LOW VOLTAGE DIFFERENTIAL SIGNALING (LVDS) STUDIES FOR
RECONFIGURABLE PLATFORM ARCHITECTURE

Initial Project Summary

Reconfigurable Systems: Cameron D. Dennis
Chris Canine
Terseer Ityavyar

4 October 2005
1. PROJECT OVERVIEW

1.1. Stake Holders

- **Customers**
  - The Field Programmable Processor Array (FPPA) Project team
  - Scientists on NASA development teams

- **Sponsor/Client/Advisor/Mentor**
  - Greg Donohoe

- **Capstone Instructor**
  - Joe Law

- **Consultants**
  - David Buehler, FPPA Software Lead
  - Joe Hass and the Center for Advanced Microelectronics and Bimolecular Research (CAMBR) team
  - Pen-Shu Yeh, NASA Goddard Space Flight Center (GSFC)

- **Staff**
  - Greg Klemesrud - Electronics Specialist

1.2. Project Background

This project is a continuation of an existing project under a grant from NASA. The Field Programmable Processor Array (FPPA) is a multi-processing integrated circuit under development for data intensive, streaming applications aboard spacecraft. It is targeted to an ultra-low-power, radiation-tolerant CMOS technology. The FPPA implements a synchronous data flow computational model with conditional data flow instead of conditional branching. In addition to the processor chip, a suite of support software is being developed. This project will focus on the communications standard of the platform, and will develop a Low Voltage Differential Signaling (LVDS) based communications system.

1.3. Deliverables

At the end of the project, the design team will deliver:
- Complete communications specifications to enable testing of communications via a crossbar to a network of FPPA's.
- An LVDS interface PCB to enable

2. JUSTIFY THE PROJECT
2.1. **Why? (Needs):**
This LVDS experiment and research is required to ensure dedicated routing channels throughout the FPPA and interconnecting systems and to achieve high speed, high density, low power consumption signaling between a network of FPPA’s. Completion of this project will make development for future space missions much easier, benefiting everyone at NASA and other research organizations.

2.2. **Benefits:**
- **Societal / Consumer**
  - More affordable systems, built with fewer parts
  - Smaller systems since less components are required
  - Lower voltage supplies since we are using LVDS
- **Client**
  - Our client gains research results at a low cost
- **UI and the Capstone program**
  - This program will enhance the credibility of the UI College of Engineering’s Senior Design Program demonstrating outstanding product design by ethical, knowledgeable, work oriented undergraduates.
- **Team members**
  - This project allows the team to:
    - Gain experience on a design team with people from different cultures and with different levels of experience
    - Become more rounded in the Electrical and Computer Engineering field
    - Demonstrate to perspective employers their work ethic and technical proficiencies
    - Learn about high-performance digital system design, signal integrity, FPGA design, advanced board-level LVDS communications, PCB design and CAD tools / hardware development software.

2.3. **Investments & Costs:**
- **Investments**
  - Time from the team to learn about LVDS and the FPPA project
- **Financial contribution of the client**
  - Currently, the given budget is about $1000
- **Hardware and Supplies**
  - Several interface boards that will be designed will need to be fabricated
  - Cables and connectors required for various LVDS experiments
LVDS crossbar or switchboard

- Engineering Time: The estimated weekly cost is approximately $3,450 broken down as follows:
  - Student time: Total weekly cost of approximately $2,250.
    - @ $50 per hour
    - 3 students
    - Approximately 15 hours a week per student
  - Faculty time: Total weekly cost of approximately $600.
    - @ $150 per hour
    - 2 faculty members
    - Approximately 2 hours a week per member
  - Mentor time: Total weekly cost of approximately $500.
    - @ $100 per hour
    - 1 mentor
    - Approximately 5 hours per week
  - Facilities: Total weekly cost of approximately $100.
    - Shop time @ $25 per hour
    - Approximately 4 hours per week

2.4. Return on Investment (ROI):
This project will provide, at a very reasonable cost, a high quality project that will benefit many researchers and scientists. The possible scientific contributions are invaluable for the space community as well as potential commercial use of the FPPA in the future.

3. TEAM FORMATION
Based on input from each team member we are presenting the issues relevant to strong team performance in the following categories:

- Goal - To develop a robust, working product by the end of the class and to learn and develop our skills in the process. Each member of the team looks eager to accomplish this.

- Expectations - Terseer wants to gain skills/experience and the satisfaction of a successful working product. He expects team members to be diligent and passionate in their duties. Chris would like to contribute to the research at NASA, and expects that team members will give their absolute best work to the project. Cameron desires to learn and experience the design cycle and aide in the leadership development of his team.

