Use Case

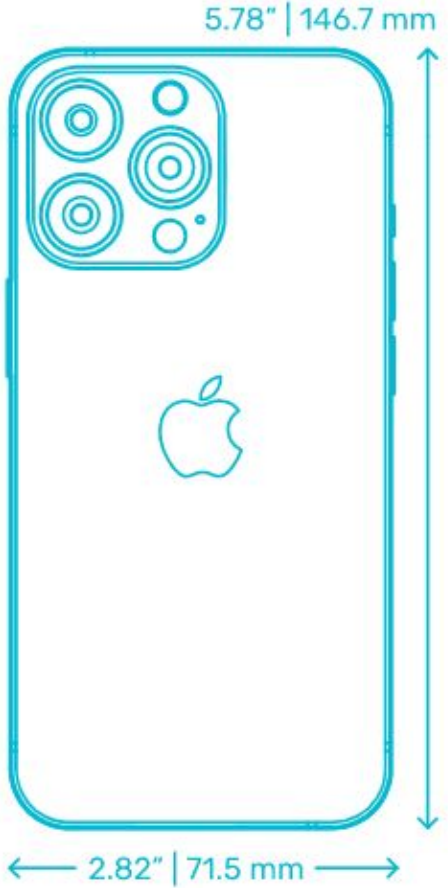
- Transmitting classified or sensitive information usually wired
- Convenient means for wireless data transmission of private files
- **Implementation:** hardware & software to interface a laptop to lasers and a receiver
- **ECE Areas:** Software Systems, Hardware Systems, Circuits, Signals and Systems

Use Case (Cont.)

	Wired	Wifi	Wifi-Direct	Bluetooth	Near-Field	Laser
Speed						
Convenience						
Security						

Use-Case Requirements

- Data transmission must work at 0.5 m
- Maximum target size is 2.81” x 4.21”
- Minimum target size is 0.7” x 0.7”
- Operates with indoor ambient light
- Detect 2-bit error, correct 1-bit error



Use-Case Requirements (Cont.)

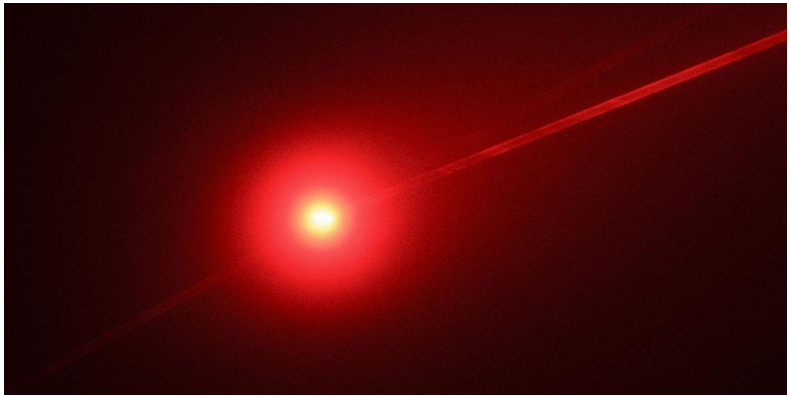
- Max total optical power is 5 mW (IIIa)
- Minimum laser transmission speed is 4 Mbps (50 pdf pages per second)
- Latency below 34 ms (BLE 5)
- Minimum USB communication at 4 Mbps
- Capable of being powered by USB (5V, 0.5 A)

Specifications	Classic Bluetooth	Bluetooth Low Energy (V 4.2)	Bluetooth 5
Range	100 m	Greater than 100 m	Greater than 400 m
Data Rate	1-3 Mbps	1 Mbps	2 Mbps

