An approach of our Power-Aware Computing

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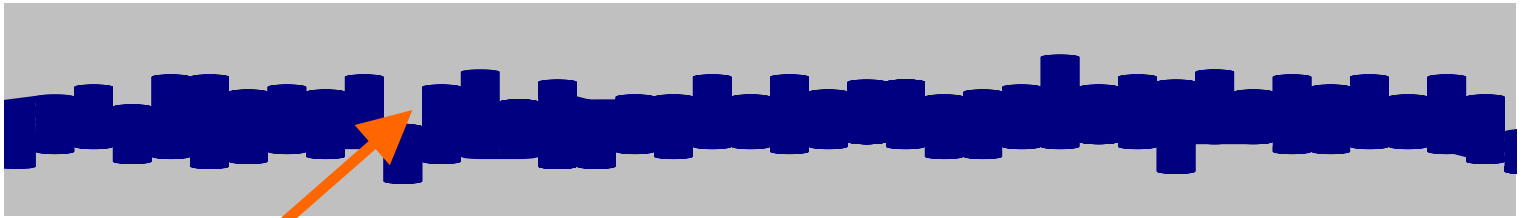
Power Aware computing

- **Recently, there has been tremendous interest in power-aware computing even in high performance computing such as PC cluster**
  - to achieve high density packaging
  - to reduce managing cost.
  - It causes a serious problem even on servers in data center.
- **Achieving Power-Aware Computing, we have investigated both software and hardware approach.**
  - Hardware
    - Characterization of processor's power consumption
    - Developing and Evaluation low power cluster
    - MegaProto
  - Software
    - Profile-based DVFS optimization
    - Slack time reclamation
    - OpenMP on CMP

Problems of short term DVFS prediction

- **DVFS facility becomes available in several high performance processors used in a PC cluster**
  - According to our previous research, the runtime DVFS control using short-time prediction by OS or firmware may fail to select the best gear for some applications in high performance computing fields.

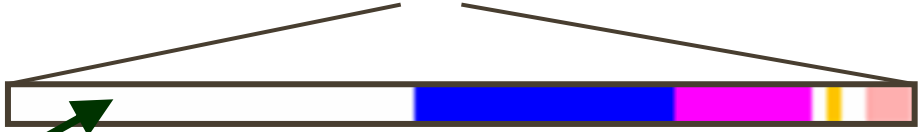
Knowledge of application beahvior is needed to control the gear for power-perfrmance optimization



≈ 510 ms

Comp.

Comm.

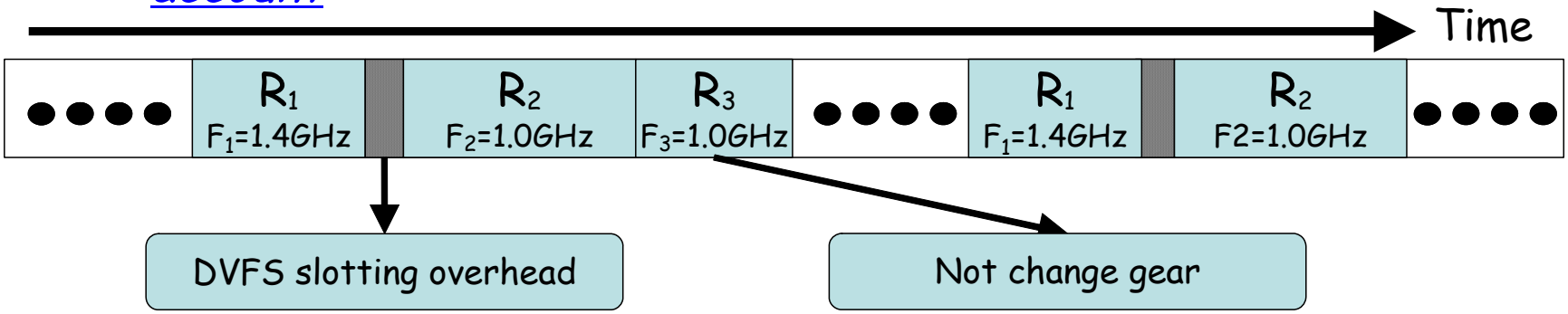


≈ 18 ms

Too short comp.(8ms) cannot make DVS ↑

Profile-based power-performance optimization Algorithm

- **We propose a profile-based power performance optimization by using DVS in HPC cluster.**
  - Exploiting application knowledge by using the execution and power profile
- **Overview of our algorithm**
  - Define regions at appropriate locations in user-level source code
  - Measure actual power consumption and obtain execution profile for each regions
  - *Choose the best gear for the executions on each region by taking the DVS overhead for frequency transition into account*



