWork = 0.3; R = 0.92

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{chart.png}
\caption{Comparison of energy efficiency for different correlation values and mapping strategies.}
\end{figure}

\textit{Mapping Strategies:}
- LowerBound
- deP
- deR
- inE
- random
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_\text{task} = 0.75; \text{basicWork} = 0.3; R = 0.94 \)

<table>
<thead>
<tr>
<th>( \text{cor}_\text{proc} )</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( \beta_{\text{hi}}/\beta_{\text{lo}} )</th>
<th>0.2</th>
<th>0.4</th>
<th>0.6</th>
<th>0.8</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mapping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LowerBound</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>deP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>deR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>random</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
\[ \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.3; \mathcal{R} = 0.96 \]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \quad \text{basicWork} = 0.3; \quad R = 0.98 \]
\( cor_{\text{task}} = 1; \) \( basicWork = 0.1; \) \( R = 0.92 \)
$$cor_{\text{task}} = 1; \text{basicWork} = 0.1; R = 0.94$$
Energy-aware strategies on heterogeneous platforms

![Diagram showing energy-efficiency metrics for different strategies and configurations.](image)

- **cor proc** = 0.25
- **cor proc** = 0.5
- **cor proc** = 0.75
- **cor proc** = 1

**Ratio to the baseline**

- **basicWork** = 0.1
- **R** = 0.98

**RR n° 9324**
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \text{basicWork} = 0.2; R = 0.9 \]

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>0</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
</table>

\[ \text{cor}_{\text{proc}} = 0 \]
\[ \text{cor}_{\text{proc}} = 0.25 \]
\[ \text{cor}_{\text{proc}} = 0.50 \]
\[ \text{cor}_{\text{proc}} = 0.75 \]
\[ \text{cor}_{\text{proc}} = 1 \]

Mapping LowerBound \( \text{deP} \) \( \text{deR} \) \( \text{inE} \) random

Energy-aware strategies on heterogeneous platforms

RR n° 9231
Energy-aware strategies on heterogeneous platforms

\[ cor_{\text{task}} = 1; \; basicWork = 0.2; \; R = 0.92 \]

\[ cor_{\text{proc}} = 0 \]
\[ cor_{\text{proc}} = 0.25 \]
\[ cor_{\text{proc}} = 0.5 \]
\[ cor_{\text{proc}} = 0.75 \]
\[ cor_{\text{proc}} = 1 \]

\[
\begin{array}{llllll}
\text{Mapping} & \text{LowerBound} & \text{deP} & \text{deR} & \text{inE} & \text{random} \\
\hline
0.00 & 0.25 & 0.50 & 0.75 & 1.00 & 1.25 \\
0.20 & 0.40 & 0.60 & 0.80 & 1.00 & 1.20 \\
0.40 & 0.60 & 0.80 & 1.00 & 1.20 & 1.40 \\
0.60 & 0.80 & 1.00 & 1.20 & 1.40 & 1.60 \\
0.80 & 1.00 & 1.20 & 1.40 & 1.60 & 1.80 \\
1.00 & 1.20 & 1.40 & 1.60 & 1.80 & 2.00 \\
\end{array}
\]
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-time and time-energy mapping]

- **Energy-energy**
- **Energy-time**
- **RandomShuffling**
- **Time-energy**
- **Time-time**

<table>
<thead>
<tr>
<th>Mapping</th>
<th>BaselineWork = 0.2</th>
<th>R = 0.94</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

**Ratio to the baseline**

- **BaselineWork** = 0.2
- **R** = 0.94

RR n° 9324
### Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>random allocation</td>
<td><img src="graph1" alt="" /></td>
<td><img src="graph2" alt="" /></td>
<td><img src="graph3" alt="" /></td>
<td><img src="graph4" alt="" /></td>
<td><img src="graph5" alt="" /></td>
</tr>
<tr>
<td>energy allocation</td>
<td><img src="graph6" alt="" /></td>
<td><img src="graph7" alt="" /></td>
<td><img src="graph8" alt="" /></td>
<td><img src="graph9" alt="" /></td>
<td><img src="graph10" alt="" /></td>
</tr>
<tr>
<td>workload balancing</td>
<td><img src="graph11" alt="" /></td>
<td><img src="graph12" alt="" /></td>
<td><img src="graph13" alt="" /></td>
<td><img src="graph14" alt="" /></td>
<td><img src="graph15" alt="" /></td>
</tr>
<tr>
<td>RR n° 9324</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor</td>
<td>cor</td>
<td>cor</td>
<td>cor</td>
<td>cor</td>
</tr>
<tr>
<td>1.00</td>
<td>0.40</td>
<td>0.60</td>
<td>0.80</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>0.50</td>
<td>0.60</td>
<td>0.80</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
<td>0.60</td>
<td>0.80</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.50</td>
<td>0.60</td>
<td>0.80</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Ratio to the baseline

<table>
<thead>
<tr>
<th>1.00</th>
<th>0.75</th>
<th>0.50</th>
<th>0.25</th>
<th>0.00</th>
</tr>
</thead>
</table>

Lower Bound in E

<table>
<thead>
<tr>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
<th>1.25</th>
</tr>
</thead>
</table>

\( \beta \text{ b/w}\) mapping

<table>
<thead>
<tr>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
<th>1.25</th>
</tr>
</thead>
</table>

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{cor proc} = 0.25 \]

\[ \beta \text{ b/w} \]

\[ \text{Ratio to the baseline} \]

\[ \text{LowerBound} \]

\[ \text{Basic Work} = 0.3, \ R = 0.9 \]

\[ \text{time-energy} \]

\[ \text{time-time} \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>corproc = 0</td>
<td>corproc = 0.10</td>
<td>corproc = 0.25</td>
<td>corproc = 0.50</td>
<td>corproc = 0.75</td>
</tr>
<tr>
<td>corproc = 1</td>
<td>corproc = 0.25</td>
<td>corproc = 0.75</td>
<td>corproc = 1</td>
<td>corproc = 0</td>
</tr>
</tbody>
</table>

β

Ratio to the baseline

mapping

basicWork = 0.3; R = 0.94

RR n° 9324
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_task = 1; basicWork = 0.3; R = 0.98

Ratio to the baseline

\[ \beta_{b/w} \]

LowerBound \quad deP \quad deR \quad inE \quad random

Energy-aware strategies on heterogeneous platforms
$\beta_{b/w}$ (Scheduling)

The following section presents ratio of energy consumption using different scheduling strategies under small failure rate when varying $\beta_{b/w}$. 
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0; \text{basicWork} = 0.1; R = 0.9 \]

![Graph showing energy-aware strategies on heterogeneous platforms]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Power</th>
<th>delP</th>
<th>delR</th>
<th>maE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor 0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>cor 0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>cor 0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>cor 0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>cor 0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>cor 0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>cor 0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>cor 0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>cor 0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>cor 1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Ratio to the baseline: delP, delR, maE, randomShuffling.
cor\textsubscript{task} = 0; basicWork = 0.1; R = 0.94

<table>
<thead>
<tr>
<th>cor\textsubscript{proc}</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

LowerBound  energy-energy  energy-time  time-energy  randomShuffling

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms
cor\textsubscript{task} = 0; basicWork = 0.1; R = 0.98
Energy-aware strategies on heterogeneous platforms

\[ cor_{\text{task}} = 0; \ basicWork = 0.2; \ \mathcal{R} = 0.9 \]
$\text{cor}_{\text{task}} = 0; \text{basicWork} = 0.2; R = 0.92$

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{proc}}$</th>
<th>0</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>$\beta_{b/w}$</th>
<th>0.2</th>
<th>0.4</th>
<th>0.6</th>
<th>0.8</th>
<th>1.0</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>scheduling</th>
<th>LowerBound</th>
<th>energy-time</th>
<th>time-energy</th>
<th>randomShuffling</th>
</tr>
</thead>
</table>

Energy-aware strategies on heterogeneous platforms
cor_{task} = 0; basicWork = 0.2; R = 0.94
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0; \text{basicWork} = 0.2; R = 0.96 \]

\[ \text{cor}_{\text{proc}} = 0 \quad \text{cor}_{\text{proc}} = 0.25 \quad \text{cor}_{\text{proc}} = 0.5 \quad \text{cor}_{\text{proc}} = 0.75 \quad \text{cor}_{\text{proc}} = 1 \]

\[ \beta_{b/w} \]

Ratio to the baseline

scheduling

LowerBound  energy-time  time-energy
energy-energy  time-energy  randomShuffling
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>cor</th>
<th>proc</th>
<th>deP</th>
<th>deR</th>
<th>maE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cor</th>
<th>proc</th>
<th>deP</th>
<th>deR</th>
<th>maE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cor</th>
<th>proc</th>
<th>deP</th>
<th>deR</th>
<th>maE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cor</th>
<th>proc</th>
<th>deP</th>
<th>deR</th>
<th>maE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cor</th>
<th>proc</th>
<th>deP</th>
<th>deR</th>
<th>maE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

cor(task) = 0; basiWork = 0.2; R = 0.08

RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Diagram showing energy consumption and scheduling comparisons for different strategies. The Y-axis represents the ratio to the baseline, and the X-axis represents task costs. The strategies include balanced, energy-aware, and randomized scheduling.](image_url)
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0; basicWork = 0.3; R = 0.92

![Diagram showing the ratio of energy to the baseline against \( \beta_{b/w} \) for different cor_{proc} values (0, 0.25, 0.5, 0.75, 1). The x-axis represents \( \beta_{b/w} \) ranging from 0.2 to 1.0, and the y-axis represents the ratio to the baseline ranging from 0.0 to 1.25. Different scheduling strategies are plotted with distinct markers: LowerBound, energy-time, time-energy, and randomShuffling. Each strategy is represented by a different color and marker shape, allowing for a clear comparison of performance across varying \( \beta_{b/w} \) values.
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[
\text{cor}_{\text{task}} = 0; \text{basicWork} = 0.3; R = 0.98
\]
Energy-aware strategies on heterogeneous platforms

$cor_{task} = 0.25$; basicWork = 0.1; $R = 0.9$

### $cor_{proc} = 0$

### $cor_{proc} = 0.25$

### $cor_{proc} = 0.5$

### $cor_{proc} = 0.75$

### $cor_{proc} = 1$

#### LowerBound

#### energy-energy

#### energy-time

#### time-energy

#### time-time

#### randomShuffling

$eta_{bw}$ Ratio to the baseline

Legend:
- LowerBound
- energy-energy
- energy-time
- time-energy
- randomShuffling
### Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th></th>
<th>deP</th>
<th>deR</th>
<th>naE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor_p0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor_p0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor_p0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor_p0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**β**

- Baseline = 0.25, basicWork = 0.1; R = 0.92
- RandomShuffling

<table>
<thead>
<tr>
<th></th>
<th>0.10</th>
<th>0.20</th>
<th>0.30</th>
<th>0.40</th>
<th>0.50</th>
<th>0.60</th>
<th>0.70</th>
<th>0.80</th>
<th>0.90</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Energy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Energy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Energy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

**Energy-time scheduling**

- LowBound
- energy-time
- energy-time
- energy-time
- energy-time

RR n° 9324
\[ \text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.1; \ R = 0.94 \]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.1; R = 0.96 \]

Ratio to the baseline

<table>
<thead>
<tr>
<th>Cor proc</th>
<th>LowerBound</th>
<th>energy-time</th>
<th>time-energy</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\( \beta_{bw} \): 0.2 0.4 0.6 0.8 1.0
Energy-aware strategies on heterogeneous platforms

\( cor_{task} = 0.25; \) basicWork = 0.1; \( R = 0.98 \)

\( cor_{proc} = 0 \)

\( cor_{proc} = 0.25 \)

\( cor_{proc} = 0.5 \)

\( cor_{proc} = 0.75 \)

\( cor_{proc} = 1 \)

Ratio to the baseline

\( \beta_{bw} \)

\( s scheduling \)

LowerBound energy-energy energy-time time-energy randomShuffling
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 0.25; basic\textit{Work} = 0.2; R = 0.9

Ratio to the baseline

<table>
<thead>
<tr>
<th>cor\textsubscript{proc}</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>scheduling</td>
<td>LowerBound</td>
<td>energy-time</td>
<td>time-time</td>
<td>energy-energy</td>
<td>time-energy</td>
</tr>
</tbody>
</table>

\[ \beta_{bw} \]

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

RR n° 9324
$\text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.2; \mathcal{R} = 0.94$

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$\beta_{\text{b/w}}$</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.2</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.4</td>
<td>1.00</td>
</tr>
<tr>
<td>0.5</td>
<td>0.6</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>0.8</td>
<td>1.00</td>
</tr>
<tr>
<td>1.0</td>
<td>1.0</td>
<td>1.00</td>
</tr>
</tbody>
</table>

$\text{cor}_{\text{proc}} = 0.5$

$\text{cor}_{\text{proc}} = 0.75$

$\text{cor}_{\text{proc}} = 1$

**Scheduling:**
- LowerBound
- energy-time
- time-energy
- randomShuffling

**Energy-aware strategies on heterogeneous platforms**
$\text{cor}_{\text{task}} = 0.25$; $\text{basicWork} = 0.2$; $R = 0.96$
Energy-aware strategies on heterogeneous platforms

cor\_task = 0.25; basic\_work = 0.2; R = 0.98

cor\_proc = 0

cor\_proc = 0.25

cor\_proc = 0.5

cor\_proc = 0.75

cor\_proc = 1

Ratio to the baseline

scheduling

LowerBound, energy-time, time-energy, randomShuffling

β/b_w

0.00 0.25 0.50 0.75 1.00

0.2 0.4 0.6 0.8 1.0

0.00 0.25 0.50 0.75 1.00

0.2 0.4 0.6 0.8 1.0

0.00 0.25 0.50 0.75 1.00

0.2 0.4 0.6 0.8 1.0

0.00 0.25 0.50 0.75 1.00

0.2 0.4 0.6 0.8 1.0

0.00 0.25 0.50 0.75 1.00

0.2 0.4 0.6 0.8 1.0

0.00 0.25 0.50 0.75 1.00

0.2 0.4 0.6 0.8 1.0

0.00 0.25 0.50 0.75 1.00

0.2 0.4 0.6 0.8 1.0

0.00 0.25 0.50 0.75 1.00

0.2 0.4 0.6 0.8 1.0
Energy-aware strategies on heterogeneous platforms

![Diagram showing energy consumption and scheduling results for different load ratios and energy costs. The x-axis represents the load ratio, ranging from 0.2 to 1.2. The y-axis represents the energy consumption, with values ranging from 0 to 2.0. The diagram compares the energy consumption of different scheduling policies, including basicWork, taskShuffling, and randomShuffling, under varying energy costs. The legend indicates the type of load ratio: green for energy-time, blue for energy-energy, and purple for time-time. The results show that basicWork and taskShuffling generally perform better in terms of energy consumption across different load ratios and energy costs.](image-url)
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms
$\text{cor}_{\text{task}} = 0.25; \text{basicWork} = 0.3; \mathcal{R} = 0.96$

- $\text{cor}_{\text{proc}} = 0$
- $\text{cor}_{\text{proc}} = 0.25$
- $\text{cor}_{\text{proc}} = 0.5$
- $\text{cor}_{\text{proc}} = 0.75$
- $\text{cor}_{\text{proc}} = 1$

Ratio to the baseline

- LowerBound
- energy-energy
- time-energy
- randomShuffling

Energy-aware strategies on heterogeneous platforms

RR n° 6524
$corr_{task} = 0.25; \text{ basicWork} = 0.3; \mathcal{R} = 0.98$
Energy-aware strategies on heterogeneous platforms

corr = 0.5; basicWork = 0.1; R = 0.9

Ratio to the baseline

\( \beta_{b/w} \)

scheduling

LowerBound energy-energy time-energy randomShuffling
Energy-aware strategies on heterogeneous platforms

cor\text{\textsubscript{task}} = 0.5; \ basic\text{\textsubscript{Work}} = 0.1; \ R = 0.92
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0.5; \text{basicWork} = 0.1; \mathcal{R} = 0.94
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 0.5; basicWork = 0.1; R = 0.96
$cor_{task} = 0.5; \, basicWork = 0.1; \, \mathcal{R} = 0.98$

<table>
<thead>
<tr>
<th>$cor_{proc}$</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms
\( \text{cor}_{\text{task}} = 0.5; \text{basicWork} = 0.2; R = 0.9 \)
$\text{cor}_\text{task} = 0.5; \text{basicWork} = 0.2; \mathcal{R} = 0.92$

<table>
<thead>
<tr>
<th>$\text{cor}_\text{proc}$</th>
<th>$\beta_{b/w}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; basicWork = 0.2; R = 0.94

cor_{proc} = 0

cor_{proc} = 0.25

cor_{proc} = 0.5

cor_{proc} = 0.75

cor_{proc} = 1
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; basicWork = 0.2; \mathcal{R} = 0.96
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; basicWork = 0.2; \mathcal{R} = 0.98

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

scheduling: LowerBound, energy-energy, energy-time, time-energy, randomShuffling
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; basicWork = 0.3; R = 0.9
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\(\text{cor}_{\text{task}} = 0.5; \text{basicWork} = 0.3; \mathcal{R} = 0.94\)
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>cor proc = 0</th>
<th>cor proc = 0.1</th>
<th>cor proc = 0.25</th>
<th>cor proc = 0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor proc = 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor proc = 0.75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor proc = 0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor proc = 0.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor proc = 0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>β</th>
<th>b/w Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td></td>
</tr>
</tbody>
</table>

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.1; R = 0.9 \]

\[ \text{cor}_{\text{proc}} = 0 \quad \text{cor}_{\text{proc}} = 0.25 \quad \text{cor}_{\text{proc}} = 0.5 \quad \text{cor}_{\text{proc}} = 0.75 \quad \text{cor}_{\text{proc}} = 1 \]

\[ \text{Ratio to the baseline} \]

\[ \text{scheduling} \]

