In this chapter I will introduce the experiments that I performed in order to validate the work produced in my thesis. This chapter will focus on the motivation and design of the experiments as well as introduce the baselines for them. It will also provide the results and analysis of the experiments.

Before proceeding to describe the precise experiments that were performed, it is important to carefully define the types of quantities used. First, when talking about power consumption, I refer to the total amount of power (usually in joules or watts) consumed. Secondly, we must clearly define the amount of load imposed on the system. TODO: Define load as used in these experiments

TODO: Argue why specific experiments performed do give a general result.

### 4.1 Experimental Setup

All of the experiments were performed with a cluster of Atom-based machines. The machines are each built from the parts as shown in figure 4.1. Some of the
testing also required machines that are more typical of the type of box that an enterprise server would run on. The configuration of these so-called “high power nodes” is shown in figure 4.2.

- Intel Atom processor 330 (Dual Core @ 1.6GHz; L1 Cache: 1MB; L2 Cache: 2x512KB; 533MHz FSB)
- Intel BOX94GCLF2 Motherboard
- Rendition by Crucial (1GB of DDR2 667 SDRAM PC2 3500)
- Roswell RV300 Power Suppy (300W Maximum Power; 70% minimum efficiency)
- SYBA SD-ADA40001 SATA II to Compact Flash Adapter (Jumper Choice: 3.3V or 5V)
- Kingston 4GB Compact Flash Memory Card (3.3V)

**Figure 4.1: Specifications of the “low power” nodes.**

- **TODO:** Write this section.

**Figure 4.2: Specifications of the “high power” machine.**

**TODO:** Describe how the cluster is formed (ie is one node a load balancer, is it one big machine, etc.?)

### 4.2 Baseline/Control Test

The purpose of this thesis is to show the performance and power-saving benefits of using dynamic configuration techniques on low-power nodes over statically
configured systems. Thus, all of the experiments performed in support of the ideas in this thesis will use measurements from a statically configured low-power cluster as the baseline for comparison. In order to establish baseline, experiments were performed with clusters of sizes two, four, and five. These sizes have been chosen as representative samples since it would become difficult to build and test clusters of other sizes. For each cluster size, loads TODO: determine how to best have loads of varying sizes were imposed on the test configuration. At each configuration, I turned on the machines in the cluster after having them off for at least one minute. After letting the cluster boot and run idle for a few minutes, I measured the power consumption by imposing the load for three minutes. The results of these tests are shown in table 4.1.

TODO: Make this table.

Table 4.1: Results of the baseline tests.

4.3 Experiments

This section describes each of the experiments that I performed, their results, and an provides an analysis of the results.

TODO: Once I choose specific technique(s) to look at, determine if it might be appropriate to split up the dynamically configured cluster experiment up by technique and do one test with all on.

4.3.1 Dynamically Configured Cluster

The most basic experiment that needs to be performed is to test the power consumption of the cluster while running the dynamic configuration techniques
proposed in this thesis. By recording the power consumption in the same sce-
narios as the baseline configuration, I show how my techniques improve on the
static configuration’s power consumption on the same cluster. It is crucial to
note that this test shows power consumption improvement on this cluster. The
introduction to this chapter discusses why it is reasonable to believe that this
experiment can be treated as representative of static vs. dynamic configuration
in general. Another important thing to note is that in this case the notion of
“number of low-power nodes” has a subtlety to it. In the baseline experiments,
this meant exactly how many nodes were on and being utilized throughout the
entire test. In the dynamic configuration cases, it is possible that the algorithms
may determine that a node should be powered off. Thus, the number of nodes in
this experiment is really a maximum.

Experimental Set-Up

The set-up of this experiment very closely matches the procedures followed
in the baseline tests. Each of the same scenarios are tested so that direct com-
parisons can be made between having a statically configured and dynamically
configured low-power cluster. TODO: Write about exactly which/how/etc tech-
niques are used.

Results and Analysis

The results of this experiment are shown in table 4.2. TODO: Write about
some of the interesting aspects of the results.

TODO: Make this table.

Table 4.2: Results of the dynamic configuration tests.
4.3.2 Addition of High Power Machines

In the previous section, I presented an experiment that showed the effects of dynamic configuration of a cluster containing solely low-power nodes. Another idea that I proposed earlier in this thesis was the addition of one or more “high-power machines” to the cluster. These are typical commodity server machines that serve in the cluster to get optimal performance during times of high load. This technique was suggested with the goal of minimizing the performance impact of using slower low-power nodes, which might get overwhelmed during heavy load (recall the problem of load unbalancing discussed in the Background chapter). This experiment will show the effects on power consumption caused by introducing “high-power” machines to the cluster during periods of heavy load.

This experiment will be beneficial for two separate analysis. First, the results of the test can be compared with the baseline test to see if this solution offers improvement over a statically configured cluster. Secondly, the results can be compared to the results of the previous experiment. This will go to show how much improvement the addition of a “high-power node” provides over just dynamic configuration.

Experimental Set-Up

The experimental set-up of the high power machine tests is the same as the other experiments. The experimental configurations from the baseline test are repeated in this experiment to allow for analysis of the change in values between the tests. TODO: Write about exactly which/how/etc the technique is used. ie
how many machines, when it is used/turned on.

Results and Analysis

The results of this experiment are shown in table 4.3. TODO: Write about some of the interesting aspects of the results.

TODO: Make this table.

Table 4.3: Results of the tests with a “high-power node”.

TODO: Write analysis about the results.