OL-LMS

Forrest N. Iandola
University of California, Berkeley, USA
forresti@eecs.berkeley.edu

Huy Vo
University of California, Berkeley, USA
huytbvo@eecs.berkeley.edu

ABSTRACT
Best abstract ever

Keywords
embedded systems and planes and stuff

1. INTRODUCTION
Overview, stuff about platform based design...

1.1 OL-LMS Goals
Talk about goals of project

2. HL-LMS
Reference Mehdi's et al work on HL-LMS. Brief description to show that we understand it.

3. LL-LMS
Talk about our LL-LMS system, its inputs/outputs, functionality, etc

4. OL-LMS
Talk about how the entire system works at a whole, how we set it up, etc.

5. EXPERIMENTAL RESULTS

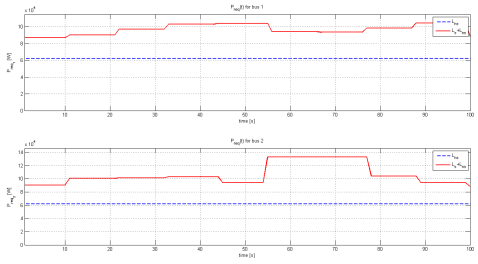

Figure 1: **Power Request** Historical data of power request on Bus 1 and Bus 2 for time 0 to 100. Notice the spikes in power usage on Bus 2 that pulls the request over 100000 Watts, well over the power rating of the generators. Load shedding is a must during those intervals.

5.1 No Failures
For our first experiment, we simulated the case when there are no power generators failures in the system using the power usage profile shown in Figure 1. Notice that Bus 1 uses more than 100000 Watts between time 30 and 60 and again around time 90. Bus 2, on the other hand, has a massive power usage between time 50 and 80. We wanted to see how the HL-LMS and the LL-LMS responds to this scenario in isolation. Our results are in Figure 2 and Figure 3. Comparing the results, we can see that the LL-LMS will shed a much larger number of loads than the the HL-LMS. In particular, the LL-LMS sheds exclusively from load 6-10 because it simply examines the priority table. The HL-LMS; however, is much smarter. It is able to minimize the number of loads shed by shedding loads much higher up in the priority table.

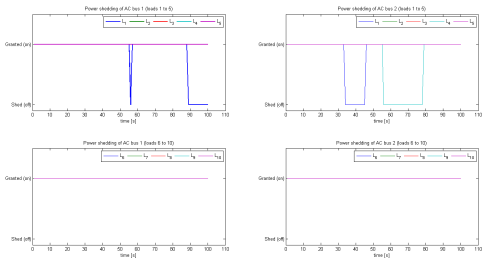

Figure 2: **HL-LMS Load Shedding** Notice the long period of load shedding around the power usage spikes.

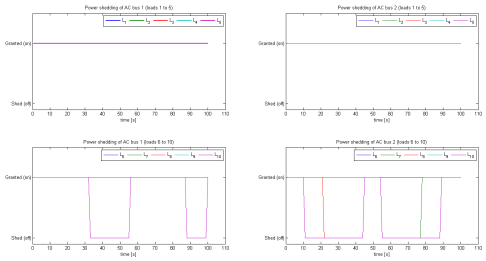

Figure 3: **LL-LMS Load Shedding** Notice that the LL-LMS sheds much more load than the HL-LMS.

5.2 Generator Failure
For this experiment, we wanted to see how a combined HL-LMS and LL-LLMS system would respond to spontaneous generator failures. To this end, we simulated the case when generator 2 would fail at time 45. Obviously, if the HL-LMS were to run in isolation, it would leave the system unpowered

from time 45 to 50. Figure 4 shows what would happen if the LL-LMS were to run in isolation. Starting at time 45, the LL-LMS sees that generator 2 has failed and it has switched to using generator 1 to power both buses according to its priority table. In order to stay under generator 1's power rating, the LL-LMS sheds a large number of loads on the second bus. Figure 5 shows what would happen in a combined HL-LMS LL-LMS system. The HL-LMS produces advice to be used from time 40 to 50. Unfortunately, there is no way for this advice to be aware of the failure at time 45. So while the advice from time 40 to 44 is optimal and safe, the advice from 45 to 49 is unsafe. The LL-LMS is able to see this at time 45 and kicks in, ignoring the unsafe advice from the HL-LMS. This behavior is observed in Figure 5 where from time 45 to 49, a large number of loads are shed. Then at time 50, the HL-LMS reoptimizes by turning on the APU. Notice the difference in the number of loads shed onward from time 50 in Figure 4 and Figure 5.