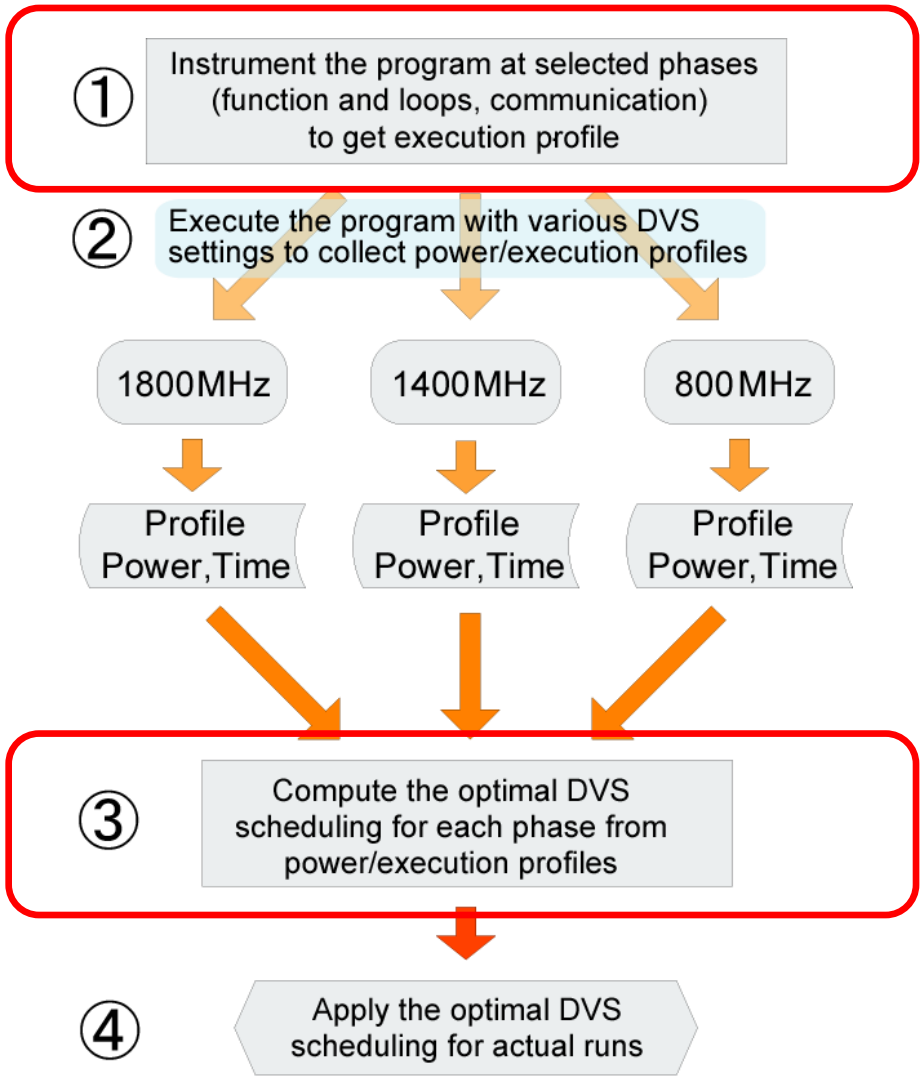
The flow of Profile-based DVS optimization

① **Trial runs for generating profile**
- Define region
- Obtain profile
  - Execution profile
  - Power profile

