

The Von Neumann Architecture

Topic Paper #3

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ABSTRACT

This paper discusses the architecture and historical aspects of von Neumann architecture in relation to stored-program digital computers and the modern computer.

Keywords

Von Neumann, Bottleneck, Architecture, Stored-Program, Digital Computer

1. INTRODUCTION

The architecture that John von Neumann described in the documentation for the EDVAC computer was what led to stored-program digital computers that relied on software stored in memory. Setting switches and routing electronic data from various systems by inserting patch leads controlled the program-controlled computers of the early 1940s.

2. HISTORY AND ARCHITECTURE

In 1945, while the ENIAC, a program-controlled machine, was still being developed, John von Neumann was also engineering the concept of a stored-program computer. His desire was for a high-speed digital computer that was powerful enough to solve complex mathematical problems and could also be abstracted enough that it could employ multiple mathematical techniques without having to be entirely reprogrammed (as the ENIAC needed to be) each time [3].

The computer that Von Neumann's architecture was first implemented on was the EDVAC, a binary computer that allowed memory (where a program would be stored) to communicate with a control unit, which decodes and manipulates instructions, and an arithmetic logic unit, which communicated directly with the input/output stream from/to the user.

3. STORED-PROGRAM CONCEPT

Using these units, the user was able to store data directly to the computer for later use; additionally, and more importantly, the user could store programs directly into the computers memory. In the ENIAC and other program-based computers, running a separate program required potentially weeks of redesigning, reengineering, and finally rewiring and patching all the hardware in the machine.

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4. THE BOTTLENECK

In our culture, von Neumann is almost more famous for the bottleneck he created than he is for his actual work. The von Neumann bottleneck is the limited throughput between the CPU and the memory. It is the largest limiting factor for the speed of a computer.

5. VON NEUMANN IN MODERN COMPUTING

The von Neumann bottleneck is one of the largest impediments in modern technology. Making a uni-processor faster without increasing the allowed transfer rate in the throughput will result in *no* advantage to the end user. In actuality, it is only deceiving; it raises the cost of the CPU (and thus the cost of the computer) and deceives the customer into thinking they are getting a faster computer when, in reality, it cannot function any faster due to the bottleneck [2].

Modern processors and multi-core processors are trying to find ways around this, but the bus speed, which communicates, between the CPU and memory is still a major factor in the speed of the computer [2].

6. CONCLUSIONS

Von Neumann's architecture is what made our modern processors possible, specifically stored-program computers. However, like every technological advancement, it has its drawbacks, the most notable of which is the bottleneck.

7. REFERENCES

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