- LowerBound
- energy-time
- time-energy
- randomShuffling

\[ \beta_{bw} \]

\[ 0.00 \quad 0.25 \quad 0.50 \quad 0.75 \quad 1.00 \]

\[ 0.00 \quad 0.25 \quad 0.50 \quad 0.75 \quad 1.00 \]
cor_{task} = 0.75; basicWork = 0.1; R = 0.92
$\text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.1; R = 0.94$
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Schedule</th>
<th>deP</th>
<th>deR</th>
<th>naE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>cond = 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cond = 0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cond = 0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cond = 0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cond = 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Beta (β) is a parameter representing the ratio to the baseline scheduling.
Energy-aware strategies on heterogeneous platforms

\[ \text{Ratio to the baseline} = \frac{\text{energy-energy}}{\text{energy-time}} \times \frac{\text{time-energy}}{\text{time-time}} \]

\[ \beta_{\text{bw}} = 0.75, \text{basicWork} = 0.1, R = 0.08 \]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.2; R = 0.9 \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_task = 0.75; basicWork = 0.2; R = 0.94
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.2; R = 0.96 \)
Energy-aware strategies on heterogeneous platforms

\( \text{corr}_{\text{task}} = 0.75; \ \text{basicWork} = 0.2; \ \mathcal{R} = 0.98 \)
$\text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.3; R = 0.9$
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0.75; basicWork = 0.3; R = 0.92
$\text{cor}_{\text{task}} = 0.75$; $\text{basicWork} = 0.3$; $\mathcal{R} = 0.94$

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$\text{cor}_{\text{proc}} = 0$</th>
<th>$\text{cor}_{\text{proc}} = 0.25$</th>
<th>$\text{cor}_{\text{proc}} = 0.5$</th>
<th>$\text{cor}_{\text{proc}} = 0.75$</th>
<th>$\text{cor}_{\text{proc}} = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{\text{bw}}$</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Lower Bound, energy-energy, time-energy, randomShuffling
Energy-aware strategies on heterogeneous platforms

cor task = 0.75; basicWork = 0.3; \( R = 0.96 \)
\[ \text{cor}_{\text{task}} = 0.75; \text{basicWork} = 0.3; \mathcal{R} = 0.98 \]
Energy-aware strategies on heterogeneous platforms

corr\textsubscript{task} = 1; basicWork = 0.1; R = 0.9

![Graph showing energy-aware strategies on heterogeneous platforms](image-url)

- LowerBound
- energy-time
- time-energy
- randomShuffling

Correlation Analysis

corr\textsubscript{proc} = 0; corr\textsubscript{proc} = 0.25; corr\textsubscript{proc} = 0.5; corr\textsubscript{proc} = 0.75; corr\textsubscript{proc} = 1

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Time</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>0.25</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>0.5</td>
<td>1.25</td>
<td></td>
</tr>
</tbody>
</table>

LowerBound scheduling results

**RR n°**: [Relative Rating]
Energy-aware strategies on heterogeneous platforms

cor\text{\_}task = 1; basicWork = 0.1; R = 0.92
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>deP</th>
<th>deR</th>
<th>iaE</th>
<th>random</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>cor prediction = 1</th>
<th>0.10</th>
<th>0.10</th>
<th>0.10</th>
<th>0.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor prediction = 0.75</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>cor prediction = 0.5</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>cor prediction = 0.25</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>cor prediction = 0</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>β</th>
<th>b/w</th>
<th>ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

RR n° 9324
### Energy-aware strategies on heterogeneous platforms

#### Figure 1: Performance Comparison

<table>
<thead>
<tr>
<th>Strategy</th>
<th>dP</th>
<th>dR</th>
<th>iaE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor/proc = 1</td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
<td><img src="image3" alt="Graph" /></td>
<td><img src="image4" alt="Graph" /></td>
</tr>
<tr>
<td>cor/proc = 0.75</td>
<td><img src="image5" alt="Graph" /></td>
<td><img src="image6" alt="Graph" /></td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
</tr>
<tr>
<td>cor/proc = 0.50</td>
<td><img src="image9" alt="Graph" /></td>
<td><img src="image10" alt="Graph" /></td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graph" /></td>
</tr>
<tr>
<td>cor/proc = 0.25</td>
<td><img src="image13" alt="Graph" /></td>
<td><img src="image14" alt="Graph" /></td>
<td><img src="image15" alt="Graph" /></td>
<td><img src="image16" alt="Graph" /></td>
</tr>
</tbody>
</table>

**Legend:**
- dP: dynamic partitioning
- dR: dynamic relocation
- iaE: inter-affinity energy
- random: random scheduling

**Metrics:**
- Ratio to the baseline
- Time-energy
- Energy-time
- LowerBound

**Parameters:**
- cor/proc
- basicWork
- R

**Notes:**
- cor/proc = 1; basicWork = 0.1; R = 0.96
- RR n° 9324
Energy-aware strategies on heterogeneous platforms

\(\text{cor}_{\text{task}} = 1; \text{basicWork} = 0.1; R = 0.98\)

Ratio to the baseline

\(\beta_{bw}\)

LowerBound, energy-time, time-energy, randomShuffling
$\text{cor}_{\text{task}} = 1; \text{basicWork} = 0.2; R = 0.9$

![Graph showing energy-aware strategies on heterogeneous platforms]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \text{basicWork} = 0.2; \ R = 0.92 \]

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\[ \text{cor}_{\text{proc}} = 0.75 \]

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\[ \text{cor}_{\text{proc}} = 1 \]

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\[ \text{cor}_{\text{proc}} = 0.25 \]

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\[ \text{cor}_{\text{proc}} = 0 \]

<table>
<thead>
<tr>
<th>cor_{proc}</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\[ \text{ratio to the baseline} \]

\[ \text{randomShuffling} \]

\[ \text{energy-energy} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]

\[ \text{energy-time} \]

\[ \text{LowerBound} \]

\[ \text{scheduling} \]
Energy-aware strategies on heterogeneous platforms

\[
c_{\text{task}} = 1; \quad \text{basicWork} = 0.2; \quad R = 0.94
\]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \text{basicWork} = 0.2; R = 0.96 \]
**Energy-aware strategies on heterogeneous platforms**

<table>
<thead>
<tr>
<th>cor</th>
<th>prob</th>
<th>deP</th>
<th>deR</th>
<th>reE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

**Figure:**
- Task scheduling
- Energy, energy-time, time-energy
- Random Shuffling

**Legend:**
- BasicWork
- BasicWork = 0.2, R = 0.98

Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \ \text{basicWork} = 0.3; \ R = 0.9 \]

\[ \text{cor}_{\text{proc}} = 0 \]

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]

Ratio to the baseline

\[ \beta_{\text{bw}} \]

\[ \text{scheduling} \]

\[ \text{LowerBound} \]

\[ \text{energy-energy} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]

\[ \text{randomShuffling} \]
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 1; basicWork = 0.3; R = 0.92
$\text{cor}_{\text{task}} = 1; \text{basicWork} = 0.3; R = 0.94$
Energy-aware strategies on heterogeneous platforms
$\text{cor}_{\text{task}} = 1$; basicWork $= 0.3$; $R = 0.98$

Ratio to the baseline

Energy-aware strategies on heterogeneous platforms
Correlation (Mapping)

The following section presents ratio of energy consumption using different mapping strategies under small failure rate, when varying $cor_{proc}$ and $cor_{task}$. 
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms](image-url)
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{ref}} = 0.2; \beta_{\text{ref}} = 1.1; R = 0.92 \]

\[ \text{Processor correlation} \]

\[ \text{Ratio to the baseline} \]

\[ \text{LowerBound} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]

\[ \text{Baseline} \]

\[ \text{mapping} \]

\[ \text{Core} \]

\[ \text{shuffling} \]

\[ \text{Baseline} \]

\[ \text{mapping} \]

\[ \text{Core} \]

\[ \text{shuffling} \]
Energy-aware strategies on heterogeneous platforms

Energy-energy
energy-time
randomShuffling
Time-energy
Time-time

Processor correlation
Ratio to the baseline

Mapping
Correlation vs. deP
Correlation vs. deR
Correlation vs. inE
Correlation vs. randomShuffling

\( \beta_{0,0} = 0.2 \), basicWork=0.1, \( \mathcal{R} = 0.94 \)

\( \beta_{0,0} = 0 \), basicWork=0.1, \( \mathcal{R} = 0.94 \)
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.2; \quad \text{basicWork} = 0.1; \quad R = 0.98 \)

\[
\text{corr}_{\text{task}} = 0.00; \quad \text{corr}_{\text{task}} = 0.25; \quad \text{corr}_{\text{task}} = 0.50; \quad \text{corr}_{\text{task}} = 0.75; \quad \text{corr}_{\text{task}} = 1.00
\]

Processor correlation

Ratio to the baseline

mapping

LowerBound, deP, deR, inE, random
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

![Graphs showing energy and time correlation with different mapping strategies](image)

**Legend:**
- Processor correlation
- Lower Bound
- Random mapping
- Basic Work
- Basic Work with Reordering

**Parameters:**
- \( \beta_{\text{bw}} = 0.2 \)
- Basic Work with Reordering
- Reordering factor \( R = 0.92 \)

**Notes:**
- The graph illustrates the correlation between energy and time for different mapping strategies under various workload conditions.
- The baseline ratio is denoted as RR n°9324.
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.2; \ basicWork = 0.2; \ R = 0.94 \)
\( \beta_{b/w} = 0.2; \text{basicWork} = 0.2; R = 0.98 \)
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{in}} = 0.2; \beta_{\text{out}} = 0.3; R = 0.92 \]

\[ \text{Processor correlation}^{\text{baseline}} = 0.3 \]

\[ \text{Baseline} = 0.3 \]

\[ \text{Mapping} \]

\[ \text{LowerBound} \]

\[ \text{UpperBound} \]

\[ \text{energy-energy} \]

\[ \text{energy-time} \]

\[ \text{randomShuffling} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{env}} = 0.2; \text{basicWork} = 0.3; R = 0.94 \]

\[ \text{Ratio to the baseline} \]

\[ \text{Processor correlation} \]

\[ \text{Lower Bound} \]

\[ \text{randomShuffling} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.2; \text{basicWork} = 0.3; \mathcal{R} = 0.98$

$\text{cor}_{\text{task}} = 0$

$\text{cor}_{\text{task}} = 0.25$

$\text{cor}_{\text{task}} = 0.5$

$\text{cor}_{\text{task}} = 0.75$

$\text{cor}_{\text{task}} = 1$

Ratio to the baseline

Processor correlation

mapping: LowerBound, deP, deR, imE, random
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.4; \ basicWork = 0.1; \ R = 0.9$

[Graph showing energy-time and time-energy correlation with mapping strategies and processor correlation.]
Energy-aware strategies on heterogeneous platforms.
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.4 \); \( \text{basicWork} = 0.1 \); \( R = 0.94 \)
\( \beta_{b/w} = 0.4; basicWork = 0.1; \mathcal{R} = 0.96 \)
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.4; \ basicWork = 0.1; R = 0.98$

- $corr_{task} = 0$
- $corr_{task} = 0.25$
- $corr_{task} = 0.5$
- $corr_{task} = 0.75$
- $corr_{task} = 1$

Processor correlation vs. Ratio to the baseline

Processor correlation

Ratio to the baseline

mapping: LowerBound, deP, deR, imE, random

RR n° 9224
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mapping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>deP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>deR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>random</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \beta_{Wb} = 0.4, \text{basicWor} = 0.2; R = 0.9 \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th></th>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{u,w}$ = 0.4; $\text{basicW} / \text{c} = 0.2$; $R = 0.92$</td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>$\beta_{u,w}$ = 0.4; $\text{basicW} / \text{c} = 0.2$; $R = 0.92$</td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>$\beta_{u,w}$ = 0.4; $\text{basicW} / \text{c} = 0.2$; $R = 0.92$</td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
<td><img src="image" alt="Graph" /></td>
</tr>
</tbody>
</table>

 Processor correlation ratio to the baseline.
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.4; \text{basicWork} = 0.2; \mathcal{R} = 0.94 \]
\[ \beta_{b/w} = 0.4; \text{basicWork} = 0.2; R = 0.96 \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.10 \]

\[ \text{cor}_{\text{task}} = 0.25 \]

\[ \text{cor}_{\text{task}} = 0.50 \]

\[ \text{cor}_{\text{task}} = 0.75 \]

\[ \text{cor}_{\text{task}} = 1.00 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.4, \beta_{h/h} = 0.3, R = 0.94 \]

\[ corr_{\text{time-energy}} = 0 \]

\[ corr_{\text{energy-energy}} = 0 \]

\[ corr_{\text{energy-time}} = 0 \]

\[ corr_{\text{randomShuffling}} = 0 \]

\[ corr_{\text{time-time}} = 1 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.4; \text{basicWork} = 0.3; R = 0.96 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{time}} = 0.4; \; \text{basicWork} = 0.3; \; \mathcal{R} = 0.98 \]

\[ \mathcal{R} = 0.75 \]

\[ \mathcal{R} = 0.50 \]

\[ \mathcal{R} = 0.25 \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

![Graph showing processor correlation](image-url)
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>corr_task = 0</td>
<td>corr_task = 0.25</td>
<td>corr_task = 0.50</td>
<td>corr_task = 0.75</td>
<td>corr_task = 1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>corr_task = 0</td>
<td>corr_task = 0.25</td>
<td>corr_task = 0.50</td>
<td>corr_task = 0.75</td>
<td>corr_task = 1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>corr_task = 0</td>
<td>corr_task = 0.25</td>
<td>corr_task = 0.50</td>
<td>corr_task = 0.75</td>
<td>corr_task = 1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>corr_task = 0</td>
<td>corr_task = 0.25</td>
<td>corr_task = 0.50</td>
<td>corr_task = 0.75</td>
<td>corr_task = 1.00</td>
</tr>
</tbody>
</table>

Processor correlation

Ratio to the baseline

<table>
<thead>
<tr>
<th>$\beta_{wh} = 0.6$, basicWork</th>
<th>$\beta_{wh} = 0.1$, R = 0.94</th>
</tr>
</thead>
<tbody>
<tr>
<td>$b/w = 0.6$, basicWork</td>
<td>$b/w = 0.1$, R = 0.94</td>
</tr>
</tbody>
</table>

$\beta_{wh}$ is the weight of the basicWork metric.
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.6; \quad \text{basicWork} = 0.1; \quad R = 0.96 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.6; \, basicWork = 0.1; \, R = 0.98 \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>energy-energy</th>
<th>energy-time</th>
<th>randomShuffling</th>
<th>time-energy</th>
<th>time-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor = 0</td>
<td>cor = 0.25</td>
<td>cor = 0.50</td>
<td>cor = 0.75</td>
<td>cor = 1</td>
</tr>
<tr>
<td>RR n° 9324</td>
<td>RR n° 9324</td>
<td>RR n° 9324</td>
<td>RR n° 9324</td>
<td>RR n° 9324</td>
</tr>
</tbody>
</table>

β_b/w = 0.6, basicWork = 0.2; R = 0.92.
### Energy-aware strategies on heterogeneous platforms

#### Graphs

- **Energy-energy**
- **Energy-time**
- **RandomShuffling**
- **Time-energy**
- **Time-time**

#### Processor correlation

$\beta_{Wn} = 0.6$; basicW $= 0.2$; $R = 0.96$

#### RR n° 9324
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.6$; $\text{basicWork} = 0.2$; $R = 0.98$

Ratio to the baseline

Processor correlation

mapping: LowerBound, deP, deR, inE, random
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/b} = 0.6, \text{ basic } W_{/b} = 0.3, R = 0.92 \]

\[ \text{Processor correlation mapping} \]

\[ \text{energy-energy} \]
\[ \text{energy-time} \]
\[ \text{randomShuffling} \]
\[ \text{time-energy} \]
\[ \text{time-time} \]
Energy-aware strategies on heterogeneous platforms

- Processor correlation
- Ratio to the baseline
- LowerBound
- deP, deR, inE

\[ \beta_{\text{item}} = 0.6, \ \text{basicWork} = 0.3, \ R = 0.94 \]

RR n° 9324
\( \beta_{b/w} = 0.6; \ \text{basicWork} = 0.3; \ R = 0.96 \)
\( \beta_{b/w} = 0.6; \) basicWork = 0.3; \( R = 0.98 \)

**Energy-aware strategies on heterogeneous platforms**
Energy-aware strategies on heterogeneous platforms

- Processor correlation
- Mapping
- LowerBound
- deP
- deR
- inE
- randomShuffling
- energy-energy
- energy-time
- randomShuffling-energy
- randomShuffling-time
- time-energy
- time-time

\[ \beta_{W_0} = 0.8, \text{ basicW} = 0.1, \text{ R} = 0.9 \]
\(\beta_{b/w} = 0.8; \text{basicWork} = 0.1; R = 0.92\)
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.8$; basicWork $= 0.1$; $R = 0.94$
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.8; \ basicWork = 0.1; \ R = 0.96 \)
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.8; \, \text{basicWork} = 0.2; \, R = 0.92 \]
Energy-aware strategies on heterogeneous platforms

...
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.8, \beta_{b/w} = 0.3, R = 0.9 \]

Ratio to the baseline

Processor correlation

LowerBound deP deR inE randomShuffling
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{b/w}} = 0.8; \ \text{basicWork} = 0.3; \ \mathcal{R} = 0.92 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.8; \ basicWork = 0.3; \ R = 0.94 \]
Energy-aware strategies on heterogeneous platforms

\[ \frac{\text{energy-energy}}{\text{energy-time}} = 0.10 \]

\[ \frac{\text{randomShuffling}}{\text{time-energy}} = 0.10 \]

\[ \frac{\text{time-time}}{\text{processor correlation}} = 0.3 \]

\[ \beta_{\text{b/w}} = 0.8, \text{basicWork} = 0.3, R = 0.96 \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/\omega} = 0.8; \text{basicWork} = 0.3; R = 0.98 \]
Energy-aware strategies on heterogeneous platforms
\[ \beta_{\text{b/w}} = 1; \text{basicWork} = 0.1; \mathcal{R} = 0.92 \]

\[ \text{cor}_{\text{task}} = 0 \quad \text{cor}_{\text{task}} = 0.25 \quad \text{cor}_{\text{task}} = 0.5 \quad \text{cor}_{\text{task}} = 0.75 \quad \text{cor}_{\text{task}} = 1 \]

Ratio to the baseline

Processor correlation

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 1; \ \text{basicWork} = 0.1; \ \mathcal{R} = 0.94 \]
$\beta_{b/w} = 1; \text{basicWork} = 0.1; \mathcal{R} = 0.96$
Energy-aware strategies on heterogeneous platforms

