

Paper Review

"BEOWULF: A PARALLEL WORKSTATION FOR SCIENTIFIC COMPUTATION"

1. Summary

This paper introduced BEOWULF, a parallel workstation for scientific computation. Compared to mainframes and supercomputers at that age, BEOWULF uses COTS (Commodity Off The Shelf) (some implementations of BEOWULF even use IoT devices).

The critical point of BEOWULF is the network communication interface. By [CAP theorem](#), any distributed data store can only provide two of the following three guarantees: Consistency, Availability, and Partition tolerance. The performance of each node is not strong. BEOWULF gets vital Availability and Consistency with the sacrificing of Partition tolerance. The BEOWULF communicates by socket between nodes, the overhead of packing and unpacking a message is rather marked. The network interface now becomes [OpenMPI](#), which can pass messages between multiple nodes. However, the overhead of MPI is still significant, mainly focusing on wait and all to all collection. Nvidia even uses specific hardware called [DPU](#) to decrease the overhead. However, introducing exclusive destroys freedoms of BEOWULF and can be expensive.

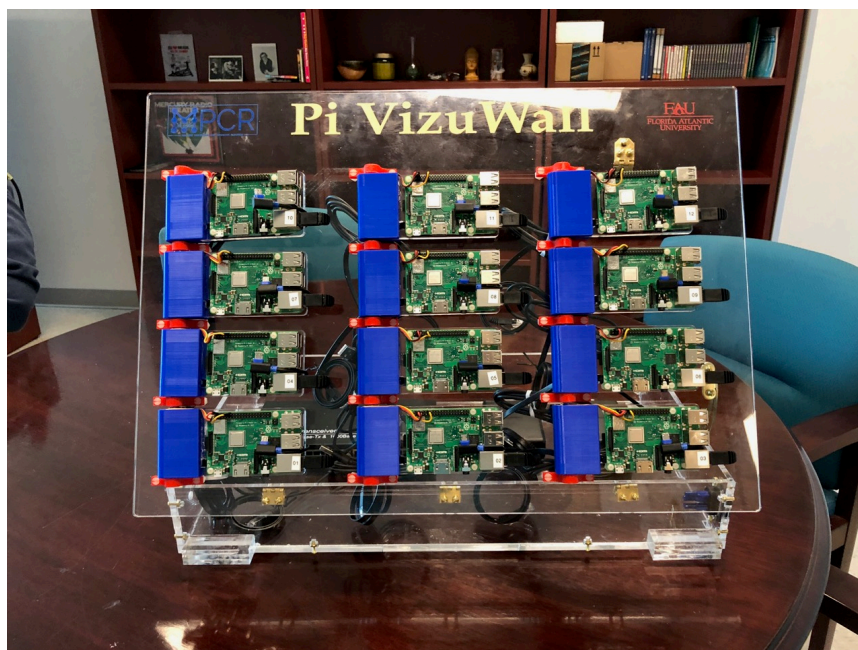


Figure 1: a multi-Raspberry Pi MPI computing system, I saw a similar one on the table in Toast lab. I believe this is quite power-consuming

To explain the practicality of BEOWULF, use the [Amdahl's law](#):

$$S_{latency}(s) = \frac{1}{(1-p) + \frac{p}{s}}$$

Where $S_{latency}$ is the speedup rate, p is the part that can be parallelized, and s is parallel computation nodes. With BEOWULF, we can add the amount of s with little cost and decrease some amount to p (Overhead of communication). s cannot be significant because we do not want p to decrease, and the accumulated cost may make it expensive.

This idea can be used in supercomputing though their machine has nothing to do with COTS. With the introduction of MPI, two supercomputers can achieve better performance than one and more. (The participants of Super Computing prefer to use two machines). Efforts are paid on adjusting OpenMP and MPI arguments.

2. Advantages

- + Consists of the most common hardware devices
- + Enables systems consisting of multiple computers to be used for parallel computing
- + Get good acceleration by Amdahl's law

3. Disadvantages

- Sometimes BEOWULF get performance by accumulation of low computing power devices (like Figure.1, which no practical use other than fun), make it carbon-unfriendly.