② **Calculate EDP and PDP on profile**
- All regions @ all gear

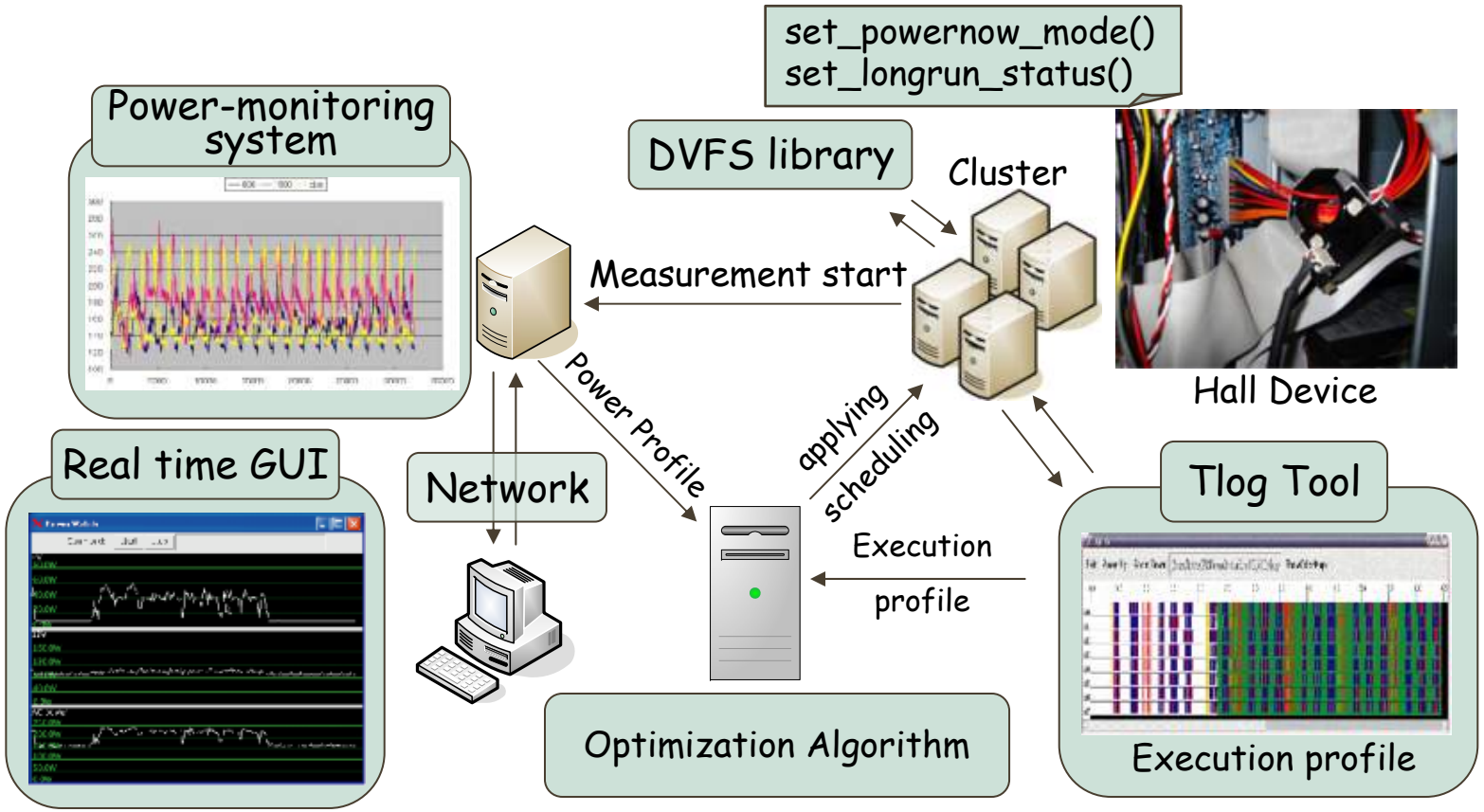
③ **Select the best gear**
- Using our propose algorithm to take the overhead of DVS into account