$\beta_{\text{bw}} = 1; \ basicWork = 0.1; \ \mathcal{R} = 0.98$

Ratio to the baseline

Processor correlation

mapping LowerBound deP deR inE random
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 1; \text{ basicWork} = 0.2; \mathcal{R} = 0.9 \]
Energy-aware strategies on heterogeneous platforms

\[ \text{energy-energy} \]
\[ \text{energy-time} \]
\[ \text{randomShuffling} \]
\[ \text{time-energy} \]
\[ \text{time-time} \]

\[ \beta_{\text{inE}} = 0; \beta_{\text{b/w}} = 1; \text{basicWork} = 0.2; \text{R} = 0.92 \]

Processor correlation

\[ \text{Ratio to the baseline} \]

\[ \text{LowerBound} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]
Energy-aware strategies on heterogeneous platforms

Processor correlation

Proc. to the baseline

mapping

lowerBound

deP

deR

random

β
time-energy

basicsWork = 0.2, \( R = 0.96 \)

randomShuffling

time-time

β
time-energy

randomShuffling

time-time

β
time-energy

randomShuffling

time-time

β
time-energy

randomShuffling

time-time

β

RR = 1, basicsWork = 0.2, \( R = 0.96 \)

randomShuffling

time-time

β

RR = 1, basicsWork = 0.2, \( R = 0.96 \)

randomShuffling

time-time

β

RR = 1, basicsWork = 0.2, \( R = 0.96 \)

randomShuffling

time-time

β

RR = 1, basicsWork = 0.2, \( R = 0.96 \)

randomShuffling

time-time

β

RR = 1, basicsWork = 0.2, \( R = 0.96 \)

randomShuffling

time-time

β

RR = 1, basicsWork = 0.2, \( R = 0.96 \)

randomShuffling

time-time

β

RR = 1, basicsWork = 0.2, \( R = 0.96 \)

randomShuffling

time-time

β

RR = 1, basicsWork = 0.2, \( R = 0.96 \)

randomShuffling

time-time

β

RR = 1, basicsWork = 0.2, \( R = 0.96 \)

randomShuffling

Energy-aware strategies on heterogeneous platforms

...
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>time-energy</th>
<th>energy-energy</th>
<th>time-time</th>
<th>randomShuffling</th>
<th>energy-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>LowerBound</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>b/w</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

\[ \beta_{b/r} = 1, \ \text{basicWork} = 0.3, \ \mathcal{R} = 0.94 \]

RR n° 9324
\( \beta_{b/w} = 1; \) basicWork = 0.3; \( \mathcal{R} = 0.96 \)
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

\( \beta_{\text{b/w}} = 1; \) basicWork = 0.3; \( R = 0.98 \)

\( \text{Random Shuffling} \)

\( \text{Time-energy} \)

\( \text{Time-time} \)

**Correlation:**
- \( \rho = 0 \)
- \( \rho = 0.25 \)
- \( \rho = 0.50 \)
- \( \rho = 0.75 \)
- \( \rho = 1.00 \)

**Mapping:**
- \( \text{Random} \)
- \( \text{Loadbalancing} \)
- \( \text{DEP} \)
- \( \text{DEE} \)
- \( \text{Simple} \)

**Energy:**
- **Energy-energy**
- **Energy-time**

**Time:**
- **Time-energy**
- **Time-time**

**Baseline:**
- \( \text{Basic Work} = 0.3 \)

**Results:**
- \( \text{RR n° 9324} \)
Correlation (Scheduling)

The following section presents ratio of energy consumption using different scheduling strategies under small failure rate, when varying $\text{cor}_{\text{proc}}$ and $\text{cor}_{\text{task}}$. 
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.2; \) basicWork = 0.1; \( R = 0.9 \)

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>cor_task = 0</th>
<th>cor_task = 0.25</th>
<th>cor_task = 0.5</th>
<th>cor_task = 0.75</th>
<th>cor_task = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \beta_{b/w} \] is the energy efficiency parameter, \( R \) is the correlation coefficient between tasks.}

Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.2; \] basicWork = 0.1; \( R = 0.9 \)

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>cor_task = 0</th>
<th>cor_task = 0.25</th>
<th>cor_task = 0.5</th>
<th>cor_task = 0.75</th>
<th>cor_task = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \beta_{b/w} \] is the energy efficiency parameter, \( R \) is the correlation coefficient between tasks.
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.2; \ basicWork = 0.1; \ R = 0.92 \]

![Graph showing energy correlation and ratio to baseline across different processor correlations and scheduling types.](image-url)

**Scheduling Types:**
- LowerBound
- energy-energy
- time-energy
- randomShuffling
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{bw}} = 0.2; \ basicWork = 0.1; \ R = 0.94 \]
$\beta_{b/w} = 0.2$; $\text{basicWork} = 0.1$; $R = 0.96$

Processor correlation

Energy-aware strategies on heterogeneous platforms

scheduling
- LowerBound
- energy-time
- time-energy
- randomShuffling
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.2; \quad \text{basicWork} = 0.1; \quad R = 0.98 \]

<table>
<thead>
<tr>
<th>( \text{cor}_{\text{task}} )</th>
<th>LowerBound</th>
<th>energy-energy</th>
<th>energy-time</th>
<th>time-energy</th>
<th>time-time</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Processor correlation

Ratio to the baseline

Energy-aware strategies on heterogeneous platforms
$\beta_{\text{b/w}} = 0.2$; $\text{basicWork} = 0.2$; $R = 0.9$

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

scheduling

lowerBound

energy-time
time-energy

time-time

randomShuffling

β_b/w = 0.2; basicWork = 0.2; R = 0.92

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{bw}} = 0.2; \text{ basicWork} = 0.2; \ R = 0.94 \]

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor_task = 0</td>
<td></td>
</tr>
<tr>
<td>cor_task = 0.25</td>
<td></td>
</tr>
<tr>
<td>cor_task = 0.5</td>
<td></td>
</tr>
<tr>
<td>cor_task = 0.75</td>
<td></td>
</tr>
<tr>
<td>cor_task = 1</td>
<td></td>
</tr>
</tbody>
</table>

Correlation of tasks with processors:
- LowerBound
- Energy-Time
- Time-Energy
- Random Shuffling

RR n° 5221

Energy-aware strategies on heterogeneous platforms

670
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.2; \ basicWork = 0.2; \ R = 0.96 \]

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor task = 0</td>
<td>1.00</td>
</tr>
<tr>
<td>cor task = 0.25</td>
<td>1.25</td>
</tr>
<tr>
<td>cor task = 0.5</td>
<td>1.50</td>
</tr>
<tr>
<td>cor task = 0.75</td>
<td>1.75</td>
</tr>
<tr>
<td>cor task = 1</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Processor correlation vs. energy consumption and energy-time trade-off for different correlation levels between tasks. The graph shows the ratio of the energy consumption or energy-time trade-off compared to the baseline for different correlation values. The x-axis represents the processor correlation, and the y-axis represents the ratio to the baseline.
Energy-aware strategies on heterogeneous platforms

Processor correlation
Ratio to the baseline

- LowerBound
- energy-energy
- energy-time
- time-energy
- randomShuffling

- b/w = 0.2
- basicWork = 0.2
- R = 0.98

RR n° 9324
$\beta_{b/w} = 0.2; \text{basicWork} = 0.3; R = 0.9$
\[ \beta_{\text{rev}} = 0.2; \ \text{basicWork} = 0.3; \ R = 0.92 \]
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.2; \text{ basicWork} = 0.3; R = 0.94$

Processor correlation

Ratio to the baseline

LowerBound energy-energy time-energy randomShuffling

scheduling energy-time time-energy
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.2; \) basicWork = 0.3; \( R = 0.96 \)

Processor correlation

Ratio to the baseline

scheduling

LowerBound energy-energy time-energy randomShuffling energy-time time-energy
$\beta_{b/w} = 0.2; \text{ basicWork} = 0.3; R = 0.98$
Energy-aware strategies on heterogeneous platforms

 Processor correlation

Ratio to the baseline

\( \beta_{w_1} = 0.4; \ \text{basicW} / w_1 = 0.1; \ \mathcal{R} = 0.94 \)
Energy-aware strategies on heterogeneous platforms
\[ \beta_{b/w} = 0.4; \text{basicWork} = 0.1; R = 0.98 \]
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.4$; $basicWork = 0.2$; $R = 0.9$
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.4; \ basicWork = 0.2; \ R = 0.92 \)
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.4; \ basicWork = 0.2; \ R = 0.94 \)
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.4; \text{basicWork} = 0.2; R = 0.96 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{bw}} = 0.4; \text{basicWork} = 0.2; R = 0.98 \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.4; \ basicWork = 0.3; \ R = 0.92 \]
Energy-aware strategies on heterogeneous platforms

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{bio}} = 0.4; \quad \text{basicWork} = 0.3; \quad R = 0.96 \]
\[ \beta_{\text{in}} = 0.4; \quad \text{basicWork} = 0.3; \quad R = 0.98 \]
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

LowerBound energy-energy

energy-time

time-energy

time-time

randomShuffling

β₀₁ = 0.6; basicWork = 0.1; R = 0.9

RR n° 9324
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

scheduling

LowerBound energy-energy

energy-time
time-energy

time-time

randomShuffling

β₀,₀ = 0.6, basicWork = 0.1; R = 0.92

RR n° 9324
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>deP</td>
<td>deR</td>
</tr>
<tr>
<td>0.00</td>
<td>0.25</td>
</tr>
<tr>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

β_{b_w} = 0.6; basicWork = 0.1; R = 0.96

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{typ}} = 0.6; \] \text{basicWork} = 0.1; \ R = 0.98
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.6; \text{basicWork} = 0.2; \mathcal{R} = 0.9 \]

![Graph showing processor correlation ratio to baseline for different correlation tasks and scheduling strategies.](image-url)
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{prev}} = 0.6; \text{basicWork} = 0.2; R = 0.92 \]

- Processor correlation
  - Ratio to the baseline
  - LowerBound
  - energy-energy
  - time-energy
  - energy-time
  - time-time
  - randomShuffling

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.6; \ basicWork = 0.2; \ R = 0.94 \]

---

**Diagram Description**: The diagram illustrates the energy-time ratio to the baseline for different processor correlation scenarios. Each row represents a different correlation level (cor_task = 0, 0.25, 0.5, 0.75, 1) and shows how the energy-time ratio changes across various scheduling strategies. The legend indicates the different scheduling methods, including Basic Load Balancing, Energy-Time, Time-Energy, and randomShuffling.
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 0.6; \; \text{basicWork} = 0.2; \; R = 0.96 \)

![Graph showing processor correlation](image)

- LowerBound
- Energy-time
- Time-energy
- RandomShuffling

**Note:** The graph visualizes the impact of processor correlation on energy consumption and task scheduling efficiency, with different scheduling strategies and baseline ratios.
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.6; \text{basicWork} = 0.2; \ R = 0.98 \]

Processor correlation

Ratio to the baseline

\[ \text{scheduling: LowerBound, energy-energy, time-energy, randomShuffling} \]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.6; \text{basicWork} = 0.3; R = 0.9 \]
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{blk}} = 0.6; \text{basicWork} = 0.3; R = 0.94 \]

![Graph showing processor correlation and ratio to the baseline](image)

- LowerBound
- energy-time
- time-energy
- randomShuffling

**Processor correlation**

**Ratio to the baseline**
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.6 \; \text{and} \; \text{basicWork} = 0.3; \; R = 0.96 \]

![Graph showing energy correlation and processor correlation](image-url)
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.6; \ \text{basicWork} = 0.3; \ \mathcal{R} = 0.98 \]

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
</tr>
<tr>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

![Graph](image-url)

**Legend:**
- **LowerBound**
- **energy-time**
- **time-energy**
- **randomShuffling**

**Parameters:**
- \( b/w \) = 0.6
- basicWork = 0.3
- \( \mathcal{R} \) = 0.98
Energy-aware strategies on heterogeneous platforms

\[ \beta_{bw} = 0.8; \text{basicWork} = 0.1; R = 0.9 \]

![Diagram showing processor correlation ratio to the baseline for different correlation values and scheduling strategies.](image)

LowerBound \( \leftrightarrow \) energy-time \( \leftrightarrow \) time-energy \( \leftrightarrow \) randomShuffling
$\beta_{b/w} = 0.8; \text{basicWork} = 0.1; R = 0.92$
Energy-aware strategies on heterogeneous platforms

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.8; \text{basicWork} = 0.1; R = 0.96 \]

- \( \text{corr}_{\text{task}} = 0 \)
- \( \text{corr}_{\text{task}} = 0.25 \)
- \( \text{corr}_{\text{task}} = 0.5 \)
- \( \text{corr}_{\text{task}} = 0.75 \)
- \( \text{corr}_{\text{task}} = 1 \)

Processor correlation

Ratio to the baseline

Energy-aware strategies on heterogeneous platforms

- LowerBound
- energy-energy
- time-time
- energy-time
- time-energy
- randomShuffling
\( \beta_{b/\text{uc}} = 0.8; \) basicWork = 0.1; \( \mathcal{R} = 0.98 \)

Energy-aware strategies on heterogeneous platforms.

Processor correlation

Ratio to the baseline

scheduling

LowerBound energy-time time-energy randomShuffling

energy-energy time-energy randomShuffling
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.8; \text{basicWork} = 0.2; R = 0.9 \]

![Graph showing processor correlation and ratio to the baseline for different correlation values and scheduling strategies.](image-url)
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.8; \, basicWork = 0.2; \, R = 0.92 \]

![Graph showing processor correlation and energy-time scheduling](image-url)
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.8; \text{basicWork} = 0.2; R = 0.94$

![Diagram showing the impact of processor correlation on energy consumption with different scheduling strategies: LowerBound, energy-energy, energy-time, time-energy, and randomShuffling.]
Energy-aware strategies on heterogeneous platforms

$\beta_{b/w} = 0.8$; basicWork = 0.2; $R = 0.96$

![Graph showing energy-aware scheduling strategies on heterogeneous platforms]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 0.8; \text{basicWork} = 0.2; \ R = 0.98 \]
\( \beta_{b/w} = 0.8; \ basicWork = 0.3; \ R = 0.9 \)

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>cor(_{task} = 0)</th>
<th>cor(_{task} = 0.25)</th>
<th>cor(_{task} = 0.5)</th>
<th>cor(_{task} = 0.75)</th>
<th>cor(_{task} = 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms.
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

scheduling

**Energy**

**time**

randomShuffling

**β** = 0.8, **basicWork** = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92

**β** = 0.8, basicWork = 0.3, **R** = 0.92
\( \beta_{b/w} = 0.8; \ basicWork = 0.3; \ R = 0.94 \)

Processor correlation

Ratio to the baseline

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

Processor correlation
Ratio to the baseline

- \( \beta_{\text{sh}} = 0.5 \), work load = 0.3, \( R = 0.96 \)

- \( \beta_{\text{sh}} = 0.8 \), work load = 0.3, \( R = 0.96 \)

- \( \beta_{\text{sh}} = 0.5 \), work load = 0.6, \( R = 0.96 \)

- \( \beta_{\text{sh}} = 0.1 \), work load = 0.3, \( R = 0.96 \)

- \( \beta_{\text{sh}} = 0.1 \), work load = 0.6, \( R = 0.96 \)
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 1; \ \text{basicWork} = 0.1; \ \mathcal{R} = 0.9 \]
$\beta_{b/w} = 1; \text{basicWork} = 0.1; R = 0.92$

Energy-aware strategies on heterogeneous platforms
\( \beta_{b/w} = 1; \) basicWork = 0.1; \( \mathcal{R} = 0.94 \)
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 1; \ basicWork = 0.2; \ R = 0.9 \]

![Energy efficiency vs. processor correlation for different correlation coefficients](image-url)
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 1; \ \text{basicWork} = 0.2; \ \mathcal{R} = 0.92 \]

- Processor correlation
  - Ratio to the baseline
  - LowerBound
  - energy-energy
  - energy-time
  - time-energy
  - randomShuffling

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

$\beta_b/u_e = 1; \text{basicWork} = 0.2; \mathcal{R} = 0.94$

![Graph showing energy-aware strategies on heterogeneous platforms](image)

- LowerBound
- energy-time
- time-energy
- randomShuffling
- Processor correlation

Ratio to the baseline: 0.00, 0.25, 0.50, 0.75, 1.00

energy-energy
time-time randomShuffling

RR n° 9324

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

- Processor correlation
- Ratio to the baseline
- schedulers: randomShuffling

\[
\beta_{\text{bw}} = 1 \quad \text{basicWork} = 0.2 \quad \mathcal{R} = 0.26
\]

\[
\mathcal{R} = 0.96
\]

\[
\beta_{\text{bw}} = 1 \quad \text{basicWork} = 0.2
\]
Energy-aware strategies on heterogeneous platforms

\[ \beta_{\text{bw}} = 1; \text{basicWork} = 0.2; R = 0.98 \]

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>1.25</td>
</tr>
<tr>
<td>0.50</td>
<td>1.50</td>
</tr>
<tr>
<td>0.75</td>
<td>1.75</td>
</tr>
<tr>
<td>1.00</td>
<td>2.00</td>
</tr>
</tbody>
</table>

- LowerBound
- energy-time
- time-energy
- randomShuffling

![Graph showing processor correlation vs ratio to the baseline for different correlation factors and scheduling types.](image-url)
Energy-aware strategies on heterogeneous platforms

\[ \beta_{b/w} = 1; \ \text{basicWork} = 0.3; \ \mathcal{R} = 0.9 \]
Energy-aware strategies on heterogeneous platforms

\( \beta_{b/w} = 1; \ basicWork = 0.3; \ \mathcal{R} = 0.92 \)

- **Processor correlation**
- **Ratio to the baseline**
- **LowerBound**
- **energy-energy**
- **energy-time**
- **time-energy**
- **randomShuffling**
Energy-aware strategies on heterogeneous platforms

\[
\beta_{b/w} = 1; \ basicWork = 0.3; \ R = 0.94
\]

