

Figure 1: The Q3ube Building Block

**ABSTRACT: AMMONIA COOLED HIGH PERFORMANCE COMPUTER**

A method for system optimization and performance improvement of high performance computing systems is disclosed in which individual, modular compute elements are fully encased in a hermetically sealed heat-conductive casing, aggregated around cooling tubes, and powered by a single cable which provides both power and high performance computing interconnect capability. Further, the system is operated to dynamically balance computing performance with thermodynamic system parameters, depending on various conditions, including renewable energy availability and real-time energy market conditions.

Patent Application  
of  
Troy Benjegerdes  
for

**The Q3ube: AMMONIA COOLED COMPUTING EQUIPMENT**

of which the following is a specification:

—

**FREE SOFTWARE COPYRIGHT NOTICE** This patent is a derivative work of a free software program: you can redistribute it and/or modify it under the terms of the

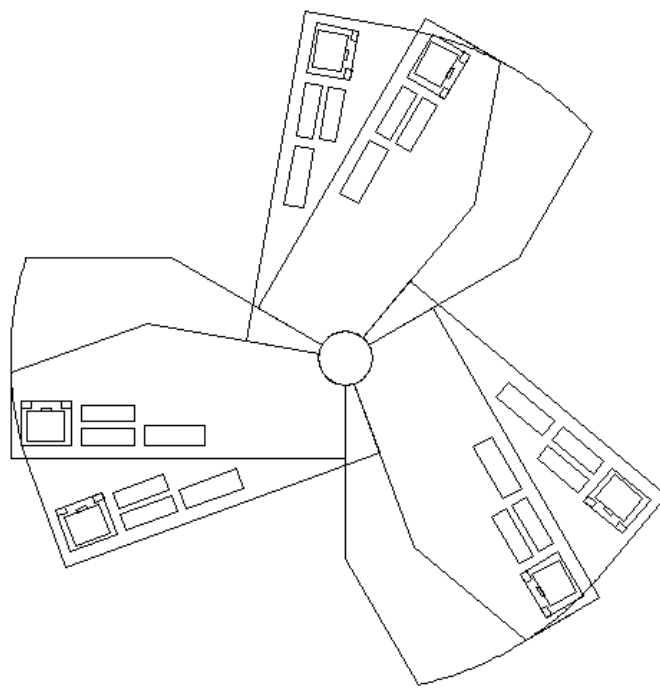


Figure 2: Compute cluster around heat removal piping

GNU Affero General Public License as published by the Free Software Foundation, either version 3 of the License, or (at your option) any later version.

Distribution of the derived works of the program (this patent application in html, pdf, or other format) without making available the full program specification, or minimally, without the source human-modifiable .tex files is subject to a license fee of \$250,000 USD per incident. Recipients of this PDF file are advised that they may be liable for copying performed on their behalf by cloud computing service providers.

Only the author (currently only Troy Benjegerdes) or his direct contractors or assignees may distribute the derived works file without corresponding .tex source code. The Internet Archive (archive.org) is specifically granted a license to archive this derived work in html form. All other rights are strictly reserved and subject to advertised copyright license fees as above.

### **FIELD OF THE INVENTION**

The present invention pertains generally to use of Ammonia (NH<sub>3</sub>) for cooling, and more particularly to a method of cooling computing equipment.

### **BACKGROUND OF THE INVENTION**

Ammonia is a widely used synthetic compound, with primary use as fertilizer, along with many important uses in chemical synthesis, refrigeration. It has been heavily used in industrial refrigeration due to the very high heat of vaporization, which is surpassed only by that of water. All other commonly used refrigerants and cooling fluids have a significantly lower heat capacity. This invention uses a commodity standard building block which can be utilized as a fanless desktop computer replacement, or aggregated around a heat removal pipe which may carry water, ammonia, or some other fluid. For even higher performance, the basic commodity building block can be sealed with an appropriate sealant and fully submerged in pressurized liquid ammonia. Temperature of the computing elements can be easily controlled by a pressure control valve, which changes the effective boiling point of the cooling liquid.

### **SUMMARY OF THE INVENTION**

An object of this invention is to provide a method to construct a device that can be utilized as a commodity consumer electronics device, or by combining many such devices with a high performance network to make a supercomputer.

It is a further object of this invention to provide such a method for cooling such a system with ammonia, water, or some other high-heat capacity refrigeration fluid.