Laser class	Hazard or potential for injury
1	Safe under reasonably foreseeable conditions
1M	Hazardous to the eye when using telescopic optical instruments (otherwise as in class 1)
2	Direct intrabeam viewing must be avoided—retinal injury is possible at intra-beam viewing times exceeding 0.25 s
2M	Hazardous to the eye when using telescopic optical instruments (otherwise as in class 2)
3A	Hazardous to the eye only when using telescopic optical instruments
3R	Hazardous to the eye
3B	Always hazardous to the eye
4	Always hazardous to the eye and skin

Technical Challenges

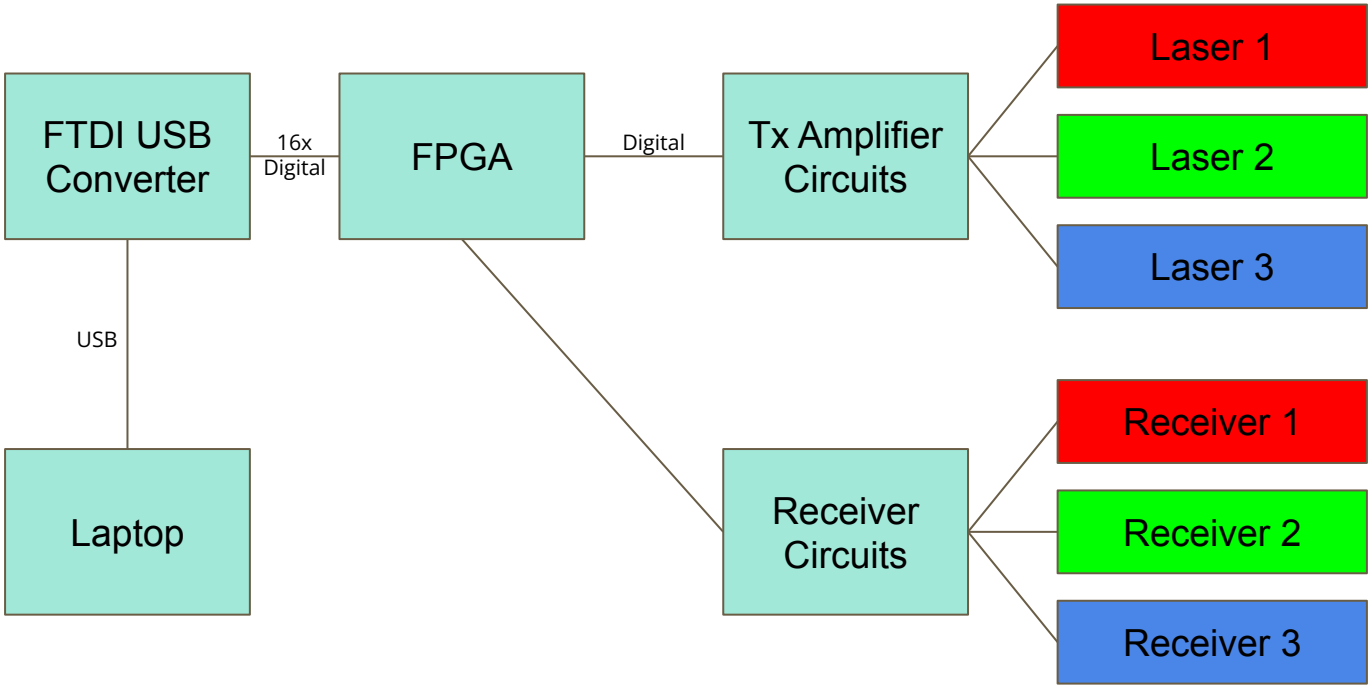
- Target size of 0.7″ x 0.7″ to 2.81″ x 4.21″
  - Diffusing light or using array of receivers
- Limited optical power of 5 mW
  - Signal-to-noise ratio
- Receiving with ambient light
  - Signal-to-noise ratio



Technical Challenges (Cont.)