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.25</td>
</tr>
<tr>
<td>0.25</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50</td>
<td>0.75</td>
</tr>
<tr>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Scheduling:
- LowerBound
- energy-time
- time-energy
- randomShuffling
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Processor correlation</th>
<th>doP</th>
<th>doR</th>
<th>inE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio to the baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>scheduling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LowerBound</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>energy-energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>energy-time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time-energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time-time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>randomShuffling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

βb/w = 1; basicWork = 0.3; R = 0.96

RR n° 9324
Energy-aware strategies on heterogeneous platforms

Processor correlation

Ratio to the baseline

scheduling

LowerBound

energy-energy

time-energy

time-time

random

randomShuffling

β_w = 1; basicWork = 0.3; R = 0.38

RR n° 9324
basicWork and $\mathcal{R}$ (Mapping)

The following section presents ratio of energy consumption using different mapping strategies under small failure rate, when varying basicWork and $\mathcal{R}$. 
Energy-aware strategies on heterogeneous platforms

- $R = 0.96$
- $R = 0.94$
- $R = 0.92$
- $R = 0.90$

- $\text{cor}_{\text{proc}} = 0$
- $\text{cor}_{\text{proc}} = 0.25$
- $\text{cor}_{\text{proc}} = 0.5$
- $\text{cor}_{\text{proc}} = 0.75$
- $\text{cor}_{\text{proc}} = 1$

- $\text{scheduling criteria: time-time}$

- $\text{cor}_{\text{task}} = 0.3$
Energy-aware strategies on heterogeneous platforms

\begin{align*}
R &= 0.98 \\
R &= 0.92 \\
R &= 0.94 \\
R &= 0.96 \\
\text{Basic Work} & = 0, \beta_{\text{min}} = 0.2, \text{ Scheduling criterion: time-energy}
\end{align*}

RR n° 9324
$cor_{task} = 0; \beta_{b/w} = 0.2; Scheduling$ criteria: energy-time

<table>
<thead>
<tr>
<th>$R$</th>
<th>$\gamma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>0.92</td>
<td>0.92</td>
</tr>
<tr>
<td>0.94</td>
<td>0.94</td>
</tr>
<tr>
<td>0.96</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 0; \beta\textsubscript{b/w} = 0.2; Scheduling criteria: energy-energy

mapping LowerBound deP deR inE random
Energy-aware strategies on heterogeneous platforms

\[ \text{corr}_{\text{task}} = 0; \beta_{b/w} = 0.4; \text{Scheduling criteria: time-time} \]
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ \text{cor} \text{proc} = 0 \]

\[ \text{cor} \text{proc} = 0.25 \]

\[ \text{cor} \text{proc} = 0.5 \]

\[ \text{cor} \text{proc} = 0.75 \]

\[ \text{cor} \text{proc} = 1 \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]

\[ \text{cor} \text{task} = 0; \text{β} \text{b/w} = 0.4; \text{Scheduling criteria: energy-time} \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms](image)

**Basic Work**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**Ratio to the baseline**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**Mapping**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**LowerBound**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**deP**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**deR**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**inE**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**Random**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**Scheduling criteria: energy-energy**

**cor**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**task**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**β**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**b/w**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**cor = 0, β₀ = 0.4**

**Scheduling criteria: energy-energy**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

**cor = 0, β₀ = 1**

**Scheduling criteria: energy-energy**

<table>
<thead>
<tr>
<th>&amp;</th>
<th>&amp;</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
<tr>
<td>&amp;</td>
<td>&amp;</td>
</tr>
</tbody>
</table>

RR n° 9324
$cor_{task} = 0; \beta_{b/w} = 0.4; \text{Scheduling criteria: randomShuffling}$
Energy-aware strategies on heterogeneous platforms

cor task = 0.75; \beta \text{b/w} = 1; Scheduling criteria: randomShuffling

Basic Work

Ratio to the baseline

Basic Work

mapping LowerBound deP deR inE random
\( \text{cor}_{\text{task}} = 1; \ \beta_{b/w} = 0.2; \) Scheduling criteria: time-time
$cor_{task} = 1$; $\beta_{b/w} = 0.2$; Scheduling criteria: energy-time

![Graph showing energy-aware strategies on heterogeneous platforms]
$cor_{task} = 1; \beta_{b/w} = 0.2$; Scheduling criteria: energy-energy
\( cor_{task} = 1; \beta_{b/w} = 0.2; \) Scheduling criteria: randomShuffling
Energy-aware strategies on heterogeneous platforms

R = 0.98

R = 0.96

R = 0.94

R = 0.92

R = 0.90

corr_{true} = 1; \beta_{0, w} = 0.4; Scheduling criteria: time-time

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\( cor_{task} = 1; \beta_{b/w} = 0.4; \) Scheduling criteria: time-energy
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0; \ \beta_{b/w} = 0.6; \ \text{Scheduling criteria: time-time} \)
$c_{\text{task}} = 1; \beta_{b/w} = 0.4; $ Scheduling criteria: randomShuffling

![Graphical data](image-url)

*Corrections to the baseline\footnote{Basic Work\footnote{Ratio to the baseline}}\footnote{LowerBound\footnote{deP\footnote{deR\footnote{inE\footnote{random}}}}\footnote{Scheduling criteria: randomShuffling}}*
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \ \beta_{b/w} = 0.6; \ \text{Scheduling criteria: time-time} \]
Energy-aware strategies on heterogeneous platforms

cor_{task} = 1; \beta_{b/w} = 0.6; Scheduling criteria: time-energy
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ cor_{\text{proc}} = 0 \]

\[ cor_{\text{proc}} = 0.25 \]

\[ cor_{\text{proc}} = 0.5 \]

\[ cor_{\text{proc}} = 0.75 \]

\[ cor_{\text{proc}} = 1 \]

Basic Work

\[ \text{Ratio to the baseline} \]

mapping

Correlation: energy-time

\[ cor_{\text{task}} = 1; \beta_{0,\text{uw}} = 0.6 \]

Scheduling criteria: energy-time

\[ \beta_{b/w} = 0.6 \]

\[ \text{scheduling} \text{, } \text{energy} \text{, } \text{time} \]
Energy-aware strategies on heterogeneous platforms

\[ R = 0.98 \]

\[ R = 0.96 \]

\[ R = 0.94 \]

\[ R = 0.92 \]

\[ R = 0.90 \]

\[ \text{cor}_{\text{task}} = 1; \beta_{\text{cor}} = 0.6; \text{Scheduling criteria: energy-energy} \]
Energy-aware strategies on heterogeneous platforms

$R = 0.9$. $\text{cor}_{\text{proc}} = 0.92$. $\text{cor}_{\text{proc}} = 0.94$. $\text{cor}_{\text{proc}} = 0.96$. $\text{cor}_{\text{proc}} = 0.98$.

cor proc $= 0.25$. cor proc $= 0.5$. cor proc $= 0.75$. cor proc $= 1.0$.

Basic Work

Ratio to the baseline

mapping

deP

deR

inE

random

$\text{cor}_{\text{task}} = 1; \beta_{0u} = 0.6$. Scheduling criteria: randomShuffling

RR n° 9324
Energy-aware strategies on heterogeneous platforms

cor_{task} = 1; \beta_{b/w} = 0.8; Scheduling criteria: time-time

Ratio to the baseline

Basic Work

mapping LowerBound deP deR inE random
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ \text{cor}_{\text{proc}} = 0 \]
\[ \text{cor}_{\text{proc}} = 0.25 \]
\[ \text{cor}_{\text{proc}} = 0.5 \]
\[ \text{cor}_{\text{proc}} = 0.75 \]
\[ \text{cor}_{\text{proc}} = 1 \]

Basic Work

Ratio to the baseline mapping

LowerBound
deP
deR
inE
random

Scheduling criteria: time-energy

cor_{task} = 1, \ beta_{w} = 0.8

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9, R' = 0.92, R'' = 0.94, R''' = 0.96, R'''' = 0.98 \]

\[ \text{cor} \text{proc} = 0, \text{cor} \text{proc} = 0.25, \text{cor} \text{proc} = 0.5, \text{cor} \text{proc} = 0.75, \text{cor} \text{proc} = 1 \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ \text{LowerBound} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]

\[ \text{Mapping} \]

\[ \beta_{\text{b/w}} = 0.8 \]

Scheduling criteria: energy-energy

\[ \text{cor} \text{task} = 1; \beta_{\text{dil}} = 0.8 \]
cor_{task} = 0; \beta_{b/w} = 0.6; Scheduling criteria: time-energy
$cor_{task} = 1; \beta_{b/w} = 0.8; $ Scheduling criteria: randomShuffling
Energy-aware strategies on heterogeneous platforms

\( cor_{\text{task}} = 1; \ \beta_{b/w} = 1; \ \text{Scheduling criteria: time-time} \)
Energy-aware strategies on heterogeneous platforms

$R = 0.98$

$R = 0.96$

$R = 0.94$

$R = 0.92$

$R = 0.9$

Mapping

- Correlated
- Correlation
- Correlation
- Correlation

Task

- Basic Work
- LowerBound
- Random

Optimization: % Time

- 0.00
- 0.50
- 1.00
- 1.50
- 2.00
- 2.50
- 3.00

Optimization: % Energy

- 0.00
- 0.50
- 1.00
- 1.50
- 2.00
- 2.50
- 3.00

Optimization: % Mapping

- 0.00
- 0.50
- 1.00
- 1.50
- 2.00
- 2.50
- 3.00
Energy-aware strategies on heterogeneous platforms

\[ R = 0.98 \]
\[ R = 0.96 \]
\[ R = 0.94 \]
\[ R = 0.92 \]
\[ R = 0.90 \]

\( \text{cor} \) task \( \beta \) /w \( \text{deP} \) \( \text{deR} \) inE random

Basic Work

LowerBound	 dlp
dcE 

mapping

RR n° 9324
$cor_{task} = 1; \beta_{b/w} = 1$; Scheduling criteria: energy-energy

Basic Work

Ratio to the baseline

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms
\( cor_{t\text{ask}} = 0; \; \beta_{b/w} = 0.6; \) Scheduling criteria: energy-time

Basic Work

Ratio to the baseline

mapping

LowerBound  deP  deR  inE  random
### Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>Correlation (ρ)</th>
<th>Basic Work</th>
<th>Lower Bound</th>
<th>deP</th>
<th>deR</th>
<th>inE</th>
<th>Random</th>
</tr>
</thead>
<tbody>
<tr>
<td>ρ = 0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ρ = 0.10</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
<td><img src="image3.png" alt="Graph" /></td>
<td><img src="image4.png" alt="Graph" /></td>
<td><img src="image5.png" alt="Graph" /></td>
<td><img src="image6.png" alt="Graph" /></td>
</tr>
<tr>
<td>ρ = 0.20</td>
<td><img src="image7.png" alt="Graph" /></td>
<td><img src="image8.png" alt="Graph" /></td>
<td><img src="image9.png" alt="Graph" /></td>
<td><img src="image10.png" alt="Graph" /></td>
<td><img src="image11.png" alt="Graph" /></td>
<td><img src="image12.png" alt="Graph" /></td>
</tr>
<tr>
<td>ρ = 0.30</td>
<td><img src="image13.png" alt="Graph" /></td>
<td><img src="image14.png" alt="Graph" /></td>
<td><img src="image15.png" alt="Graph" /></td>
<td><img src="image16.png" alt="Graph" /></td>
<td><img src="image17.png" alt="Graph" /></td>
<td><img src="image18.png" alt="Graph" /></td>
</tr>
</tbody>
</table>

**Correlation task**: ρ = 0; β̂_uw = 0.6. Scheduling criteria: energy-energy.
$\text{cor}_{\text{task}} = 0$; $\beta_{b/w} = 0.6$; Scheduling criteria: randomShuffling

Basic Work

Ratio to the baseline

Basic Work
Energy-aware strategies on heterogeneous platforms

![Graphical representation of energy-aware strategies on heterogeneous platforms.](image-url)
Energy-aware strategies on heterogeneous platforms
$\text{cor}_{\text{task}} = 0; \beta_{b/w} = 0.8; \text{Scheduling criteria: energy-time}$
Energy-aware strategies on heterogeneous platforms

\( cor_{task} = 0; \beta_{b/w} = 0.8; \) Scheduling criteria: energy-energy
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\sigma_{prw}$</th>
<th>$R$ = 0.98</th>
<th>$R$ = 0.96</th>
<th>$R$ = 0.94</th>
<th>$R$ = 0.92</th>
<th>$R$ = 0.90</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{cor}<em>{\text{task}} = 0; \beta</em>{\text{in}} = 0.8$</td>
<td>Scheduling criteria: randomShuffling</td>
<td>basic Work</td>
<td>LowerBound</td>
<td>deP</td>
<td>deR</td>
</tr>
<tr>
<td></td>
<td>$\text{cor}<em>{\text{task}} = 0; \beta</em>{\text{in}} = 0.8$</td>
<td>$\text{cor}<em>{\text{task}} = 0; \beta</em>{\text{in}} = 0.8$</td>
<td>$\text{cor}<em>{\text{task}} = 0; \beta</em>{\text{in}} = 0.8$</td>
<td>$\text{cor}<em>{\text{task}} = 0; \beta</em>{\text{in}} = 0.8$</td>
<td>$\text{cor}<em>{\text{task}} = 0; \beta</em>{\text{in}} = 0.8$</td>
</tr>
<tr>
<td>$\text{cor}<em>{\text{task}} = 0; \beta</em>{\text{in}} = 0.8$</td>
<td>Scheduling criteria: randomShuffling</td>
<td>basic Work</td>
<td>LowerBound</td>
<td>deP</td>
<td>deR</td>
</tr>
<tr>
<td>$\text{cor}<em>{\text{task}} = 0; \beta</em>{\text{in}} = 0.8$</td>
<td>Scheduling criteria: randomShuffling</td>
<td>basic Work</td>
<td>LowerBound</td>
<td>deP</td>
<td>deR</td>
</tr>
</tbody>
</table>

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>( \text{cor}_{\text{prev}} = 0 )</th>
<th>( \text{cor}_{\text{prev}} = 0.25 )</th>
<th>( \text{cor}_{\text{prev}} = 0.5 )</th>
<th>( \text{cor}_{\text{prev}} = 0.75 )</th>
<th>( \text{cor}_{\text{prev}} = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R = 0.06 )</td>
<td>( R = 0.10 )</td>
<td>( R = 0.14 )</td>
<td>( R = 0.18 )</td>
<td>( R = 0.22 )</td>
</tr>
<tr>
<td>( \text{cor}_{\text{proc}} = 0.10 )</td>
<td>( \text{cor}_{\text{proc}} = 0.10 )</td>
<td>( \text{cor}_{\text{proc}} = 0.10 )</td>
<td>( \text{cor}_{\text{proc}} = 0.10 )</td>
<td>( \text{cor}_{\text{proc}} = 0.10 )</td>
</tr>
<tr>
<td>( \text{cor}_{\text{proc}} = 0.15 )</td>
<td>( \text{cor}_{\text{proc}} = 0.15 )</td>
<td>( \text{cor}_{\text{proc}} = 0.15 )</td>
<td>( \text{cor}_{\text{proc}} = 0.15 )</td>
<td>( \text{cor}_{\text{proc}} = 0.15 )</td>
</tr>
<tr>
<td>( \text{cor}_{\text{proc}} = 0.20 )</td>
<td>( \text{cor}_{\text{proc}} = 0.20 )</td>
<td>( \text{cor}_{\text{proc}} = 0.20 )</td>
<td>( \text{cor}_{\text{proc}} = 0.20 )</td>
<td>( \text{cor}_{\text{proc}} = 0.20 )</td>
</tr>
<tr>
<td>( \text{cor}_{\text{proc}} = 0.25 )</td>
<td>( \text{cor}_{\text{proc}} = 0.25 )</td>
<td>( \text{cor}_{\text{proc}} = 0.25 )</td>
<td>( \text{cor}_{\text{proc}} = 0.25 )</td>
<td>( \text{cor}_{\text{proc}} = 0.25 )</td>
</tr>
<tr>
<td>( \text{cor}_{\text{proc}} = 0.30 )</td>
<td>( \text{cor}_{\text{proc}} = 0.30 )</td>
<td>( \text{cor}_{\text{proc}} = 0.30 )</td>
<td>( \text{cor}_{\text{proc}} = 0.30 )</td>
<td>( \text{cor}_{\text{proc}} = 0.30 )</td>
</tr>
</tbody>
</table>

Basic Work: \( \alpha_{\text{work}} = 0 \); \( \beta_{\text{work}} = 1 \). Mapping criteria: time-time.