It is a further object of this invention to provide such an improved control system for operating a variable rate computing process to act as a power grid stabilization and regulation function, by adjusting input power based on a signal from a power grid regulator ('balancing authority') or via a real-time market based mechanism. (Smart grid integration)

### **DESCRIPTION OF PRIOR ART**

\* reference cray patents on cooling \*

Additionally, the inventor, Troy Benjegerdes has published prior art for the concept of software systems which adapt to real-time power market or renewable energy availability. This prior art was primarily published via the <http://Grid.coop> domain name, registered April, 2008, and the Iowa Power Fund application entitled 'Iowa Grid: Open source infrastructure for time-of-day and location-based electric power trading', submitted to the Iowa Power fund on or about March 18, 2008.

**(can we incorporate the power fund application by reference??)**

### **BRIEF DESCRIPTION OF THE DRAWINGS**

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 shows a general block outline of the base consumer electronics building block, which utilizes a single RJ45 jack for power and network communication

FIG. 2 shows a diagram of a cluster of 6 compute nodes in a high performance computing configuration around a fluid-carrying heat removal pipe.

In either diagram, the control system, electronics, and software interfaces needed to embody the variable-rate control and real-time power market interactions are not explicitly shown in the diagrams.

While the patent invention shall now be described with reference to the preferred embodiments shown in the drawings, it should be understood that the intention is not to limit the invention only to the particular embodiments shown but rather to cover all alterations, modifications and equivalent arrangements possible within the scope of appended claims.

### **DETAILED DESCRIPTION OF THE DRAWINGS**

#### **PRIOR ART**

/ Some sort of narrative description of the drawings and process /

#### **FIRST EMBODIMENT**

Figure 1 shows a block diagram of the embodiment, which will now be described

Describe a high-performance small single-board computer capable of running Debian Linux and running emulation/virtualization of legacy hardware and operating systems

#### **INITIAL PRACTICAL EMBODIMENT**

Figure 2 shows an initial practical embodiment of a high performance computing device in which the cooling fluid is contained in a copper, aluminum, or other appropriate high-heat conductive material.

#### **ENHANCEMENTS**

Full immersion cooling in liquid ammonia or other material  
renewable energy grid stabilization  
Integrated space heating

#### **BENEFITS OF THE INVENTION**

This section may or may not refer to additional figures. Often to record the fact that you have thought about implications of your new invention, people will include a section describing some of the benefits of their invention. Thus if the patent is later challenged in court, you will have a record that you did anticipate and understand the necessity and impact of your invention, and that you did not just make a lucky guess when you made your invention.

#### **OTHER EMBODIMENTS**

From the foregoing description, it will thus be evident that the present invention provides a design for ammonia production. As various changes can be made in the above embodiments and operating methods without departing from the spirit or scope of the following claims, it is intended that all matter contained in the above description or shown in the accompanying drawings should be interpreted as illustrative and not in a limiting sense.

Variations or modifications to the design and construction of this invention, within the scope of the appended claims, may occur to those skilled in the art upon reviewing the disclosure herein (especially to those using computer aided design systems). Such variations or modifications, if within the spirit of this invention, are intended to be encompassed within the scope of any claims to patent protection issuing upon this invention.

#### **CROSS REFERENCE TO DISCLOSURE DOCUMENT**

## CLAIMS

The embodiments of the invention in which I claim an exclusive property or privilege are defined as follows:

1. A method for usage of Ammonia for cooling a high performance computer
2. A method for usage of a basic consumer electronics building block to construct a high performance computer
3. A method for design and simulation of a consumer electronics building block and a derived high performance computer using open-source software design processes. In other words, a computer loaded with all software required to design itself.
4. A method for modifying consumer electronics and high performance computing equipment to dynamically vary energy utilization and associated heat production based on a control input
5. A process for the method of claim 4 to manage costs when linked with real-time power markets
6. A process for the method of claim 4 to control heat production for home or commercial heating
7. A process for the method of claim 4 to control heat production for a heat-recover power production
8. A process for the method of claim 4 to control heat production for a thermally-driven space-cooling method
9. A process for producing a new physical computer hardware design utilizing a software program running on an existing design that contains all software and specifications to produce a derivative physical design. (recursive hardware)
10. A process for the method of claim 9 utilizing the 'fpgatools' package from the Debian computer operation system distribution.