④ **Applying the results in actual run**



PowerWatch : A Power Profile System

- **We have designed and developed the power profiling system.**



Power Watch : A Power Profile System

Result of Turion cluster

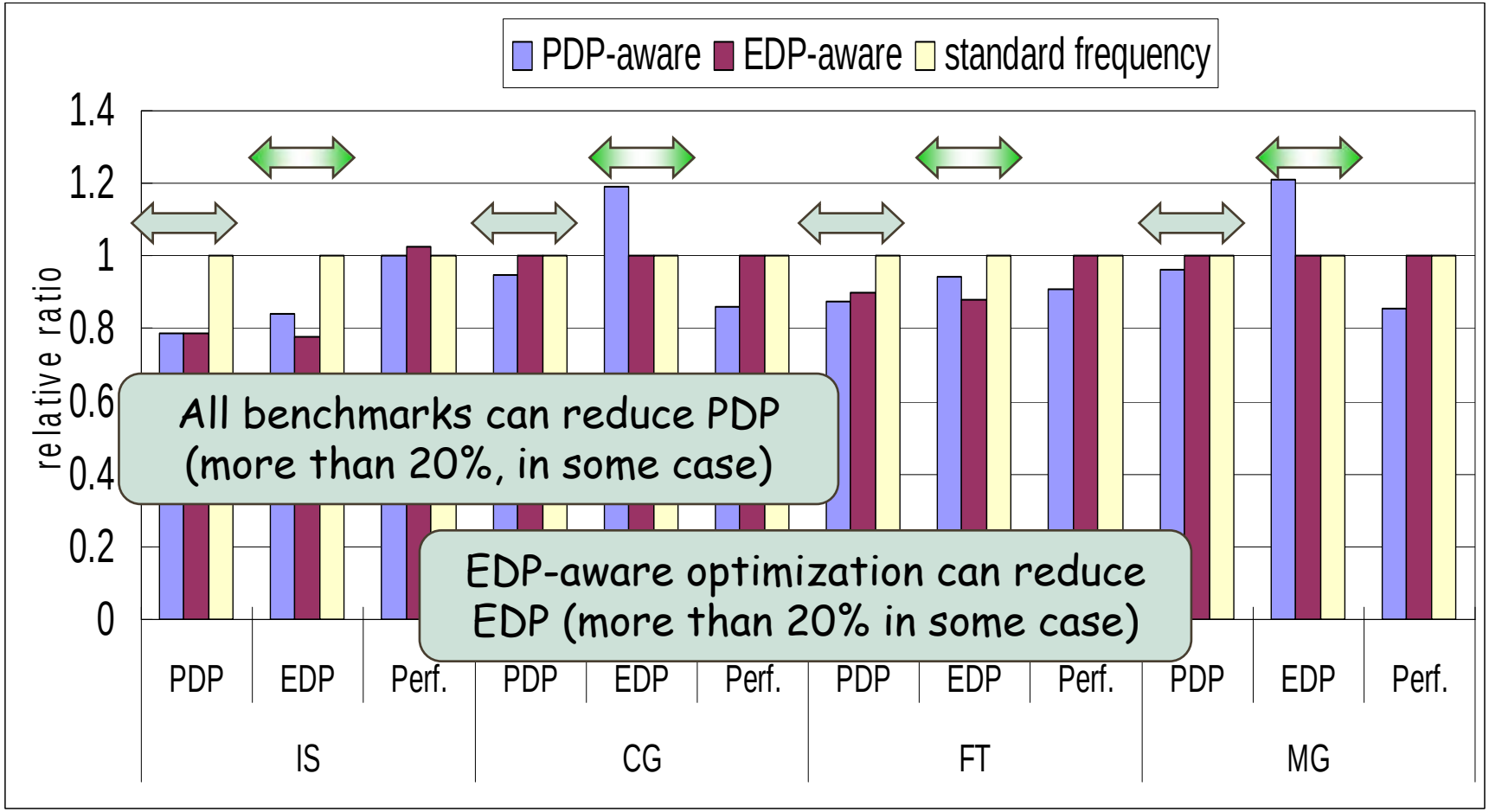


Fig : The result of two types of optimization normalized to standard frequency

Conclusion

- **We have proposed a profile-based power performance optimization algorithm by using DVS in a HPC cluster.**
  - Our algorithm takes into account the overhead of DVS transition for avoiding wasted transition.
  - We have designed PowerWatch for obtaining actual power and execution profile.
  - We have examined the effect of our algorithm on two types of low power cluster. The result shows that it reduce the EDP more than 30%.

- **For future work**
  - Automatic instrumentation to define more effective regions.
  - Adaptation of our algorithm to large scale systems by estimating power profile from the small system's results.