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ R = 0.92 \]

\[ R = 0.94 \]

\[ R = 0.96 \]

\[ R = 0.98 \]

\[ \text{Basic Work Mapping} \]

\[ \text{cor task} = 0; \beta_{i,j}, \alpha = 1; \beta_{i,j}, \alpha = 1 \]

\[ \text{Scheduling criteria: time-energy} \]

\[ \text{Lower bound} \]

\[ \text{Initial solution} \]

\[ \text{Random} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]

\[ \text{Ir} \]
$cor_{task} = 0; \beta_{b/w} = 1$; Scheduling criteria: energy-time
$c_{\text{task}} = 0; \beta_{b/w} = 1$; Scheduling criteria: energy-energy

<table>
<thead>
<tr>
<th>R</th>
<th>$\text{cor}_{\text{proc}} = 0$</th>
<th>$\text{cor}_{\text{proc}} = 0.10$</th>
<th>$\text{cor}_{\text{proc}} = 0.15$</th>
<th>$\text{cor}_{\text{proc}} = 0.20$</th>
<th>$\text{cor}_{\text{proc}} = 0.25$</th>
<th>$\text{cor}_{\text{proc}} = 0.30$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.92</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work Ratio to the baseline
$\text{cor}_{\text{task}} = 0; \beta_{b/w} = 1; \text{Scheduling criteria: randomShuffling}$

Basic Work Ratio to the baseline

$\text{LowerBound} \rightarrow \text{deP} \rightarrow \text{deR} \rightarrow \text{inE} \rightarrow \text{random}$
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms](image-url)
Energy-aware strategies on heterogeneous platforms

corr = 0.25; \beta_{b/w} = 0.2; Scheduling criteria: time-energy

Basic Work

Ratio to the baseline

Scheduling criteria: time-energy
### Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$\text{R}$</th>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$\text{R}$</th>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$\text{R}$</th>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$\text{R}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.98</td>
<td>0.25</td>
<td>0.92</td>
<td>0.5</td>
<td>0.94</td>
<td>0.75</td>
<td>0.96</td>
</tr>
<tr>
<td>0.25</td>
<td>0.75</td>
<td>0.5</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>0.5</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
</tbody>
</table>

### Basic Work

- $\text{cor}_{\text{task}} = 0.25$, $\beta_{\text{uw}} = 0.2$, Scheduling criteria: energy-time

### LowerBound

- $\text{cor}_{\text{task}} = 0.25$, $\beta_{\text{uw}} = 0.2$, Scheduling criteria: energy-time

### deP, deR, inE, random

Scheduling criteria: energy-time
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\cos_{\text{pre}}$</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R = 0.98$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.96$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.94$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.92$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.90$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work: $\cos_{\text{task}} = 0.25$, $\beta_{\text{low}} = 0.2$; Scheduling criteria: energy-energy mapping

$\beta_{\text{b/w}} = 0.2$; $S_{\text{low}} = 0.00$; $S_{\text{high}} = 1.00$; $T_{\text{low}} = 0.00$; $T_{\text{high}} = 1.00$; $\delta_{\text{low}} = 0.00$; $\delta_{\text{high}} = 1.00$

RR n° 9324
$\text{cor}_{\text{task}} = 0.25; \beta_{b/w} = 0.2; \text{Scheduling criteria: randomShuffling}$
$\text{cor}_{\text{task}} = 0.25$; $\beta_{b/w} = 0.4$; Scheduling criteria: time-time
Energy-aware strategies on heterogeneous platforms

\[
cor_{task} = 0.25; \beta_{b/w} = 0.4; \text{Scheduling criteria: time-energy}
\]
Energy-aware strategies on heterogeneous platforms

- **Basic Work**
  - Ratio to the baseline
  - Mapping
  - Lower Bound
  - deP
  - deR
  - inE
  - random

- **cor**
  - cor_{task} = 0.25
  - β = 0.4
  - Scheduling criteria: energy-time

- **RR n° 9324**
Energy-aware strategies on heterogeneous platforms

![Diagram showing energy-aware strategies on heterogeneous platforms]

- \( R = 0.98 \)
- \( R = 0.96 \)
- \( R = 0.94 \)
- \( R = 0.92 \)
- \( R = 0.90 \)

- Correlation coefficient: \( \rho_{uw} = 0.25 \)
- \( \beta_{uw} = 0.4 \)
- Scheduling criteria: energy-energy

Basic Work

Correlation mapping

LowerBound: dP, b/w, \( \beta_{uw} \), random

Basic Work: energy-energy

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$cor_{pre}$</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R = 0.96$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.94$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.92$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.90$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work

Mapping

LowerBound

deP

deR

$eta_{thr} = 0.25, \beta_{thr} = 0.4$; Scheduling criteria: randomShuffling

RR n° 9324
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>( \text{cor}_{\text{pre}} = 0 )</th>
<th>( \text{cor}_{\text{pre}} = 0.25 )</th>
<th>( \text{cor}_{\text{pre}} = 0.5 )</th>
<th>( \text{cor}_{\text{pre}} = 0.75 )</th>
<th>( \text{cor}_{\text{pre}} = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R = 0.98 )</td>
<td>( R = 0.96 )</td>
<td>( R = 0.94 )</td>
<td>( R = 0.92 )</td>
<td>( R = 0.90 )</td>
</tr>
</tbody>
</table>

**Basic Work**

- Ratio to the baseline
- Mapping
- Correlation: task
- Task: \( \text{cor}_{\text{task}} = 0.25 \)
- \( \beta_{\text{acc}} = 0.6 \)
- Scheduling criteria: time-energy

**LowerBound**

- \( \text{deP} \)
- \( \text{deR} \)
- \( \text{inE} \)
- \( \text{random} \)

**Scheduling criteria: time-energy**

- \( \beta_{\text{b/w}} = 0.6 \)

**RR n° 9324**
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ R = 0.92 \]

\[ R = 0.96 \]

\[ R = 0.98 \]

\[ \text{cor task} = 0.25; \beta_{cor} = 0.6; \text{Scheduling criteria: energy-time} \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>( \text{cor}_{\text{pre}} )</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R )</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>( \text{R}_{\text{basic work}} )</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>( \text{cor}_{\text{task}} )</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>( \beta_{\text{bw}} )</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Scheduling criteria: energy-energy
cor_{\text{task}} = 0.25; \beta_{b/w} = 0.6; \text{Scheduling criteria: randomShuffling}
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 0.25; \beta_{b/w} = 0.8; Scheduling criteria: time-time
$cor_{task} = 0.25; \beta_{b/w} = 0.8$; Scheduling criteria: time-energy
Energy-aware strategies on heterogeneous platforms
\textit{cor}_{\text{task}} = 0.25; \beta_{b/w} = 0.8; \text{Scheduling criteria: energy-energy}

\text{Ratio to the baseline}

\text{Basic Work}

\text{mapping}  \rightarrow \text{LowerBound} \rightarrow \text{deP} \rightarrow \text{deR} \rightarrow \text{inE} \rightarrow \text{random}
Energy-aware strategies on heterogeneous platforms

\[ R = 0.98 \]

\[ R = 0.96 \]

\[ R = 0.94 \]

\[ R = 0.92 \]

\[ \text{cor}_{\text{task}} = 0.25; \beta_{\text{inv}} = 0.8; \text{Scheduling criteria: randomShuffling} \]

\[ \text{cor}_{\text{proc}} = 0 \]

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]

Basic Work

Perfect Mapping

\[ \text{cor}_{\text{proc}} \text{, cor}_{\text{task}} = 0.25; \beta_{\text{inv}} = 0.8; \text{Scheduling criteria: randomShuffling} \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms]

**Basic Work**: Ratio to the baseline mapping

**Scheduling criteria**: time-time

**Mapping categories**: LowLoad, HighLoad, HighLoad, LowLoad

**Graph axes**: x-axis: Load to the baseline; y-axis: Experimental results

**Variables**:
- \( \cos \theta_{corr} = 0 \)
- \( \cos \theta_{corr} = 0.25 \)
- \( \cos \theta_{corr} = 0.5 \)
- \( \cos \theta_{corr} = 0.75 \)
- \( \cos \theta_{corr} = 1 \)

**Additional parameters**:
- \( R = 0.98 \)
- \( R = 0.96 \)
- \( R = 0.94 \)
- \( R = 0.92 \)
- \( R = 0.90 \)
Energy-aware strategies on heterogeneous platforms

RR n° 9324
Energy-aware strategies on heterogeneous platforms

- $R = 0.98$
- $R = 0.96$
- $R = 0.94$
- $R = 0.92$

Scheduling criteria: energy-time

1. Correlation between the baseline and the proposed strategy.
2. Beta parameter: $0.25$, $0.50$, $0.75$, $1.00$.

RR n° 9324
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0.25; \; \beta_{b/w} = 1; \; \text{Scheduling criteria: energy-energy}
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \ \beta_{b/w} = 1; \ \text{Scheduling criteria: randomShuffling} \]

<table>
<thead>
<tr>
<th>( \mathcal{R} )</th>
<th>( \mathcal{R} = 0.9 )</th>
<th>( \mathcal{R} = 0.92 )</th>
<th>( \mathcal{R} = 0.94 )</th>
<th>( \mathcal{R} = 0.96 )</th>
<th>( \mathcal{R} = 0.98 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{cor}_{\text{proc}} )</td>
<td>( \text{cor}_{\text{proc}} = 0.10 )</td>
<td>( \text{cor}_{\text{proc}} = 0.15 )</td>
<td>( \text{cor}_{\text{proc}} = 0.20 )</td>
<td>( \text{cor}_{\text{proc}} = 0.25 )</td>
<td>( \text{cor}_{\text{proc}} = 0.30 )</td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

Mapping: LowerBound, deP, deR, inE, random
$cor_{task} = 0.5; \beta_{j,w} = 0.2$; Scheduling criteria: time-time
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; \beta_{b/w} = 0.2; Scheduling criteria: time-energy
Energy-aware strategies on heterogeneous platforms

\( cor_{task} = 0.5 \), \( \beta_{j.w} = 0.2 \); Scheduling criteria: energy-time

- Mapping
- LowerBound
- deP
- deR
- imE
- random
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>( \cos_{\text{proc}} )</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R = 0.98 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R = 0.96 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R = 0.94 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R = 0.92 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R = 0.90 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mapping: Lower bounds, \( \text{dep} \), \( \beta_{\text{w}} \), \( \beta_{\text{w}} \), random

Basic Work: \( \alpha \), \( \beta \), \( \alpha \), \( \beta \), \( \alpha \), \( \beta \)

Scheduling criteria: energy-energy

\( \cos_{\text{proc}} = 0.5, \beta_{\text{w}} = 0.2 \)
Energy-aware strategies on heterogeneous platforms

\[ \text{\textit{cor}}_{\text{task}} = 0.5; \ \beta_{j,w} = 0.4; \text{ Scheduling criteria: time-time} \]

<table>
<thead>
<tr>
<th>R</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>...</td>
</tr>
<tr>
<td>0.92</td>
<td>...</td>
</tr>
<tr>
<td>0.94</td>
<td>...</td>
</tr>
<tr>
<td>0.96</td>
<td>...</td>
</tr>
<tr>
<td>0.98</td>
<td>...</td>
</tr>
</tbody>
</table>

Basic Work

mapping: LowerBound, deP, deR, inE, random

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\alpha_{\text{pre}}$</th>
<th>$\beta_{\text{w}}$</th>
<th>$\gamma_{\text{time}}$</th>
<th>$\delta_{\text{energy}}$</th>
<th>$\epsilon_{\text{random}}$</th>
<th>$\zeta_{\text{mapping}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>0.25</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>0.5</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>0.75</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>1</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Scheduling criteria: time-energy

Basic Work

LowerBound

d.deP

d.deR

d.deE

RR n° 9324
$cor_{\text{task}} = 0.5; \beta_{j,w} = 0.4; \text{Scheduling criteria: energy-time}$
\( cor_{\text{task}} = 0.5; \ \beta_{j/w} = 0.4; \) Scheduling criteria: energy-energy
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_\text{task} = 0.5; \beta_{j,u} = 0.4; \) Scheduling criteria: randomShuffling

<table>
<thead>
<tr>
<th>( R )</th>
<th>LowerBound</th>
<th>deP</th>
<th>deR</th>
<th>inE</th>
<th>random</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.92</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

mapping: LowerBound, deP, deR, inE, random
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$cor_{prev}$</th>
<th>$R$</th>
<th>0.00</th>
<th>0.25</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td>0.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td>0.92</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work: $cor_{task} = 0.5, \beta_{w} = 0.6$, Scheduling criteria: time-time
$c_{\text{task}} = 0.5; \beta_{b/w} = 0.6; \text{Scheduling criteria: time-energy}$
Energy-aware strategies on heterogeneous platforms

$\text{cor}_{\text{task}} = 0.5; \beta_{j/c} = 0.6; \text{Scheduling criteria: energy-time}$

**Basic Work:**
- Correlation of tasks
- Mapping
- Scheduling criteria: energy-time

**Mapping:**
- LowerBound
- deP
- deR
- inE
- random

**Ratio to the baseline:**
- $R = 0.9$
- $R = 0.92$
- $R = 0.94$
- $R = 0.96$
- $R = 0.98$

**LowerBound:**
- $b/w = 0.6$
- $b/w = 0.75$
- $b/w = 1.0$

**Energy-time:**
- $0.10$
- $0.15$
- $0.20$
- $0.25$
- $0.30$
- $0.35$
- $0.40$

**Basic Work:**
- $0.00$
- $0.25$
- $0.50$
- $0.75$
- $1.00$
- $1.25$

**Energy-aware strategies on heterogeneous platforms**
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{corr}_{\text{proc}}$</th>
<th>$R = 0.98$</th>
<th>$R = 0.96$</th>
<th>$R = 0.94$</th>
<th>$R = 0.92$</th>
<th>$R = 0.90$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{corr}<em>{\text{task}} = 0$, $\beta</em>{E,M} = 0.6$; Scheduling criteria: energy-energy</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
<td><img src="image3.png" alt="Graph" /></td>
<td><img src="image4.png" alt="Graph" /></td>
<td><img src="image5.png" alt="Graph" /></td>
</tr>
</tbody>
</table>

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ R = 0.92 \]

\[ R = 0.94 \]

\[ R = 0.96 \]

\[ R = 0.98 \]

\[ \text{cor task} = 0.5, \beta_{d,l} = 0.6 \]

\[ \text{Scheduling criteria: randomShuffling} \]

\[ \text{Basic Work} \]

\[ \text{LowerBound} \]

\[ \text{dP} \]

\[ \text{dR} \]

\[ \text{random} \]

\[ \text{mapping} \]
\[ \text{cor}_{\text{task}} = 0.5; \beta_{b/w} = 0.8; \text{Scheduling criteria: time-time} \]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\beta_{\text{opt}}$</th>
<th>$\beta_{\text{opt}}$</th>
<th>$\beta_{\text{opt}}$</th>
<th>$\beta_{\text{opt}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_{\text{opt}} = 0.0$</td>
<td>$\beta_{\text{opt}} = 0.25$</td>
<td>$\beta_{\text{opt}} = 0.5$</td>
<td>$\beta_{\text{opt}} = 1$</td>
</tr>
<tr>
<td>$R = 0.98$</td>
<td>$R = 0.96$</td>
<td>$R = 0.94$</td>
<td>$R = 0.92$</td>
</tr>
</tbody>
</table>

Basic Work: $\text{cor}_{\text{proc}} = 0.10, \beta_{\text{opt}} = 0.8$; Scheduling criteria: time-energy

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ \text{cor}_{prac} = 0 \]

\[ \text{cor}_{prac} = 0.25 \]

\[ \text{cor}_{prac} = 0.5 \]

\[ \text{cor}_{prac} = 0.75 \]

\[ \text{cor}_{prac} = 1 \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ \text{LowerBound} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]

\[ \text{Scheduling criteria: randomShuffling} \]

\[ \text{cor}_{task} = 0.5, \beta_{\text{sh}} = 0.8 \]

\[ \beta_{\text{prac}} / \beta_{\text{sh}} = 0.8 \]

\[ \text{mapping} \]

\[ \text{cor}_{prac} \]

\[ \text{rr} \]

\[ \text{rr}^* \]

\[ \text{rr}^** \]
\[ \text{cor}_{\text{task}} = 0.5; \beta_{\text{r/w}} = 1; \text{Scheduling criteria: time-time} \]
Energy-aware strategies on heterogeneous platforms

### Basic Work

#### Ratio to the baseline

<table>
<thead>
<tr>
<th>$\text{corr}_{\text{task}} = 0.0$</th>
<th>$\text{corr}_{\text{task}} = 0.5$</th>
<th>$\text{corr}_{\text{task}} = 1.0$</th>
</tr>
</thead>
</table>

#### LowerBound

<table>
<thead>
<tr>
<th>$\beta_{w} = 0.0$</th>
<th>$\beta_{w} = 0.5$</th>
<th>$\beta_{w} = 1.0$</th>
</tr>
</thead>
</table>

#### Scheduling criteria: time-energy

<table>
<thead>
<tr>
<th>$\text{deR}$</th>
<th>$\text{deP}$</th>
<th>$\text{inE}$</th>
</tr>
</thead>
</table>

### RR $= 0.92$

<table>
<thead>
<tr>
<th>$\text{corr}_{\text{prac}} = 0$</th>
<th>$\text{corr}_{\text{prac}} = 0.25$</th>
<th>$\text{corr}_{\text{prac}} = 0.5$</th>
</tr>
</thead>
</table>

### RR $= 0.94$

<table>
<thead>
<tr>
<th>$\text{corr}_{\text{prac}} = 0$</th>
<th>$\text{corr}_{\text{prac}} = 0.25$</th>
<th>$\text{corr}_{\text{prac}} = 0.5$</th>
</tr>
</thead>
</table>

### RR $= 0.96$

<table>
<thead>
<tr>
<th>$\text{corr}_{\text{prac}} = 0$</th>
<th>$\text{corr}_{\text{prac}} = 0.25$</th>
<th>$\text{corr}_{\text{prac}} = 0.5$</th>
</tr>
</thead>
</table>

### RR $= 0.98$

<table>
<thead>
<tr>
<th>$\text{corr}_{\text{prac}} = 0$</th>
<th>$\text{corr}_{\text{prac}} = 0.25$</th>
<th>$\text{corr}_{\text{prac}} = 0.5$</th>
</tr>
</thead>
</table>

**Legend:**
- Low-load: red
- High-load: green
- Mapping: blue
- Scheduling criteria: orange
- Baseline: black
$R_{\text{task}} = 0.5; \beta_{b/w} = 1; \text{Scheduling criteria: energy-time}$
Energy-aware strategies on heterogeneous platforms

\[ c_{\text{task}} = 0.5; \beta_{\text{r/w}} = 1; \] Scheduling criteria: energy-energy
### Energy-aware strategies on heterogeneous platforms

![Graph showing energy-aware strategies on heterogeneous platforms]
Energy-aware strategies on heterogeneous platforms

\[ R = 0.98 \]

\[ R = 0.96 \]

\[ R = 0.94 \]

\[ R = 0.92 \]

\[ R = 0.90 \]

\[ cor_{\text{proc}} = 0 \]

\[ cor_{\text{proc}} = 0.25 \]

\[ cor_{\text{proc}} = 0.5 \]

\[ cor_{\text{proc}} = 0.75 \]

\[ cor_{\text{proc}} = 1 \]

Basic Work

\[ \text{Ratio to the baseline} \]

LowerBound
deP
deR
inE

random

Scheduling criteria: time-time

\[ \text{cor}_{\text{task}} = 0.75, \beta_{\text{in}} = 0.2 \]

\[ \beta_{\text{in}} = 0.25; Scheduling criteria: time-time \]
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} \text{=} 0.75; \beta_{b/w} = 0.2; Scheduling criteria: time-energy

task = 0.75; \beta_{b/w} = 0.2; Scheduling criteria: time-energy
$cor_{task} = 0.75; \beta_{b/w} = 0.2$; Scheduling criteria: energy-time.
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ R = 0.98 \]
\[ R = 0.96 \]
\[ R = 0.94 \]
\[ R = 0.92 \]
\[ R = 0.90 \]

Correlation between tasks: \( \rho_{task} = 0.75 \);
\( \beta_{app} = 0.4 \).

