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Professor Tom Conte
Editor-in-Chief
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Dear Professor Conte:

We thank the reviewers for the time and effort required for their thorough reviews of our submission and greatly appreciate their candid and valuable comments, which clearly strengthen our manuscript. We have taken all comments into full consideration, addressing them in the revised manuscript, as detailed in sequence. Please find separate response documents, one for each of the reviewers, in the enclosed attachments to this cover letter.

Respectfully Yours,

Adam Wade Lewis

encl: (1) Response to Reviewer #1

TACO-2010-27: Review Response: Reviewer #1

First of all, we greatly appreciate your time and effort put toward your candid and informative review, which helps to improve the quality of our submission. The following lists our responses to your concerns and comments made on our initial manuscript. Hopefully, we have addressed all your concerns and comments to your satisfaction.

First Comment/Concern:

> *First, again, I think the paper title needs to be clearer. As it stands, it refers to an "approximation of an estimation". Based on your response, CAP is an instantaneous power estimation method, and I think "Run-time Energy Consumption Estimation based on time-series approximation.." might be more representative.*

Response:

The title of our paper has been adjusted to address the reviewer's concern.

Second Comment/Concern:

> *Next, it is still not clear to me where the benefit of CAP comes from. For example, can you give an example to where simple, Mantis-like approaches do not perform well for the workloads you evaluate?*

Response:

The issue of workloads inadequately addressed by Mantis-like approaches has been addressed in recent work, particularly by [Varsamopoulos et al. 2010],[Kansal et al. 2010], and [Hsu and Poole 2011]. Also, one should consider the recent work by [Davis et al. 2011], while not an exact match to the scenarios in our work, is follow-up work to [Economou et al. 2006] and [Rivoire 2008] that considers issues with MANTIS-like models over multiple nodes. We have added additional material to our prior work discussion (Section 2, paragraph 5) that discusses additional details about these references.

Third Comment/Concern *As you argue in the beginning of the paper, these approaches relate usage information to the power of the entire system rather than its individual components. So what kind of improvement do we see with the CAP approach with subcomponent prediction?* ***Response***:

Fourth Comment/Concern:

> *Along the same lines of comparative evaluation, as I had mentioned in the original review, there are other prior approaches that predict future behavior based patterns/statistics. How does CAP compare to even simplistic approaches for future behavior prediction like last-value, or simple exponentially-weighted moving averaging? I suspect the resulting power curves would look very similar, albeit slightly shifted versions of what is depicted in Figures 7/8. A simple error analysis can demonstrate the value of CAP, in addition to those included for AR and MARS.*

Response:

The reviewers intuition about the shape of the power curves is correct their is some similarity between CAP and exponentially-weighted moving averages (EWMA). CAP differs from such methods by using points on the attractor to approximate the next entry in the series. By doing so, we improve upon the approximation error as compared to EWMA and others. Additional discussion is provided in Section 5.1 and the Appendix of our paper that compares CAP and EWMA.

Fifth Comment/Concern

I am also still not sure how the four SPEC benchmarks can help verify the subcomponent power models beyond memory per your response. Do you see these benchmarks exercising these components at different rates and creating different dynamic power? Section 5.1 para-1, suggests these four were selected as workloads more common to server workloads. Can you please explain what this means? Can you also further provide an example to subcomponent power estimations?

Response:

The SPEC CPU2006 benchmarks were selected so as to provide a balance between branch behavior and memory access patters, per the guidelines provided in [Phansalkar et al. 2007]. This benchmark suite has been used for Additional discussion of the decision criteria used in the benchmark selection has been included in Section 5.1, Paragraph 1 of the revised document.

Sixth Comment/Concern

Last, I am still not clear how these servers exhibit just 60W-70W and 45W-70W idle-active power ranges. Are you showing ONLY CPU power? Can you please provide more details to how you confirm this with data provided by server manufacturers? Based on what I had seen, Sun quick reference reports 450W power consumption for Sun Fire 2200 and Dell PowerEdge Power and Performance Data Sheet reports Min:138W, Typical:285W, and Max:425W, which are more in line with what I expected.

Response:

The values reported in Figure 7 & 8 were showing only CPU power. These figures have been adjusted to show full system power.