Reliability Analysis of a Highly-Integrated Multiprocessor System

Abstract

AMHRENIUS, MA 01003
University of Massachusetts
Electrical & Computer Eng Dep

VENKAT R. CHILLURI

Isidore Koren
In this section, the authors describe the implementation of a multithreaded processor using the MIPS architecture. They discuss the design choices and optimizations made to enhance performance and efficiency. The focus is on the hardware aspects, including the use of a cache hierarchy and parallel execution units. The authors also present their results and evaluate the impact of these design choices on performance.
of the devices/components.

Since $R_{D}$ is dependent on the chip pitch, the resistance cannot exceed the limit of $R_{D}$.

It is also important to note that the thermal resistance of the chip may vary with the chip's temperature, which affects the distribution of the heat on the chip.

In the case of the $0.08$ microprocessor, the thermal resistance is specified at $0.07$ W/m$^2$K.

The thermal specifications are shown in Table 1. Parameters such as power distribution, current and voltage are listed, along with other relevant specifications.

**Table 1: Thermal Specifications of Intel 80486 Microprocessor**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power dissipation</td>
<td>$75$ W</td>
</tr>
<tr>
<td>Maximum current</td>
<td>$150$ mA</td>
</tr>
<tr>
<td>Maximum voltage</td>
<td>$3.3$ V</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>$0$ to $55$ °C</td>
</tr>
<tr>
<td>Thermal resistance</td>
<td>$0.07$ W/m$^2$K</td>
</tr>
</tbody>
</table>

A microprocessor can be used to improve the efficiency of the device by reducing the resistance and improving the heat dissipation. This is achieved by optimizing the design and materials used in the chip construction.

### 3.2 Example energy rate calculation

For the Intel 80486 microprocessor, the energy rate can be calculated using the following steps:

1. Identify the power dissipation: $75$ W
2. Consider the operating temperature: $10$ °C
3. Calculate the thermal resistance: $0.07$ W/m$^2$K
4. Use the formula: $\frac{75}{0.07} = 1071.43$ Wh

This calculation shows the energy rate required to maintain the operation of the microprocessor.
Power distribution in VLSI circuits is of considerable importance due to the fact that actual power dissipation predicted by the equation power dissipation in VLSI circuits is somewhat close to the maximum power dissipation of the circuit. In this context, an accurate model for power distribution of VLSI circuits is necessary to determine the overall power dissipation. In this chapter, we present an analysis of power distribution of VLSI circuits and how it can be estimated from known parameters.

The effect of cooling on the performance of a VLSI circuit can significantly affect the overall performance. In this section, we discuss the impact of cooling on the power distribution of VLSI circuits. The diagrams illustrate the relationship between power dissipation and temperature, showing the importance of effective cooling solutions.

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5.3 Performance and die size

The number of transistors and die size of the chip are important factors in determining the performance and cost of a processor. In general, a larger die size corresponds to higher performance, but at a higher cost. This trade-off is critical in the design of modern processors.

5.4 Power consumption

As the number of transistors increases, so does the power consumption of the chip. This is a significant concern, especially for portable devices where battery life is crucial.

Table 3: Power distribution of different functional blocks

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Power Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAM</td>
<td>25W/MHz</td>
</tr>
<tr>
<td>Memory</td>
<td>25W/MHz</td>
</tr>
<tr>
<td>CPU</td>
<td>25W/MHz</td>
</tr>
<tr>
<td>Graphics</td>
<td>25W/MHz</td>
</tr>
<tr>
<td>I/O</td>
<td>25W/MHz</td>
</tr>
</tbody>
</table>

Figure 4. Level of integration vs. power distribution

The figure shows the power distribution of different functional blocks in a processor. The x-axis represents the level of integration, while the y-axis shows the power distribution. A high level of integration results in a more power-efficient design.
6. Reliability Analysis

Reliability criteria and requirements for power and ground pins are included. These criteria are based on the expected mission profile and mission-specific requirements. The parameters are calculated for chips with different configurations and memory banks. The reliability of the system is assessed based on the failure rate of the chips and the mission requirements.

Table: Area and Power Distribution Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area per signal pad</td>
<td>50%</td>
</tr>
<tr>
<td>Area per memory cell</td>
<td>70%</td>
</tr>
<tr>
<td>Power distribution per signal pad</td>
<td>60%</td>
</tr>
<tr>
<td>Power distribution per memory cell</td>
<td>60%</td>
</tr>
</tbody>
</table>

**Formula:**

\[
rac{\sum N_d X}{N} = \frac{N}{N}
\]

**Note:** The number of failures is given in Equation 5.

Figure 6.1: Number of Processors-Memory pairs vs. Number of Processors-Memory pairs in the chip
be increased by higher level of information exchange. Better
structure of the information network, such as richer
versatility of the network and more efficient
information processing algorithms on the computer/ 
and microcomputer system depends on the computer's
and microcomputer system depends on the computer's
ability to exchange information at a higher level
and the demand for information at a higher level
and the demand for information at a higher level
will improve the performance of the system.

An illustration in Section 6 of the paper of the

The impact of a higher level of information
exchange is significant. The benefit of the

In summary, improvements in the computer's

Section 7

Conditions

Similar techniques may be possible with different
components of the system. However, the

References

The references to this paper and Section

Table 5: Power disaggregation and edge calculation

<table>
<thead>
<tr>
<th>Process</th>
<th>40,000 Translations and 999 Kbytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td></td>
</tr>
<tr>
<td>128</td>
<td></td>
</tr>
<tr>
<td>256</td>
<td></td>
</tr>
</tbody>
</table>

Legend:

- Power Total
- Power at Site
- Power at (winter)