Scheduling criteria: time-time

Basic Work

\[ cor_{proc} = 0 \]
\[ cor_{proc} = 0.25 \]
\[ cor_{proc} = 0.5 \]
\[ cor_{proc} = 0.75 \]
\[ cor_{proc} = 1 \]

Relative to the baseline
\( \text{cor}_{\text{task}} = 0.75; \ \beta_{b/w} = 0.4; \ \text{Scheduling criteria: time-energy} \)
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>( \text{cor}_{\text{perm}} = 0 )</th>
<th>( \text{cor}_{\text{perm}} = 0.25 )</th>
<th>( \text{cor}_{\text{perm}} = 0.5 )</th>
<th>( \text{cor}_{\text{perm}} = 0.75 )</th>
<th>( \text{cor}_{\text{perm}} = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R = 0.98 )</td>
<td>( R = 0.96 )</td>
<td>( R = 0.94 )</td>
<td>( R = 0.92 )</td>
<td>( R = 0.9 )</td>
</tr>
</tbody>
</table>

Basic Work, LowerBound, ddp, dR, mE, rakek

Scheduling criteria: energy-time

\( \text{cor}_{\text{task}} = 0.75, \beta_{\text{uw}} = 0.4 \)
$cor_{task} = 0.75; \beta_{b/w} = 0.4$; Scheduling criteria: energy-energy
Energy-aware strategies on heterogeneous platforms

\[ R = 0.98 \]

\[ R = 0.96 \]

\[ R = 0.94 \]

\[ R = 0.92 \]

\[ R = 0.9 \]

Basic Work

\[ \text{Ratio to the baseline} \]

\[ \text{mapping} \]

\[ \text{LowerBound} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random}Shuffling \]

\[ \text{randomShuffling} \]

\[ \text{RR} \]

\[ \text{n} \]

\[ \text{o} \]

\[ \text{9324} \]
Energy-aware strategies on heterogeneous platforms

\[ \text{corr}_{\text{task}} = 0.75; \; \beta_{b/w} = 0.6; \text{Scheduling criteria: time-time} \]
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$cor_{proc} = 0$</th>
<th>$cor_{proc} = 0.25$</th>
<th>$cor_{proc} = 0.5$</th>
<th>$cor_{proc} = 0.75$</th>
<th>$cor_{proc} = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R = 0.98$</td>
<td>$R = 0.96$</td>
<td>$R = 0.94$</td>
<td>$R = 0.92$</td>
<td>$R = 0.90$</td>
</tr>
<tr>
<td>$\rho_{task}$</td>
<td>$\beta_{bw}$</td>
<td>$\delta_{uw}$</td>
<td>$\lambda_{deP}$</td>
<td>$\delta_{deR}$</td>
</tr>
</tbody>
</table>

Scheduling criteria: time-energy

Basic Work

Mapping

Low-bottleneck

Mapping

High-bottleneck

Scheduling criteria: time-energy

Basic Work

Low-bottleneck

High-bottleneck
Energy-aware strategies on heterogeneous platforms

\[ R = 0.98 \]

\[ R = 0.92 \]

\[ R = 0.96 \]

\[ R = 0.94 \]

\[ R = 0.98 \]

\[ \text{Baseline Work} \]

\[ \text{Ratio to the baseline} \]

\[ \text{Lower Bound} \]

\[ \text{deP} \]

\[ \text{deR} \]

\[ \text{inE} \]

\[ \text{random} \]

\[ \text{scheduling criteria: energy-time} \]

\[ \text{cost} \tau_{\text{in}} = 0.75; \beta_{\text{in}} = 0.6; \text{Scheduling criteria: energy-time} \]
$r_{\text{task}} = 0.75$; $\beta_{b/w} = 0.6$; Scheduling criteria: energy-energy
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\cos_{\text{prev}}$</th>
<th>$R = 0.96$</th>
<th>$R = 0.94$</th>
<th>$R = 0.92$</th>
<th>$R = 0.90$</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor proc = 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor proc = 0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor proc = 0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor proc = 0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cor proc = 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

Mapping

LowerBound: df.p, df.p, df.4, df.4, randomShuffling

Scheduling criteria: randomShuffling

RR n° 9324
\( \text{core}_{\text{task}} = 0.75; \; \beta_{b/w} = 0.8; \) Scheduling criteria: time-time

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\( \text{cor}_{\text{task}} = 0.75; \ \beta_{b/w} = 0.8; \ \text{Scheduling criteria: time-energy} \)

Basic Work

Ratio to the baseline

mapping: LowerBound, deP, deR, deE, random
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_\text{task} = 0.75; \ \beta_{b/w} = 0.8; \text{Scheduling criteria: energy-energy} \]
Energy-aware strategies on heterogeneous platforms

\[ cor_{\text{task}} = 0.75; \beta_{b/w} = 0.8; \text{Scheduling criteria: randomShuffling} \]

<table>
<thead>
<tr>
<th>( R = 0.9 )</th>
<th>( R = 0.92 )</th>
<th>( R = 0.94 )</th>
<th>( R = 0.96 )</th>
<th>( R = 0.98 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>0.05</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
</tr>
<tr>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>0.05</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Mapping: LowerBound, deP, deR, inE, random

Energy-aware strategies on heterogeneous platforms
### Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$cor_{pre} = 0$</th>
<th>$cor_{pre} = 0.25$</th>
<th>$cor_{pre} = 0.5$</th>
<th>$cor_{pre} = 0.75$</th>
<th>$cor_{pre} = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R = 0.98$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.96$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.94$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.92$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R = 0.90$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Basic Work**

**Scheduling criteria:** time-time

$cor_{task} = 0.75, \beta_{\delta_{uw}} = 1$

$R/R_{b/w} = 1$

### Mapping

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>$cor_{baseline}$</th>
<th>$cor_{deP}$</th>
<th>$cor_{deR}$</th>
<th>$cor_{inE}$</th>
<th>$cor_{random}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

**LowerBound**

$cor_{baseline} = 0.00, \beta_{\delta_{uw}} = 0$

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>$cor_{baseline}$</th>
<th>$cor_{deP}$</th>
<th>$cor_{deR}$</th>
<th>$cor_{inE}$</th>
<th>$cor_{random}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

**Scheduling criteria:** time-time

$cor_{task} = 0.75, \beta_{\delta_{uw}} = 1$

$R/R_{b/w} = 1$

### Results

<table>
<thead>
<tr>
<th>$R$</th>
<th>$cor_{baseline}$</th>
<th>$cor_{deP}$</th>
<th>$cor_{deR}$</th>
<th>$cor_{inE}$</th>
<th>$cor_{random}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

### Analysis

- Energy-aware strategies on heterogeneous platforms are crucial for optimizing performance and efficiency.
- The choice of $cor_{pre}$ significantly affects the performance metrics.
- Basic Work algorithms outperform others in terms of lower bounds.
- Scheduling criteria play a critical role in achieving optimal results.

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\[ R = 0.98 \]

\[ R = 0.96 \]

\[ R = 0.94 \]

\[ R = 0.92 \]

\[ R = 0.9 \]

\[ \text{cor}_{\text{proc}} = 0 \]

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]

Basic Work

LowerBound

deP

deR

inE

random

Scheduling criteria: time-energy
$corr_{task} = 0.75; \beta_{b/w} = 1; $ Scheduling criteria: energy-time
Energy-aware strategies on heterogeneous platforms

\( cor_{task} = 0.75; \beta_{b/w} = 1; \) Scheduling criteria: energy-energy
basicWork and $\mathcal{R}$ (Scheduling)

The following section presents ratio of energy consumption using different scheduling strategies under small failure rate, when varying basicWork and $\mathcal{R}$. 
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0; \ \beta_{b/w} = 0.2; \ \text{Mapping criteria: inE} \]

<table>
<thead>
<tr>
<th>R = 0.9</th>
<th>R = 0.92</th>
<th>R = 0.94</th>
<th>R = 0.96</th>
<th>R = 0.98</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Work</td>
<td>Ratio to the baseline</td>
<td>LowerBound</td>
<td>energy-energy</td>
<td>time-energy</td>
</tr>
<tr>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

- LowerBound
- energy-energy
- time-energy
- randomShuffling
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0; \beta_{b/w} = 0.2; \text{ Mapping criteria: deR} \]

\[ R = 0.9 \quad R = 0.92 \quad R = 0.94 \quad R = 0.96 \quad R = 0.98 \]

\[ \text{cor}_{\text{proc}} = 0.25; \text{cor}_{\text{proc}} = 0.5; \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{LowerBound} \quad \text{energy-energy} \quad \text{energy-time} \quad \text{time-energy} \quad \text{time-time} \]

\[ \text{scheduling} \quad \text{LowerBound} \quad \text{energy-time} \quad \text{time-energy} \quad \text{randomShuffling} \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ \text{LowerBound} \quad \text{energy-energy} \quad \text{energy-time} \quad \text{time-energy} \quad \text{time-time} \]
Energy-aware strategies on heterogeneous platforms

Basic Work

Ratio to the baseline

scheduling

cor_{pren} = 0
cor_{pren} = 0.25
cor_{pren} = 0.5
cor_{pren} = 0.75
cor_{pren} = 1

$R = 0.98$

$R = 0.96$

$R = 0.94$

$R = 0.92$

$cor_{task} = 0; \beta_{b/w} = 0.2; Mapping criteria: deP$
$cor_{task} = 0; \beta_{b/w} = 0.2; \text{Mapping criteria: random}$
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0; \beta_{b/w} = 0.4; Mapping criteria: inE

<table>
<thead>
<tr>
<th>N</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>0.92</td>
<td></td>
</tr>
<tr>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>0.98</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>LowerBound</th>
<th>energy-time</th>
<th>time-energy</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
</tr>
<tr>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
</tr>
<tr>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
<td>0.45</td>
</tr>
<tr>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
<td>0.45</td>
<td>0.50</td>
</tr>
<tr>
<td>0.35</td>
<td>0.40</td>
<td>0.45</td>
<td>0.50</td>
<td>0.55</td>
</tr>
<tr>
<td>0.40</td>
<td>0.45</td>
<td>0.50</td>
<td>0.55</td>
<td>0.60</td>
</tr>
<tr>
<td>0.45</td>
<td>0.50</td>
<td>0.55</td>
<td>0.60</td>
<td>0.65</td>
</tr>
<tr>
<td>0.50</td>
<td>0.55</td>
<td>0.60</td>
<td>0.65</td>
<td>0.70</td>
</tr>
<tr>
<td>0.55</td>
<td>0.60</td>
<td>0.65</td>
<td>0.70</td>
<td>0.75</td>
</tr>
<tr>
<td>0.60</td>
<td>0.65</td>
<td>0.70</td>
<td>0.75</td>
<td>0.80</td>
</tr>
<tr>
<td>0.65</td>
<td>0.70</td>
<td>0.75</td>
<td>0.80</td>
<td>0.85</td>
</tr>
<tr>
<td>0.70</td>
<td>0.75</td>
<td>0.80</td>
<td>0.85</td>
<td>0.90</td>
</tr>
<tr>
<td>0.75</td>
<td>0.80</td>
<td>0.85</td>
<td>0.90</td>
<td>0.95</td>
</tr>
<tr>
<td>0.80</td>
<td>0.85</td>
<td>0.90</td>
<td>0.95</td>
<td>1.00</td>
</tr>
<tr>
<td>0.85</td>
<td>0.90</td>
<td>0.95</td>
<td>1.00</td>
<td>1.05</td>
</tr>
<tr>
<td>0.90</td>
<td>0.95</td>
<td>1.00</td>
<td>1.05</td>
<td>1.10</td>
</tr>
<tr>
<td>0.95</td>
<td>1.00</td>
<td>1.05</td>
<td>1.10</td>
<td>1.15</td>
</tr>
<tr>
<td>1.00</td>
<td>1.05</td>
<td>1.10</td>
<td>1.15</td>
<td>1.20</td>
</tr>
</tbody>
</table>


r = 0.10

\text{cor proc} = 0.25; \text{cor proc} = 0.50; \text{cor proc} = 0.75; \text{cor proc} = 1.00;
Energy-aware strategies on heterogeneous platforms

\[ cor_{task} = 0; \beta_{b/w} = 0.4; \text{Mapping criteria: deR} \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ \text{scheduling} \]

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_task = 0; \beta_{b/w} = 0.4; Mapping criteria: deP
$\text{cor}_{\text{task}} = 0$; $\beta_{b/w} = 0.4$; Mapping criteria: random

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\(c_{\text{task}} = 0; \beta_{b/w} = 0.6; \text{ Mapping criteria: inE}\)

- \(R = 0.9\)
- \(R = 0.92\)
- \(R = 0.94\)
- \(R = 0.96\)
- \(R = 0.98\)

Ratio to the baseline

Basic Work

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor task = 0; β b/w = 0.6; Mapping criteria: deR

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>1.00</td>
</tr>
<tr>
<td>0.15</td>
<td>0.95</td>
</tr>
<tr>
<td>0.20</td>
<td>0.90</td>
</tr>
<tr>
<td>0.25</td>
<td>0.85</td>
</tr>
<tr>
<td>0.30</td>
<td>0.80</td>
</tr>
<tr>
<td>0.35</td>
<td>0.75</td>
</tr>
<tr>
<td>0.40</td>
<td>0.70</td>
</tr>
<tr>
<td>0.45</td>
<td>0.65</td>
</tr>
<tr>
<td>0.50</td>
<td>0.60</td>
</tr>
<tr>
<td>0.55</td>
<td>0.55</td>
</tr>
<tr>
<td>0.60</td>
<td>0.50</td>
</tr>
<tr>
<td>0.65</td>
<td>0.45</td>
</tr>
<tr>
<td>0.70</td>
<td>0.40</td>
</tr>
<tr>
<td>0.75</td>
<td>0.35</td>
</tr>
<tr>
<td>0.80</td>
<td>0.30</td>
</tr>
<tr>
<td>0.85</td>
<td>0.25</td>
</tr>
<tr>
<td>0.90</td>
<td>0.20</td>
</tr>
<tr>
<td>0.95</td>
<td>0.15</td>
</tr>
<tr>
<td>1.00</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms

scheduling LowerBound energy-time time-time energy-energy time-energy randomShuffling

RR n° 9234
Energy-aware strategies on heterogeneous platforms

cor_{task} = 1; \beta_{b/w} = 1; Mapping criteria: random
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 0; \beta_{b/w} = 0.6; Mapping criteria: deP

<table>
<thead>
<tr>
<th>\text{Ratio to the baseline}</th>
<th>\text{Basic Work}</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{LowerBound}</td>
<td>0.10</td>
</tr>
<tr>
<td>energy-energy</td>
<td>0.15</td>
</tr>
<tr>
<td>energy-time</td>
<td>0.20</td>
</tr>
<tr>
<td>time-energy</td>
<td>0.25</td>
</tr>
<tr>
<td>time-time</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms
$c_{\text{or task}} = 0; \beta_{b/w} = 0.8; \text{Mapping criteria: inE}$
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ \text{cor proc} = 0.25 \]

\[ \text{cor proc} = 0.5 \]

\[ \text{cor proc} = 0.75 \]

\[ \text{cor proc} = 1 \]

Basic Work

Ratio to the baseline

Energy-energy

Energy-time

Time-energy

Time-time

randomShuffling

mapping criteria: deR

\[ \text{cor task} = 0; \beta_{b/w} = 0.8 \]

\[ \text{cor task} = 0.93 \]

\[ n = 24 \]
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0; \beta_{b/w} = 0.8; Mapping criteria: deP
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_\text{task} = 0; \beta_{b/w} = 0.8; \text{Mapping criteria: random} \]

![Graph showing energy efficiency across different basic work and scheduling methods.](image_url)
Energy-aware strategies on heterogeneous platforms

cor\_{task} = 0; \beta_{b/w} = 1; Mapping criteria: deR

<table>
<thead>
<tr>
<th>R</th>
<th>cor_{proc}</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.10</td>
</tr>
<tr>
<td>0.92</td>
<td>0.15</td>
</tr>
<tr>
<td>0.94</td>
<td>0.20</td>
</tr>
<tr>
<td>0.96</td>
<td>0.25</td>
</tr>
<tr>
<td>0.98</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>LowerBound</th>
<th>energy-time</th>
<th>time-energy</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
</tbody>
</table>
$cor_{task} = 0; \beta_{b/w} = 1; \text{Mapping criteria: deP}$

Basic Work

Ratio to the baseline

LowerBound

energy-energy

time-energy

energy-time

time-time

randomShuffling

Eyeright-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor\_{task} = 0; \beta_{b/w} = 1; Mapping criteria: random

Basic Work

Ratio to the baseline
$\text{cor}_{\text{task}} = 0.25$; $\beta_{b/w} = 0.2$; Mapping criteria: inE
$c_{\text{task}} = 0.25$; $\beta_{b/w} = 0.2$; Mapping criteria: deR
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \quad \beta_{b/w} = 0.2; \quad \text{Mapping criteria: deP} \]

<table>
<thead>
<tr>
<th>R</th>
<th>0.9</th>
<th>0.92</th>
<th>0.94</th>
<th>0.96</th>
<th>0.98</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>cor</th>
<th>proc</th>
<th>0.10</th>
<th>0.15</th>
<th>0.20</th>
<th>0.25</th>
<th>0.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td></td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

Energy-aware strategies on heterogeneous platforms
\( \text{cor}_{\text{task}} = 0.25; \ \beta_{b/w} = 0.2; \text{ Mapping criteria: random} \)
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.25; \beta_{b/w} = 0.4; Mapping criteria: inE

\[ R = 0.9 \]
\[ R = 0.92 \]
\[ R = 0.94 \]
\[ R = 0.96 \]
\[ R = 0.98 \]

Basic Work

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>0.10</th>
<th>0.15</th>
<th>0.20</th>
<th>0.25</th>
<th>0.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Ratio to the baseline

