**Team Name:**

Radio Communication Innovators

**Team Members (maximum 4 members)**

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| --- | --- | --- | --- | --- |
| **Last Name** | **First Name** | **Email\*** | **Dept.** | **Signature** |
| **Thibodeau** | **Brian** | [tuc69335@temple.edu](mailto:tuc69335@temple.edu) | **ECE** |  |
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**\*Email address will be used to develop Senior Design listserv. You will be required to check this address regularly (e.g. daily)**

**Advisor: By signing below, the faculty member agrees to be the Team Advisor and attests that the resources required for this project are available or obtainable.**

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| --- | --- | --- | --- | --- |
| **Last Name** | **First Name** | **Email** | **Dept.** | **Signature** |
|  |  |  |  |  |

**Sr Design Course Coordinator:**

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| --- | --- | --- |
| **Last Name** | **First Name** | **Email** |
| **Sillage** | **Dennis** |  |

**If majority of team or project is CE: Dr. Ryan**

**EE: Dr. Sullivan**

**ME: Dr. Cohen**

**Project Title:**

K3TU: FPGA-based Terminal Node Controller in Amateur Packet Radio Communication

**Project URL:**

https://sites.google.com/a/temple.edu/ fpga-based-terminal-node-controller-in-amateur-packet-radio-communication

**Project Description:**

**4 Paragraphs:**

**1) What** is the problem you are addressing?

Traditional modems were designed and implemented using analog components. However, future modems will incorporate sophisticated modulation techniques that will dramatically increase circuit complexity. The result is a longer and more costly design process. In addition, the desire to increase data rates and security along with minimizing bit error rates means future modems will require flexibility and scalability; two attributes not currently associated with traditional analog modems.

**2)** **How** will you address the problem?

The goal of this senior design project is to recreate an analog modem designed in 1994 using only programmable logic. That is, we plan to implement both analog and discrete digital technologies of the original modem design using nothing but a re-programmable FPGA and converters for communicating between the analog and digital domains. With the advent of software-defined technology, we think that this project highlights the fact that most discrete and integrated circuits that are not configurable after manufacturing can and will be replaced by less expensive re-programmable technologies.

We have selected the KD2BD Pacsat Modem to be recreated solely using programmable logic. The modem was originally designed in 1994 by John A. Magliacone for communications with low-earth orbiting amateur satellites transceiving at 1200 baud (PACSATs). The modem originally consisted of discrete analog and digital components. We plan to recreate the modem using Xilinx’s Spartan-6 FPGA equipped on the inexpensive Avnet LX9 Microboard. The Digilent Pmod AD1 and DA2 analog-to-digital and digital-to-analog converters will also be used for communicating between the digital and analog domains, or namely between a terminal node controller and an amateur satellite ground station.

**3) How** will you validate your project through testing?

Cedric:

**Rough draft:**

* Acquire a BPSK signal so it can be demodulated
  + We can use Matlab to generate a Manchester Encoded signal bury in some SNR level and try to extract the AX.25 signal back
* Create an AX.25 bit stream and modulate
  + Using a test-bench we generate a stream of random data
    - Assessment: Analyze the signal using Matlab
* Use different SNR and test how effective is the demodulation
* Adjust the Radio to the Doppler shift
* Finally our final goal will be to monitor an incoming satellite so we can communicate
  + PREDICT which was developed by John Magliacane looks really good

We intend on using a DAC, an ADC to analyze the modulated and demodulated waveforms from the Avnet's Xilinx Spartan-6 FPGA. Matlab’s signal processing and communication toolbox will help observe the waveforms in the frequency domain as well as the time domain. The modulated waveform will be created by generating a stream of data following the AX.25 protocol through testbenches in Xilinx’s ISE Design. Using Matlab we will ensure that the modulated waveform has the appropriate **carrier frequency** and a low amount of **phase jittering**.The demodulation procedure will be analyzed using Matlab’s toolboxes after being acquired from using a DAC. The demodulator’s analysis will be geared towards optimizing the Signal to Noise Ratio (SNR) of the demodulator. Providing different SNR we will observe the efficiency of the demodulator which will be configured to demodulate waveforms regardless of a low SNR.

Finally, to test our modem we plan on monitoring Amateur Satellites orbiting to transmit and receive packets. The satellite transponder will be tracked using the computer software PREDICT which allows to interactive monitor the satellite and provides us with the Doppler Shift needed.

**4) What** will you deliver at the end of the second semester?

At the end of the second semester, we plan to deliver a re-programmable modem capable of modulating and demodulating 1200 bps BPSK signals between an amateur satellite ground station and a terminal node controller. This will satisfy the original functional purpose of the KD2BD Pacsat Modem.