- Accountability - Terseer and Chris will hold themselves accountable by doing every project task to the very best of their ability. They will hold their peers
accountable by checking up with them casually and at official meeting times on the progress they are making and in turn discuss their own progress with them. Cameron will continue to set himself to high moral standards and values. Each member of the team should also hold themselves to their own high standards. When someone fails to do so, they will be open and honest with the team about the issue so the team can work together to fix the problem.

- **Roles**
  - Terseer Itavyar
    - Project Manager: To act as a point of contact for information flow, to track tasks, and prepare Project Status Reports for submission to the customer, Capstone Instructor and the Administrative Assistant for filing.
  - Cameron D. Dennis
    - Administrative Assistant - Maintains documentation binder, disseminates the information to other team members and updates weekly the Action Item Review.
    - Accountant - Maintains the budget and provides weekly reports to the team & customer.
  - Chris Canine
    - Facilitator - Prepares the program for meetings and conducts the procession & moderates discussions.
    - Webmaster - Creates and maintains the team website, ensuring it is up-to-date at all times.

- **Assessment** - Each team member will assess themselves and the other team members regularly, upon request, and provide feedback to the rest of the team on possible improvements.

- **Rules**
  - Maintain integrity, honor and loyalty at all times.
  - Assist each other in academic endeavors and personal growth, remembering that education is the goal, not just the product.
  - Do not be late or absent from anything concerning the project team without prior notification.
  - Listen and be open to all ideas from everyone, without passing judgment, and come to a decision in an unbiased approach.
  - Do not continuously “drive” a subject into the ground. Once a decision is made, move on.
  - Be respectful and courteous to everyone.
  - Hold ourselves to higher standards than normal, to lead the engineering student body by setting the example.
4. EXPLORING THE PROJECT

4.1. Client and Stakeholder Interview Questions:

- **People**
  - Whom should we target as the final customer? Should we consider Greg and the project team to be the final customer, or possibly someone at NASA?
  - How will the rest of the FPPA project team relate with us?
  - How often should the design team meet with the client?
  - Should the client be able to establish deadlines for when particular milestones are achieved?

- **Needs**
  - Where exactly are we picking up? We know John has a piece of our project that he is turning over, but where will that fit in our project planning (i.e. which stage)?
  - What explicitly is the task for the reconfigurable systems project team?
  - Where does this fit into the entire project mission?

- **Constraints**
  - Are there any with our part of the project?
  - Are there already expected standards for interfacing, power use or size of the final product?
  - What is the scope of the project? Will it only need to communicate internally, or will it need to communicate with outside equipment?
  - What happens if we optimally speed up baud rates for the serial signals using the proposed methods?

- **Functions**
  - What are the most desired functions of the project?
  - Are there “bonus features” that are desirable, but not required?
  - Does the primary desired outcome border around the speed of the data transmission?

- **Scope**
  - How much individual average weekly time do we think is necessary for the success of this particular project?
  - In the event of a surplus or deficit budget, what would be the course of action?

- **Existing Knowledge:**
  - Will our project only involve setting the precedence for the use of LVDS with the FPPA or will we be involved in development of an actual chip set?
We could probably develop new Intellectual Property if the project is successful, do we know if anything close to this has already been done?

- Expectations
  - What exactly do you, as an advisor/mentor, expect from the team? Each individual?
  - How fast a data rate should we ultimately be satisfied with if it comes to that?

4.2. Research & Learning Needs:
- Technical Knowledge
  - The team needs to do more research on LVDS.
  - There needs to be some training with ORCAD.
  - Using advanced FPGA design features needs to be explored.

- Interdisciplinary Topics
  - How much interaction will we have with the Computer Science team (Bob Rinker’s team)?
  - Digital circuit design.

- Codes and Standards
  - Are there communications standards that should act as a basis for our design, or should we develop these from scratch?
  - Are the any standards established by NASA that we should follow?
  - Are we involved with the radiation tolerance standards at all?
  - IEEE code of ethics. Issues pertaining to Public safety, improving understanding of technology, and coherence with religious/ethical belief.

- Product Knowledge
  - The team will need to understand the various equipment used in the measurement of LVDS signals.
  - Basis for the development of reconfigurable computing systems
  - Applicable to embedded systems such as spacecraft

5. CAPSTONE INSTRUCTOR SIGN OFF
   The capstone instructor will sign off on this document before the client interview.

Instructor: ___________________________ Date: ___________________________

Joseph D. Law, Ph.D., P.E.
6. CLIENT INTERVIEW

The first client interview is to be documented below.

7. ASSESSMENT OF PHASE ZERO

We have divided our assessment of this phase into the following categories:

- **Strengths** - Our first meeting was effective, one of the reasons is because it showed passion for the project from eagerness to clear up any ambiguities concerning what is ahead. Cameron presented many cogent questions that yielded us important information.

- **Improvements** - To meet and discuss more regularly, even in this phase. Chris and Terseer should speak up a little more in the team meetings.

- **Insights** - None as of yet