

North Dakota State University--Fargo

From the Selected Works of Jeremy Straub

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Design of an Onboard Distributed Multiprocessing System for a CubeSat

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Introduction

The OpenOrbiter Small Spacecraft Development Initiative at the University of North Dakota [1] aims to make access to space for research and educational purposes easier by enabling the creation of low-cost CubeSats. It is creating the Open Prototype for Educational Nanosats (OPEN), a framework for developing a 1-U CubeSat spacecraft with a parts cost of less than \$5,000 [2]. The designs [3], documentation and computer code from this will be made publically available to enable the development of programs at other institutions.

The OpenOrbiter I mission will demonstrate and characterize the efficacy of the CubeSat design while also testing whether multiple types of image processing can be efficiently performed onboard a small spacecraft. To operate this software, additional computing power beyond the Raspberry Pi flight computer is needed. Multiple GumStix Overo WaterSTORM computer-on-module (COM) units have been selected for this application.

This poster describes the subsystem that has been designed to facilitate the use of these GumStix COMs for distributed processing (based on software developed by Honeywell [4]) and to facilitate communication between the GumStix clusters and other spacecraft systems.

Project Goals:

Providing Additional Processing Power

- Free up Flight Computer
- e.g. Attitude Determination, Orbital Calculation

Compact & Modular Design

- 77x28 mm²
- Only Requires 3.3 V input & Ethernet Output
- Scalable to any number of need Gumstix COMs

Standard Interface—Ethernet

Key Features:

- 1. Connectors with GumStix**
 - 2x 70 pin Connectors
- 2. Ethernet Controller**
 - Based around LAN 9221 IC
 - 10/100 Variable Speed Control
 - 16-bit Interface
- 3. Ethernet Conditioning**
 - ESD protection
 - Isolation Transformer