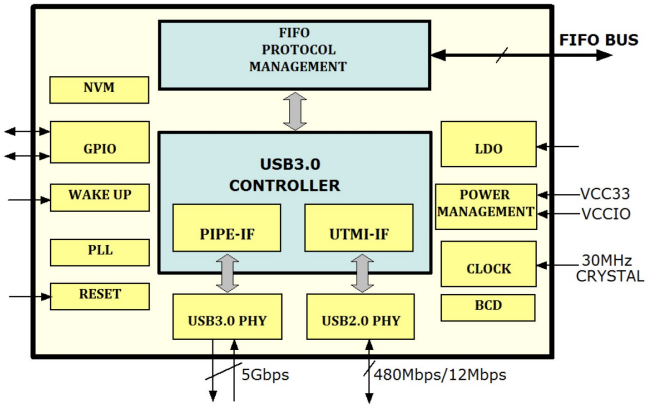
- Transmission at 4 Mbps
  - High-speed PCB routing
  - Optical component rise/fall time
- Error detection
  - Proper encoding of 2-bit error detection and 1-bit error correction
- Providing sufficient power to the entire circuit via USB
  - Receivers work faster with high voltage bias

Solution Approach



Solution Approach

- **Transmission:** 3 Laser diodes with 100 MHz+ rating (ams OSRAM)
  - 1 clock, 2 data. If clock is not needed, switch to 3 data
- **Receiver:** PN Photodiodes + colored filters
- **USB chip** (FTDI)
  - FT600Q-B: 16-bit FIFO, 1.2 Gbps
  - Alternative is UART (FT260), 12 Mbps
- **FPGA** (Altera)
- **Error correction:** Hamming code
- **Data protocol**
  - Handshaking procedure
  - Modulation: square wave or AM on carrier frequency
- **Software:** Laptop script to send/receive over COM port and separate/reconstruct files



Testing, Verification, and Metrics

Speed/Latency Test: transmit a file to/from the same laptop, time transmission

Range Test: test with 2 laptops at 0.5 meters, time receiving laptop to verify speed

Error Correction Test: inject messages with errors and evaluate result

Power Test: measure current draw from a power supply

Ambient Light Test: run tests in varying lighting environments

Tasks and Division of Labor

- **Component selection** (All)
- **PCB design** (KJ)
- **Create data protocol** (All)
- **Signal analysis** (Roger)
- **Laser communication - Circuits** (KJ)
- **Laser communication - FPGA** (Anju)
- **Error correction** (Anju & Roger)
- **User application** (Roger)
- **Testing** (All)

Schedule

Tasks	Week 1 (2/6)	Week 2 (2/13)	Week 3 (2/20)	Week 4 (2/27)	Week 5 (3/6)	Week 6 (3/13)	Week 7 (3/20)	Week 8 (3/27)	Week 9 (4/3)	Week 10 (4/10)	Week 11 (4/17)	4/24
Hardware												
Pick parts for preliminary testing	All											
Test preliminary parts		All										
Laser communication signal analysis		Roger										
Schematic design & simulation			KJ									
PCB layout				KJ								
PCB & parts ordering				KJ								
Assemble & test PCB						KJ						
Firmware/FPGA												
FPGA development envrionment setup		Anju										
FPGA - USB side			Anju									
FPGA - Laser side				Anju								
Error correction/detection					Spring	Roger/Anju						
FPGA compilation onto PCB					Break		Anju/KJ					
Software												
Develop a GUI			Roger									
Establish communication to device				Roger								
Design a test suite							Roger					
Systems												
Create laser communication protocol		All										
SW/HW integration								All				
Testing & Validation												
Speed/latency test									All			
Range test									All			
Error correction test									All			
Power consumption test									All			
Slack										All	All	
Deadlines	Proposal		Design Review	Report Due (3/3)					Interim Demo (4/3)			Final Presentation

Conclusion

- Lasers to communicate sensitive information conveniently and securely
- Proof-of-concept for wireless, high-speed, secure data transfer
- Aim to achieve performance greater than Bluetooth