Energy-aware strategies on heterogeneous platforms

scheduling

LowerBound \[ \text{energy-energy} \] \[ \text{time-energy} \] \[ \text{randomShuffling} \]
$c_{or\text{ task}} = 0.25$; $\beta_{b/w} = 0.4$; Mapping criteria: deR
$cor_{task} = 0.25$; $\beta_{b/w} = 0.4$; Mapping criteria: deP
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \quad \beta_{b/w} = 0.4; \quad \text{Mapping criteria: random} \]
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.25; \] \[ \beta_{\text{b/w}} = 0.6; \] Mapping criteria: inE

<table>
<thead>
<tr>
<th>( \mathcal{N} = 0.9 )</th>
<th>( \mathcal{N} = 0.92 )</th>
<th>( \mathcal{N} = 0.94 )</th>
<th>( \mathcal{N} = 0.96 )</th>
<th>( \mathcal{N} = 0.98 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Work</td>
<td>Ratio to the baseline</td>
<td>Basic Work</td>
<td>Ratio to the baseline</td>
<td>Basic Work</td>
</tr>
<tr>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
<td>0.35</td>
</tr>
<tr>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>0.55</td>
<td>0.55</td>
<td>0.55</td>
<td>0.55</td>
<td>0.55</td>
</tr>
<tr>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>0.65</td>
<td>0.65</td>
<td>0.65</td>
<td>0.65</td>
<td>0.65</td>
</tr>
<tr>
<td>0.70</td>
<td>0.70</td>
<td>0.70</td>
<td>0.70</td>
<td>0.70</td>
</tr>
<tr>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>0.80</td>
<td>0.80</td>
<td>0.80</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td>0.85</td>
<td>0.85</td>
<td>0.85</td>
<td>0.85</td>
<td>0.85</td>
</tr>
<tr>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
</tr>
<tr>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
<td>0.95</td>
</tr>
<tr>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1.05</td>
<td>1.05</td>
<td>1.05</td>
<td>1.05</td>
<td>1.05</td>
</tr>
<tr>
<td>1.10</td>
<td>1.10</td>
<td>1.10</td>
<td>1.10</td>
<td>1.10</td>
</tr>
<tr>
<td>1.15</td>
<td>1.15</td>
<td>1.15</td>
<td>1.15</td>
<td>1.15</td>
</tr>
<tr>
<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
</tr>
<tr>
<td>1.25</td>
<td>1.25</td>
<td>1.25</td>
<td>1.25</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Scheduling: LowerBound, energy-energy, time-time, randomShufflig
$\text{cor}_{\text{task}} = 0.25$; $\beta_{b/w} = 0.6$; Mapping criteria: deR

<table>
<thead>
<tr>
<th>$R$</th>
<th>0.9</th>
<th>0.92</th>
<th>0.94</th>
<th>0.96</th>
<th>0.98</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Work</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
</tbody>
</table>
| Ratio to the baseline | LowerBound | energy-time | time-energy | randomShuffling

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.25; \beta_{b/w} = 0.6; Mapping criteria: deP
cor_{task} = 0.25; \beta_{b/w} = 0.6; Mapping criteria: random
$cor_{task} = 0.25$; $\beta_{b/w} = 0.8$; Mapping criteria: inE

<table>
<thead>
<tr>
<th>$\mathcal{R}$</th>
<th>$cor_{proc}$</th>
<th>$energy-energy$</th>
<th>$energy-time$</th>
<th>$time-energy$</th>
<th>$time-time$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>0.92</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>0.94</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>0.96</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>0.98</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

scheduling

LowerBound: energy-energy, time-time
energy-energy, time-energy, randomShuffling
\( cor_{\text{task}} = 0.25; \ \beta_{\text{b/w}} = 0.8; \ \text{Mapping criteria: deR} \)

<table>
<thead>
<tr>
<th>( \mathcal{R} )</th>
<th>( \mathcal{R} )</th>
<th>( \mathcal{R} )</th>
<th>( \mathcal{R} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.92</td>
<td>0.94</td>
<td>0.96</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>LowerBound</th>
<th>energy-time</th>
<th>time-energy</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
</tr>
<tr>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
</tr>
<tr>
<td>0.30</td>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
<td>0.40</td>
</tr>
</tbody>
</table>
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>cor$_{proc}$</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.98</td>
<td>0.96</td>
<td>0.94</td>
<td>0.96</td>
<td>0.98</td>
</tr>
</tbody>
</table>

\[ R = 0.98 \]

\[ \text{cor}_{\text{proc}} = 0 \]

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]

<table>
<thead>
<tr>
<th>cor$_{task}$</th>
<th>0.25</th>
<th>( \beta_{\text{dP}} ) = 0.8</th>
<th>Mapping criteria: deP</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.92</td>
<td>0.92</td>
<td>0.92</td>
</tr>
</tbody>
</table>

\[ \text{cor}_{\text{task}} = 0.25 ; \beta_{\text{dP}} = 0.8 \]

Basic Work

LowerBound

Energy-time

Time-energy

Random Shuffling

RR n° 9324
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.25; \beta_{b/w} = 0.8; Mapping criteria: random

Basic Work

Ratio to the baseline

0.00 0.25 0.50 0.75 1.00

0.10 0.15 0.20 0.25 0.30 0.35

LowerBound  energy-energy  time-energy  randomShuffling
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ \text{cor}_{e,n} = 0 \]

\[ \text{cor}_{e,n} = 0.25 \]

\[ \text{cor}_{e,n} = 0.5 \]

\[ \text{cor}_{e,n} = 0.75 \]

\[ \text{cor}_{e,n} = 1 \]

Basic Work

Ratio to the baseline

scheduling

LowerBound

energy-energy
energy-time
time-energy
time-time
randomShuffling

\[ \text{cor}_{e,n} = 0.25; \beta_{n,w} = 1; \text{Mapping criteria: inE} \]

\[ \text{cor}_{e,n} = 0.5 \]

\[ \text{cor}_{e,n} = 0.75 \]

\[ \text{cor}_{e,n} = 1 \]

\[ R = 0.92 \]

\[ R = 1 \]

\[ R = 0.98 \]

\[ R = 0.96 \]

\[ R = 0.94 \]

RR n° 9324
Energy-aware strategies on heterogeneous platforms

Correlation of task $\rho_{\text{task}} = 0.25$; correlation of hardware $\beta_{\text{hw}} = 1$; Mapping criteria: deR

<table>
<thead>
<tr>
<th>$\mathcal{R}$</th>
<th>LowerBound</th>
<th>Energy-Time</th>
<th>Time-Energy</th>
<th>RandomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mathcal{R} = 0.9$</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
<td><img src="image3.png" alt="Graph" /></td>
<td><img src="image4.png" alt="Graph" /></td>
</tr>
<tr>
<td>$\mathcal{R} = 0.92$</td>
<td><img src="image5.png" alt="Graph" /></td>
<td><img src="image6.png" alt="Graph" /></td>
<td><img src="image7.png" alt="Graph" /></td>
<td><img src="image8.png" alt="Graph" /></td>
</tr>
<tr>
<td>$\mathcal{R} = 0.94$</td>
<td><img src="image9.png" alt="Graph" /></td>
<td><img src="image10.png" alt="Graph" /></td>
<td><img src="image11.png" alt="Graph" /></td>
<td><img src="image12.png" alt="Graph" /></td>
</tr>
<tr>
<td>$\mathcal{R} = 0.96$</td>
<td><img src="image13.png" alt="Graph" /></td>
<td><img src="image14.png" alt="Graph" /></td>
<td><img src="image15.png" alt="Graph" /></td>
<td><img src="image16.png" alt="Graph" /></td>
</tr>
<tr>
<td>$\mathcal{R} = 0.98$</td>
<td><img src="image17.png" alt="Graph" /></td>
<td><img src="image18.png" alt="Graph" /></td>
<td><img src="image19.png" alt="Graph" /></td>
<td><img src="image20.png" alt="Graph" /></td>
</tr>
</tbody>
</table>

Basic Work Ratio to the baseline

scheduling

LowerBound | energy-time | time-energy | randomShuffling

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$\text{R}$</th>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$\text{R}$</th>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$\text{R}$</th>
<th>$\text{cor}_{\text{proc}}$</th>
<th>$\text{R}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.00</td>
<td>0.25</td>
<td>0.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.75</td>
<td>0.00</td>
</tr>
<tr>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

scheduling, lowerBound, energy-time, energy-energy, time-energy, task-to-Shuffling

$\text{cor}_{\text{task}} = 0.25, \beta_{\text{d/w}} = 1$; Mapping criteria: deP

RR n° 9324
Energy-aware strategies on heterogeneous platforms

\( cor_{task} = 0.25; \beta_{b/w} = 1; \) MAPPING CRITERIA: random

**Basic Work**

- LowerBound
- Energy-Time
- Time-Time
- RandomShuffling

**Ratio to the baseline**
$cotask = 0.5; \beta_{bw} = 0.2;$ Mapping criteria: inE
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.5; \quad \beta_{\text{rel}} = 0.2; \quad \text{Mapping criteria: deR} \]

<table>
<thead>
<tr>
<th>( \beta )</th>
<th>( \text{LowerBound} )</th>
<th>( \text{energy-energy} )</th>
<th>( \text{energy-time} )</th>
<th>( \text{time-energy} )</th>
<th>( \text{time-time} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>0.92</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>0.94</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>0.96</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>0.98</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

0.10  0.15  0.20  0.25  0.30  0.10  0.15  0.20  0.25  0.30

LowerBound  energy-energy  energy-time  time-energy  time-time
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_\text{task} = 0.5; \beta_{f,w} = 0.2; \text{Mapping criteria: deP} \]

<table>
<thead>
<tr>
<th>R</th>
<th>0.9</th>
<th>0.92</th>
<th>0.94</th>
<th>0.96</th>
<th>0.98</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Work</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>Ratio to the baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Bound</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy-Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time-Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random Shuffling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The diagram illustrates the performance of different scheduling strategies on various load levels, with the correlation of tasks and the weight of energy and time being key factors.
$R_{t_{ask}} = 0.5$, $\beta_{b/w} = 0.2$; Mapping criteria: random
### Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{prev}}$</th>
<th>$R = 0.98$</th>
<th>$R = 0.96$</th>
<th>$R = 0.94$</th>
<th>$R = 0.92$</th>
<th>$R = 0.9$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{cor}_{\text{prev}} = 0$</td>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
<td><img src="image3" alt="Graph" /></td>
<td><img src="image4" alt="Graph" /></td>
<td><img src="image5" alt="Graph" /></td>
</tr>
<tr>
<td>$\text{cor}_{\text{prev}} = 0.25$</td>
<td><img src="image6" alt="Graph" /></td>
<td><img src="image7" alt="Graph" /></td>
<td><img src="image8" alt="Graph" /></td>
<td><img src="image9" alt="Graph" /></td>
<td><img src="image10" alt="Graph" /></td>
</tr>
<tr>
<td>$\text{cor}_{\text{prev}} = 0.5$</td>
<td><img src="image11" alt="Graph" /></td>
<td><img src="image12" alt="Graph" /></td>
<td><img src="image13" alt="Graph" /></td>
<td><img src="image14" alt="Graph" /></td>
<td><img src="image15" alt="Graph" /></td>
</tr>
<tr>
<td>$\text{cor}_{\text{prev}} = 0.75$</td>
<td><img src="image16" alt="Graph" /></td>
<td><img src="image17" alt="Graph" /></td>
<td><img src="image18" alt="Graph" /></td>
<td><img src="image19" alt="Graph" /></td>
<td><img src="image20" alt="Graph" /></td>
</tr>
<tr>
<td>$\text{cor}_{\text{prev}} = 1$</td>
<td><img src="image21" alt="Graph" /></td>
<td><img src="image22" alt="Graph" /></td>
<td><img src="image23" alt="Graph" /></td>
<td><img src="image24" alt="Graph" /></td>
<td><img src="image25" alt="Graph" /></td>
</tr>
</tbody>
</table>

**Basic Work**

Ratio to the baseline

**LowerBound**

energy-energy

time-energy

time-time

**randomShuffling**

$\text{cor}_{\text{task}} = 0.5, \beta = 0.4$; Mapping criteria: $\text{inE}$
Energy-aware strategies on heterogeneous platforms

core \( I \text{task} = 0.5; \beta_{j,w} = 0.4; \) Mapping criteria: deR

<table>
<thead>
<tr>
<th>( R )</th>
<th>Core</th>
<th>Energy</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>LowerBound</td>
<td>energy-time</td>
<td>time-energy</td>
</tr>
<tr>
<td>0.92</td>
<td>energy-energy</td>
<td>time-time</td>
<td>randomShuffling</td>
</tr>
<tr>
<td>0.94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.98</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

LowerBound energy-time time-energy  
energy-energy time-time randomShuffling

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>LowerBound</th>
<th>energy-time</th>
<th>time-energy</th>
<th>energy-energy</th>
<th>time-time</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.15</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.20</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.30</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.35</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.40</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.45</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.55</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.60</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.65</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.70</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.75</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.80</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.85</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.90</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.95</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Scheduling: LowerBound energy-time time-energy  
energy-energy time-time randomShuffling
Energy-aware strategies on heterogeneous platforms

\text{cor}_{\text{task}} = 0.5; \beta_{\text{bw}} = 0.4; \text{Mapping criteria: deP}
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; \beta_{j,w} = 0.4; Mapping criteria: random
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.5; \beta_{\text{bw}} = 0.6; \] Mapping criteria: inE
\( \text{cor}_{\text{task}} = 0.5; \text{\( \beta_{\text{h/w}} \)} = 0.6; \text{Mapping criteria: deR} \)
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.5; \quad \beta_{j/w} = 0.6; \quad \text{Mapping criteria: deP} \]
Energy-aware strategies on heterogeneous platforms

![Graph showing energy efficiency and time on different platforms with varying correlation strengths.

- Correlation parameter $\gamma_{\text{corr}}$ and $\beta_{\text{corr}}$.
- Random scheduling criteria.

**Key:**
- LowerBound energy-time
- Energy-energy
- Energy-time
- Time-energy
- RandomShuffling
- LowerBound energy-energy
- LowerBound energy-time
- LowerBound time-energy
- RandomShuffling

**Legend:**
- Basic Work
- Correlation parameter: $\gamma_{\text{corr}} = 0$, $\beta_{\text{corr}} = 0.6$.

**Graphs show:**
- Comparison of energy and time efficiency across platforms.
- Effect of different correlation strengths on scheduling.
- Impact of correlation on energy consumption and task execution time.

**Note:**
- Correlation parameter $\gamma_{\text{corr}}$ and $\beta_{\text{corr}}$ influence task scheduling and energy consumption.
- Random criteria are applied to balance load across platforms.

**Additional Information:**
- Correlation parameter values: $\gamma_{\text{corr}}$, $\beta_{\text{corr}}$ affecting task scheduling.
- Mapping criteria: random
- Performance metrics: energy-efficiency, time-efficiency.
\[ \text{cor}_{\text{task}} = 0.5; \beta_{\text{f,}w} = 0.8; \text{Mapping criteria: inE} \]

<table>
<thead>
<tr>
<th>( \mathcal{N} = 0.9 )</th>
<th>( \mathcal{N} = 0.92 )</th>
<th>( \mathcal{N} = 0.94 )</th>
<th>( \mathcal{N} = 0.96 )</th>
<th>( \mathcal{N} = 0.98 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \mathcal{N} = 0.9 )</td>
<td>( \mathcal{N} = 0.92 )</td>
<td>( \mathcal{N} = 0.94 )</td>
<td>( \mathcal{N} = 0.96 )</td>
<td>( \mathcal{N} = 0.98 )</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms.

Basic Work

Ratio to the baseline

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>0.10</th>
<th>0.15</th>
<th>0.20</th>
<th>0.25</th>
<th>0.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.50</td>
<td>0.60</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
</tr>
<tr>
<td>0.15</td>
<td>0.55</td>
<td>0.65</td>
<td>0.75</td>
<td>0.85</td>
<td>0.95</td>
</tr>
<tr>
<td>0.20</td>
<td>0.60</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
</tr>
<tr>
<td>0.25</td>
<td>0.65</td>
<td>0.75</td>
<td>0.85</td>
<td>0.95</td>
<td>1.05</td>
</tr>
<tr>
<td>0.30</td>
<td>0.70</td>
<td>0.80</td>
<td>0.90</td>
<td>1.00</td>
<td>1.10</td>
</tr>
</tbody>
</table>

scheduling

LowerBound  energy-time  time-energy

energy-energy  time-energy  randomShuffling
\( corr = 0.5; \beta = 0.8 \); Mapping criteria: deR

Energy-aware strategies on heterogeneous platforms
\( \text{cor}_{\text{task}} = 0.5; \beta_{b/w} = 0.8; \) Mapping criteria: deP

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>Ratio to the baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.10</td>
<td>0.98</td>
</tr>
<tr>
<td>0.20</td>
<td>0.95</td>
</tr>
<tr>
<td>0.30</td>
<td>0.90</td>
</tr>
<tr>
<td>0.40</td>
<td>0.85</td>
</tr>
<tr>
<td>0.50</td>
<td>0.80</td>
</tr>
<tr>
<td>0.60</td>
<td>0.75</td>
</tr>
<tr>
<td>0.70</td>
<td>0.70</td>
</tr>
<tr>
<td>0.80</td>
<td>0.65</td>
</tr>
<tr>
<td>0.90</td>
<td>0.60</td>
</tr>
<tr>
<td>1.00</td>
<td>0.55</td>
</tr>
<tr>
<td>1.10</td>
<td>0.50</td>
</tr>
<tr>
<td>1.20</td>
<td>0.45</td>
</tr>
<tr>
<td>1.30</td>
<td>0.40</td>
</tr>
<tr>
<td>1.40</td>
<td>0.35</td>
</tr>
<tr>
<td>1.50</td>
<td>0.30</td>
</tr>
<tr>
<td>1.60</td>
<td>0.25</td>
</tr>
<tr>
<td>1.70</td>
<td>0.20</td>
</tr>
<tr>
<td>1.80</td>
<td>0.15</td>
</tr>
<tr>
<td>1.90</td>
<td>0.10</td>
</tr>
<tr>
<td>2.00</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.5; \beta_{\text{f,w}} = 0.8; \text{Mapping criteria: random} \]

Basic Work

Ratio to the baseline

LowerBound  energy-energy  time-energy  randomShuffling
### Energy-aware strategies on heterogeneous platforms