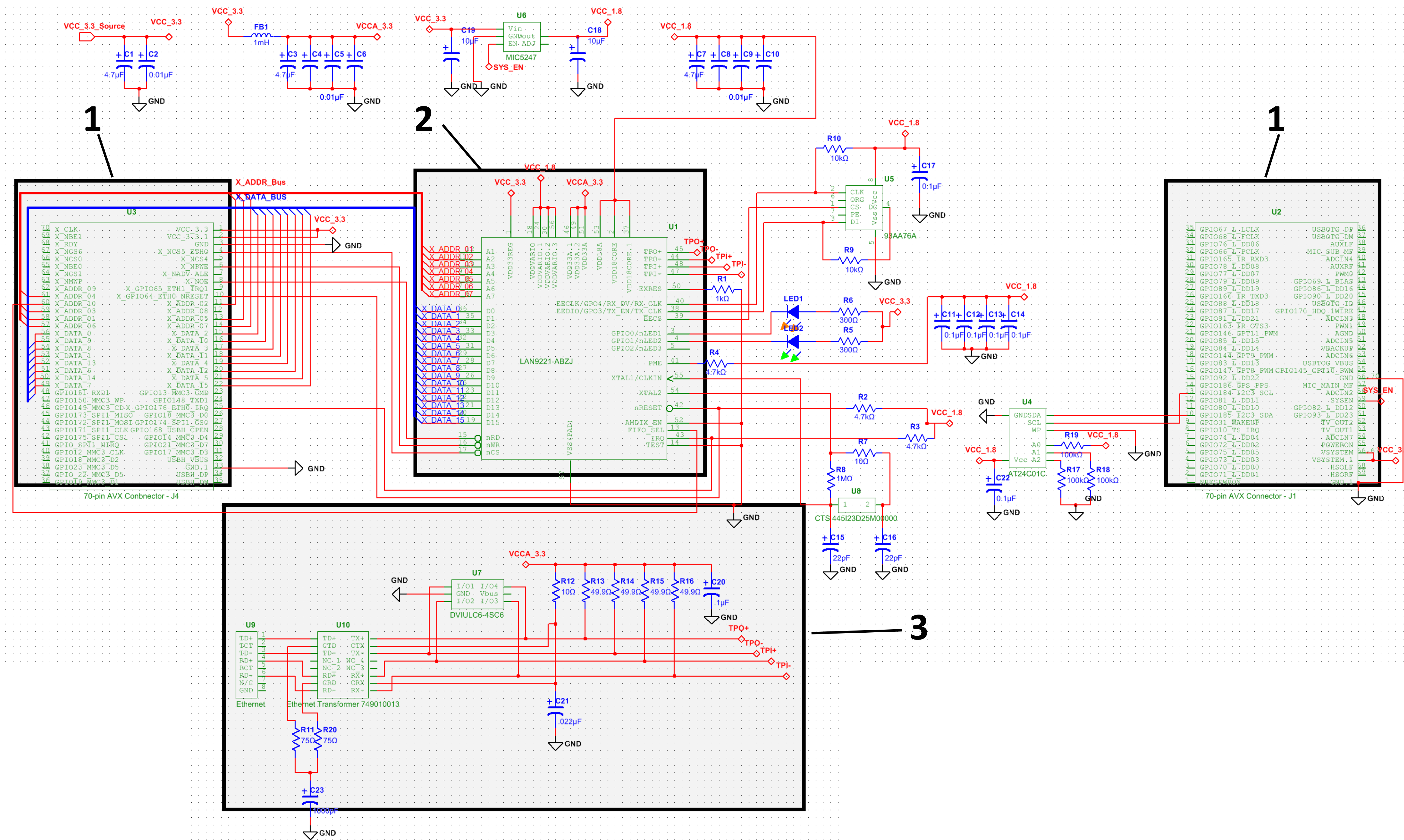


Figure 1. Wiring Diagram of Gumstix Ethernet Connector

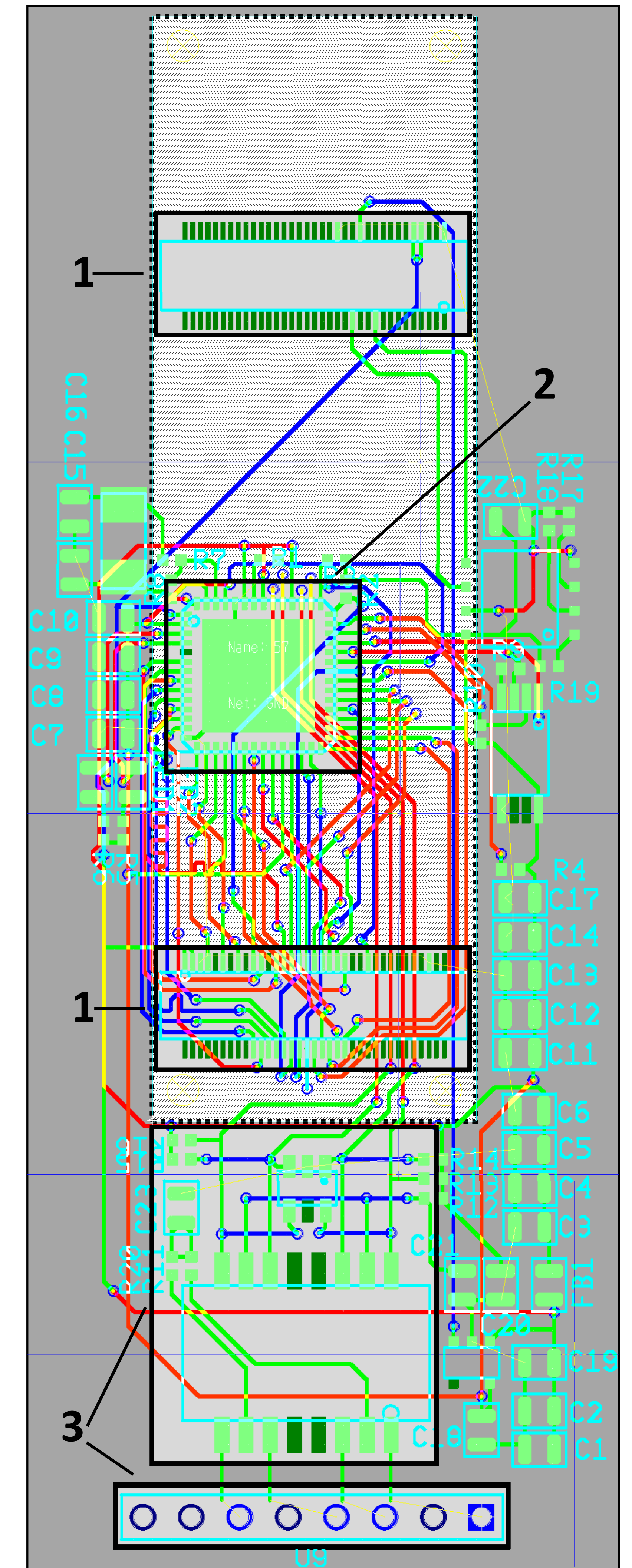


Figure 2. Circuit Layout of Gumstix Ethernet Connector

Work To-Date

Initial designs for this board were based off of the Overo Tobi Expansion Board developed by GumStix and made publically available for reference. This allowed IC component selection and elements of circuit design to be determined quickly. A wiring diagram is shown in Figure 1, above. Work is ongoing on converting this wiring diagram into a circuit layout for PCB printing and its refinement (the current version is shown in Figure 2). Once the board is printed, component attachment and board-level testing is required.

Conclusion & Future Work

The GumStix COMs and this Ethernet-based interconnection mechanism will allow the OpenOrbiter Satellite to have significantly greater processing power for performing mission specific calculations including image processing. This system can also be utilized for rapid task scheduling and other aspects of flight control.

Several challenges still exist. One is the routing the copper wire traces of the 16-bit Ethernet interface from the connectors to the LAN 9221 IC. Special care is being taken to prevent coupling between traces and to ensure that all traces are of similar length. All elements of this design must also be included within a compact area (shown in Figure 2). A second challenge is determining the optimal placement of the GumStix COMs and their respective connectors.

References

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