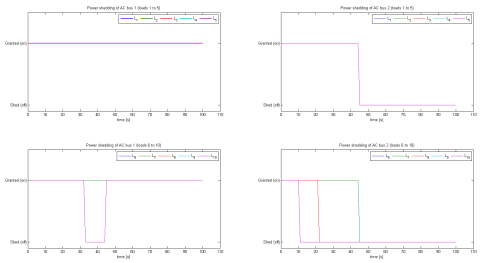

Figure 4: **LL-LMS Load Shedding – One Failure**. Notice the large amounts of load shedded in order to keep power usage below the power rating of generator 1.

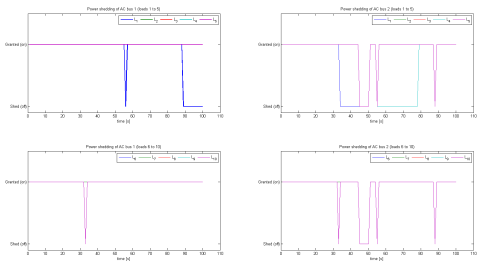

Figure 5: **OL-LMS Load Shedding – One Failure**. Notice the large number of loads dropped from time 45 to 50 before the HL-LMS can reoptimize.

5.3 Unexpected Power Spikes

The HL-LMS performs a live optimization using historical data for load power requests from previous flights. Due to the nature of the optimization problem, it is impossible to program the optimization problem with live data. As a result, it is possible for the HL-LMS to provide unsafe advice if there is a power spike. More specifically, it is possible for the HL-LMS to generate a load shedding configuration that could have one of the power generators driving a higher power request than its rating. We want to simulate such a failure case and show that the LL-LMS performs the required adjustment to keep the system in a safe state. For this experiment, we use the same historical power request as in Figure 1. However, the actual power request for this simulation is shown in Figure 6. Without the LL-LMS, the HL-LMS would use the load shedding configuration seen in Figure 2. Notice that there is a power spike from time 10 to 40 that the historical data does not account for and thus the HL-LMS is unaware of. As a result, its load shedding configuration would overload the power generator. Because we have a LL-LMS, we are able to keep the system in a safe configuration. Figure 7 shows that the LL-LMS will detect that the generators would be overloaded and thus shed some loads during this time interval.

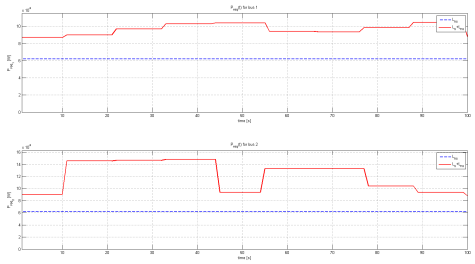

Figure 6: **Actual Power Request** Notice the difference between this power request and the power request expected by the historical data in Figure 1. In particular, there is a large power spike from time 10 to 40 that is not accounted for in the historical data.

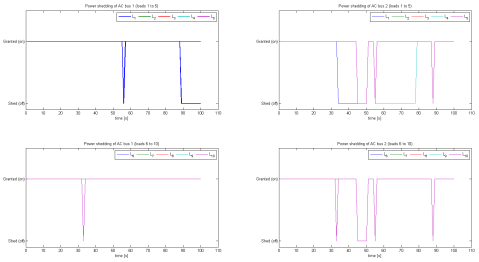

Figure 7: **OL-LMS Load Shedding – Power Spike** Whenever possible the LL-LMS will use the advice from the HL-LMS. The only time it ignores the advice from the HL-LMS is from time 10 to 40 when there is a power spike that the HL-LMS is not aware of.

6. RELATED WORK

Related [1].

7. CONCLUSION

Conclusion.

Acknowledgments

This work was supported by the US Department of Defense (DoD) through the National Defense Science & Engineering Graduate Fellowship (NDSEG) Program.

8. REFERENCES

[1] L. Lamport. *LaTeX User's Guide and Document Reference Manual*. Addison-Wesley Publishing Company, Reading, Massachusetts, 1986.