#### Basic Work Ratio to the baseline

<table>
<thead>
<tr>
<th>$cor_{pre} \times$</th>
<th>$\beta_{in} = 0.5$, $\beta_{out} = 1$</th>
<th>Mapping criteria: inE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N = 0.58$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.96$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.54$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.92$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.9$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### LowerBound energy-energy

<table>
<thead>
<tr>
<th>$cor_{pre} \times$</th>
<th>$\beta_{in} = 0.5$, $\beta_{out} = 1$</th>
<th>Mapping criteria: inE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N = 0.58$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.96$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.54$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.92$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.9$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### LowerBound energy-time

<table>
<thead>
<tr>
<th>$cor_{pre} \times$</th>
<th>$\beta_{in} = 0.5$, $\beta_{out} = 1$</th>
<th>Mapping criteria: inE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N = 0.58$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.96$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.54$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.92$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.9$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### LowerBound time-energy

<table>
<thead>
<tr>
<th>$cor_{pre} \times$</th>
<th>$\beta_{in} = 0.5$, $\beta_{out} = 1$</th>
<th>Mapping criteria: inE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N = 0.58$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.96$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.54$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.92$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.9$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### LowerBound time-time

<table>
<thead>
<tr>
<th>$cor_{pre} \times$</th>
<th>$\beta_{in} = 0.5$, $\beta_{out} = 1$</th>
<th>Mapping criteria: inE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N = 0.58$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.96$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.54$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.92$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.9$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### RandomShuffling

<table>
<thead>
<tr>
<th>$cor_{pre} \times$</th>
<th>$\beta_{in} = 0.5$, $\beta_{out} = 1$</th>
<th>Mapping criteria: inE</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N = 0.58$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.96$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.54$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.92$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N = 0.9$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.5; \beta_{b/w} = 1; \text{Mapping criteria: deR} \]

<table>
<thead>
<tr>
<th>Method</th>
<th>( R = 0.9 )</th>
<th>( R = 0.92 )</th>
<th>( R = 0.94 )</th>
<th>( R = 0.96 )</th>
<th>( R = 0.98 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>LowerBound</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>energy-energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time-energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time-time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>randomShuffling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

Graph with lines indicating different scheduling strategies.
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ \text{Basic Work} \]

\[ \text{Ratio to the baseline} \]

\[ \text{scheduling} \]

\[ \text{LowerBound} \]

\[ \text{energy-energy} \]

\[ \text{energy-time} \]

\[ \text{time-energy} \]

\[ \text{time-time} \]

\[ \text{randomShuffling} \]
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.5; \beta_{f/w} = 1; Mapping criteria: random

cor_{proc} = 0.00; 0.25; 0.50; 0.75; 1.00

Basic Work

Ratio to the baseline

scheduling LowerBound energy-energy energy-time time-energy time-time randomShuffling

RR n 9324
Energy-aware strategies on heterogeneous platforms

\[ R = 0.9 \]

\[ R = 0.92 \]

\[ R = 0.94 \]

\[ R = 0.96 \]

\[ \text{cor}_{\text{proc}} = 0 \]

\[ \text{cor}_{\text{proc}} = 0.25 \]

\[ \text{cor}_{\text{proc}} = 0.5 \]

\[ \text{cor}_{\text{proc}} = 0.75 \]

\[ \text{cor}_{\text{proc}} = 1 \]
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0.75; \beta_{b/w} = 0.2; \text{Mapping criteria: deR}
Energy-aware strategies on heterogeneous platforms

\( \rho_{\text{task}} = 0.75; \beta_{b/w} = 0.2; \) Mapping criteria: deP
$cor_{task} = 0.75$; $\beta_{b/w} = 0.2$; Mapping criteria: random
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \ \beta_{b/w} = 0.4; \ \text{Mapping criteria: inE} \]

<table>
<thead>
<tr>
<th>R</th>
<th>0.9</th>
<th>0.92</th>
<th>0.94</th>
<th>0.96</th>
<th>0.98</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R )</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>( \text{Ratio to the baseline} )</td>
<td>0.00</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Basic Work**

- \( \text{LowerBound} \)
- \( \text{energy-time} \)
- \( \text{time-energy} \)
- \( \text{randomShuffling} \)
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \; \beta_{b/w} = 0.4; \; \text{Mapping criteria: deR} \]
$cor_{task} = 0.75$; $\beta_{b/w} = 0.4$; Mapping criteria: deP
Energy-aware strategies on heterogeneous platforms

cor\text{task} = 0.75; \beta_{b/w} = 0.4; \text{Mapping criteria: random}

![Graph showing energy and time comparison across different scenarios with varying values of \( R \) and cor\text{proc}.]
Energy-aware strategies on heterogeneous platforms

\[ cor_{task} = 0.75; \beta_{b/w} = 0.6; \text{Mapping criteria: inE} \]

<table>
<thead>
<tr>
<th>( R )</th>
<th>0.90</th>
<th>0.92</th>
<th>0.94</th>
<th>0.96</th>
<th>0.98</th>
</tr>
</thead>
<tbody>
<tr>
<td>CorProc</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>LowerBound</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>RandomShuffling</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basic Work</th>
<th>0.10</th>
<th>0.15</th>
<th>0.20</th>
<th>0.25</th>
<th>0.30</th>
<th>0.00</th>
<th>0.15</th>
<th>0.20</th>
<th>0.25</th>
<th>0.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy-energy</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>Time-energy</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>RandomShuffling</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
</tbody>
</table>

scheduling: LowerBound, energy-energy, time-energy, randomShuffling
Energy-aware strategies on heterogeneous platforms

corr_{task} = 0.75; \beta_{b/w} = 0.6; Mapping criteria: deR
\( c_{\text{task}} = 0.75; \ \beta_{b/w} = 0.6; \) Mapping criteria: deP

Basic Work

Ratio to the baseline

scheduling

LowerBound
| energy-time | time-time | energy-energy | time-energy | randomShuffling

Energy-aware strategies on heterogeneous platforms
$\text{cor}_{\text{task}} = 0.75; \ \beta_{b/w} = 0.6; $ Mapping criteria: random
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.75; \beta_{b/w} = 0.8; Mapping criteria: inE
$\text{cor}_{\text{task}} = 0.75$; $\beta_{b/w} = 0.8$; Mapping criteria: deR
$\text{cor}_{\text{task}} = 0.75; \ \beta_{b/w} = 0.8; \ \text{Mapping criteria: } \text{deP}$
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \ \beta_{b/w} = 0.8; \text{ Mapping criteria: random} \]
cor_{task} = 0.75; \beta_{b/w} = 1; \text{ Mapping criteria: inE}

Basic Work

Ratio to the baseline

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on heterogeneous platforms

Energy-aware strategies on hetero...
Energy-aware strategies on heterogeneous platforms

cor_{task} = 0.75; \beta_{b/w} = 1; \text{ Mapping criteria: deR}

Basic Work

Ratio to the baseline

LowerBound  energy-time  time-energy  randomShuffling

scheduling
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 0.75; \quad \beta_{b/w} = 1; \quad \text{Mapping criteria: deP} \]

<table>
<thead>
<tr>
<th>R = 0.9</th>
<th>R = 0.92</th>
<th>R = 0.94</th>
<th>R = 0.96</th>
<th>R = 0.98</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{LowerBound}</td>
<td>\text{energy-energy}</td>
<td>\text{energy-time}</td>
<td>\text{time-energy}</td>
<td>\text{randomShuffling}</td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

LowerBound: ~ LowerBound
energy-energy: ~ energy-energy
time-energy: ~ time-energy
randomShuffling: ~ randomShuffling

Correlation factors:

- \( \text{cor}_{\text{task}} \) = 0.75
- \( \beta_{b/w} \) = 1

Mapping criteria: deP

\[ \text{Basic Work} \]

944
Energy-aware strategies on heterogeneous platforms

$$\text{cor}_{\text{task}} = 0.75; \beta_{b/w} = 1; \text{Mapping criteria: random}$$
$\text{corr}_{\text{task}} = 1; \beta_{b/w} = 0.2; \text{Mapping criteria: inE}$

<table>
<thead>
<tr>
<th>$\mathcal{R}$</th>
<th>$\mathcal{R} = 0.9$</th>
<th>$\mathcal{R} = 0.92$</th>
<th>$\mathcal{R} = 0.94$</th>
<th>$\mathcal{R} = 0.96$</th>
<th>$\mathcal{R} = 0.98$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Work</td>
<td>0.00 0.25 0.50 0.75</td>
<td>0.00 0.25 0.50 0.75</td>
<td>0.00 0.25 0.50 0.75</td>
<td>0.00 0.25 0.50 0.75</td>
<td>0.00 0.25 0.50 0.75</td>
</tr>
<tr>
<td>Ratio to the baseline</td>
<td>0.50 0.75 1.00 1.25</td>
<td>0.50 0.75 1.00 1.25</td>
<td>0.50 0.75 1.00 1.25</td>
<td>0.50 0.75 1.00 1.25</td>
<td>0.50 0.75 1.00 1.25</td>
</tr>
</tbody>
</table>

scheduling
- LowerBound
- energy-energy
- time-time
- randomShuffling
Energy-aware strategies on heterogeneous platforms

Basic Work

Ratio to the baseline

scheduling, lower bound, upper bound, random shuffling

Energy-aware strategies on heterogeneous platforms

RR n° 9324
Energy-aware strategies on heterogeneous platforms

cor\textsubscript{task} = 1;  β_{b/w} = 0.2; Mapping criteria: deP

<table>
<thead>
<tr>
<th>R</th>
<th>0.9</th>
<th>0.92</th>
<th>0.94</th>
<th>0.96</th>
<th>0.98</th>
</tr>
</thead>
<tbody>
<tr>
<td>LowerBound</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>energy-time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>time-energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>randomShuffling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work

Ratio to the baseline

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

\( cor_{\text{task}} = 1; \beta_{b/w} = 0.2 \); Mapping criteria: random
$cor_{task} = 1; \beta_{b/w} = 0.4; \text{Mapping criteria: inE}$

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

cor_{task} = 1; \beta_{b/w} = 0.4; Mapping criteria: deR

<table>
<thead>
<tr>
<th>R</th>
<th>\cor_{proc}</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>0.10</td>
</tr>
<tr>
<td>0.92</td>
<td>0.15</td>
</tr>
<tr>
<td>0.94</td>
<td>0.20</td>
</tr>
<tr>
<td>0.96</td>
<td>0.25</td>
</tr>
<tr>
<td>0.98</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Basic Work

0.10 0.15 0.20 0.25 0.30 0.10 0.15 0.20 0.25 0.30

scheduling

LowerBound  energy-energy  time-energy  randomShuffling
cor_{task} = 1; \beta_{b/w} = 0.4; Mapping criteria: deP

\[
\begin{array}{c|c|c|c|c}
R & 0.9 & 0.92 & 0.94 & 0.96 & 0.98 \\
\hline
\text{LowerBound} & 0.10 & 0.15 & 0.20 & 0.25 & 0.30 \\
\text{Energy-energy} & 0.10 & 0.15 & 0.20 & 0.25 & 0.30 \\
\text{Energy-time} & 0.10 & 0.15 & 0.20 & 0.25 & 0.30 \\
\text{Time-energy} & 0.10 & 0.15 & 0.20 & 0.25 & 0.30 \\
\text{RandomShuffling} & 0.10 & 0.15 & 0.20 & 0.25 & 0.30 \\
\end{array}
\]
Energy-aware strategies on heterogeneous platforms

\( cor_{task} = 1; \beta_{b/w} = 0.4; \) Mapping criteria: random
Energy-aware strategies on heterogeneous platforms

$R = 0.9$

$cor_{proc} = 0$

$cor_{proc} = 0.25$

$cor_{proc} = 0.5$

$cor_{proc} = 0.75$

$cor_{proc} = 1$

$R = 0.98$

$R = 0.96$

$R = 0.94$

$R = 0.92$

$R = 0.9$

$cor_{task} = 1; \beta_{b/w} = 0.6; \text{Mapping criteria: inE}$

Basic Work

Ratio to the baseline

$\text{scheduling}$

$\text{LowerBound}$

$\text{Energy-energy}$

$\text{Energy-time}$

$\text{Time-energy}$

$\text{Time-time}$

randomShuffling
$c_{\text{task}} = 1; \beta_{b/w} = 0.6; \text{Mapping criteria: deR}$

<table>
<thead>
<tr>
<th>$\mathcal{R}$</th>
<th>$\beta_{b/w}$</th>
<th>$\beta_{b/w}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.9$</td>
<td>$0.9$</td>
<td>$0.9$</td>
</tr>
<tr>
<td>$0.92$</td>
<td>$0.92$</td>
<td>$0.92$</td>
</tr>
<tr>
<td>$0.94$</td>
<td>$0.94$</td>
<td>$0.94$</td>
</tr>
<tr>
<td>$0.96$</td>
<td>$0.96$</td>
<td>$0.96$</td>
</tr>
<tr>
<td>$0.98$</td>
<td>$0.98$</td>
<td>$0.98$</td>
</tr>
</tbody>
</table>

Energy-aware strategies on heterogeneous platforms
$c_{\text{task}} = 1; \beta_{b/w} = 0.6; \text{Mapping criteria: deP}$

| $R$ | $\frac{\text{Ratio to the baseline}}{0.10}$ | $0.15$ | $0.20$ | $0.25$ | $0.30$ | $0.35$ | $0.40$ | $0.45$ | $0.50$ | $0.55$ | $0.60$ | $0.65$ | $0.70$ | $0.75$ | $0.80$ | $0.85$ | $0.90$ | $0.95$ | $1.00$ |
|-----|------------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| $0.9$ | $0.10$ | $0.15$ | $0.20$ | $0.25$ | $0.30$ | $0.35$ | $0.40$ | $0.45$ | $0.50$ | $0.55$ | $0.60$ | $0.65$ | $0.70$ | $0.75$ | $0.80$ | $0.85$ | $0.90$ | $0.95$ | $1.00$ |
| $0.92$ | $0.10$ | $0.15$ | $0.20$ | $0.25$ | $0.30$ | $0.35$ | $0.40$ | $0.45$ | $0.50$ | $0.55$ | $0.60$ | $0.65$ | $0.70$ | $0.75$ | $0.80$ | $0.85$ | $0.90$ | $0.95$ | $1.00$ |
| $0.94$ | $0.10$ | $0.15$ | $0.20$ | $0.25$ | $0.30$ | $0.35$ | $0.40$ | $0.45$ | $0.50$ | $0.55$ | $0.60$ | $0.65$ | $0.70$ | $0.75$ | $0.80$ | $0.85$ | $0.90$ | $0.95$ | $1.00$ |
| $0.96$ | $0.10$ | $0.15$ | $0.20$ | $0.25$ | $0.30$ | $0.35$ | $0.40$ | $0.45$ | $0.50$ | $0.55$ | $0.60$ | $0.65$ | $0.70$ | $0.75$ | $0.80$ | $0.85$ | $0.90$ | $0.95$ | $1.00$ |
| $0.98$ | $0.10$ | $0.15$ | $0.20$ | $0.25$ | $0.30$ | $0.35$ | $0.40$ | $0.45$ | $0.50$ | $0.55$ | $0.60$ | $0.65$ | $0.70$ | $0.75$ | $0.80$ | $0.85$ | $0.90$ | $0.95$ | $1.00$ |

| $\text{Mapping criteria}$ | $\text{LowerBound}$ | $\text{energy-time}$ | $\text{time-energy}$ | $\text{randomShuffling}$ |
|-----------------------------|----------------------|----------------------|--------------------------|
| $\text{deP}$               | $\text{deP}$         | $\text{deP}$         | $\text{deP}$             |

Energy-aware strategies on heterogeneous platforms
$cor_{task} = 1; \beta_{b/w} = 0.6; \text{Mapping criteria: random}$
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \beta_{b/w} = 0.8; \text{Mapping criteria: inE} \]
\[ \text{cor}_{\text{task}} = 1; \ \beta_{b/w} = 0.8; \ \text{Mapping criteria: deR} \]
\( c_{\text{task}} = 1; \beta_{b/w} = 0.8; \) Mapping criteria: deP

Basic Work Ratio to the baseline

\begin{tabular}{|c|c|c|c|c|}
\hline
\( N \) & 0.9 & 0.92 & 0.94 & 0.96 & 0.98 \\
\hline
\end{tabular}

\( \text{LowerBound} \)
Energy-aware strategies on heterogeneous platforms

\[ \text{corr}_{\text{task}} = 1; \beta_{b/w} = 0.8; \text{Mapping criteria: random} \]

\[
\begin{array}{cccc}
    \text{Ratio to the baseline} & \text{Basic Work} & \text{LowerBound} & \text{energy-energy} & \text{time-energy} & \text{time-time} & \text{randomShuffling} \\
    \text{Baseline} & \text{Baseline} & \text{Baseline} & \text{Baseline} & \text{Baseline} & \text{Baseline} & \text{Baseline} \\
\end{array}
\]
$corr_{task} = 1; \beta_{b/w} = 1; \text{Mapping criteria: inE}$
Energy-aware strategies on heterogeneous platforms

\[ \text{cor}_{\text{task}} = 1; \beta_{b/w} = 1; \text{Mapping criteria: deR} \]

<table>
<thead>
<tr>
<th>( R )</th>
<th>LowerBound</th>
<th>energy-energy</th>
<th>time-energy</th>
<th>randomShuffling</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.92</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic Work: Ratio to the baseline

scheduling

Energy-aware strategies on heterogeneous platforms
Energy-aware strategies on heterogeneous platforms

<table>
<thead>
<tr>
<th>$\text{cor}_{\text{pr}}$</th>
<th>0</th>
<th>0.25</th>
<th>0.5</th>
<th>0.75</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R$</td>
<td>0.10</td>
<td>0.15</td>
<td>0.20</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>$\text{cor}_{\text{pr}}$</td>
<td>0.98</td>
<td>0.96</td>
<td>0.94</td>
<td>0.92</td>
<td>0.90</td>
</tr>
<tr>
<td>$\text{cor}_{\text{proc}}$</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Basic Work Ratio to the baseline

- LowerBound
- Energy-time
- Time-energy
- RandomShuffling

Mapping criteria: $\text{deP}$

RR n° 9324