Overview

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Background

- There has been a shift from wired to wireless
- A lot of research has been put into Radio Frequency (RF) wireless.
- But not much on optical wireless
Project goals

- Develop a wireless optical communication system using laser
  - Low-powered
  - Inexpensive
  - Versatile
Motivations and Challenges

• Laser offers the following benefits
  • Long range
  • Low-powered, low interference
  • Narrow beam -> very hard to detect & intercept
  • High speed

• Laser has the following disadvantage
  • Non-mobile
  • Line of sight issue

• Challenges
  • Design a reliable coding scheme
  • Optimize for bandwidth and latency
Why Laser Instead of RF?

• Power Consumption!
  *RF network needs to constantly listen, depending on the duty cycle. This takes power. A laser node however does not need to listen, and can sleep while waiting for a laser pulse.*

• Range!
  *A RF enabled node has a limited range. A laser has a range in the kilometers. This means a node can be far away from the central network nodes.*
Project Implementation

- Composed of 2 parts:
  - Laser boards – the datalink and physical layer
  - XScale - the network and application layer
Data Flow
Data Flow Summary

- XScale parses input from files or command line
- XScale breaks data into bytes, frames them, and passes them to the laser board
- Laser board receives bytes, encodes them, send them over the air
- Laser detector receives encoded bits, decodes them into bytes, sends to XScale
- Xscales reads bytes from laser detector, reconstructs and displays data
### Framing Scheme

- **Surround the bytes sequence with a header and footer**

<table>
<thead>
<tr>
<th>Header</th>
<th>Data Bytes</th>
<th>Footer</th>
</tr>
</thead>
</table>

- **Header and footer contains special characters sequence, marking the start and end of frame**
- **Header also contains operation mode**
Encoding Scheme

• Byte to be transmitted is encoded into a specific timing pattern.
• Timing pattern contains 11 time slots, with each time slot either being a “1” (laser pulse is on) or a “0” (no laser pulse).
• All transmissions start with 101 in order to synchronize the transmitter with the receiver.
• Receiver receives pulses, records the time stamp on each pulse, and decodes the original byte that was transmitted.
Inter-level communication

- Communication between XScale and laser board is done through serial cables.
- Connecting through COM1 serial port “/dev/ttyS0”.
- Using read() and write() system call.
Result – what did we accomplish

• Implemented a basic laser communication system
• Can send data from one XScale to another
• Input data can be from a file or from command line
• Can use the system to trigger command line execution remotely
Future works

• Improve latency and bandwidth
• Support full-duplex communication
• Support multiple senders/receivers
• Improve encoding and framing schemes
• Error detection/correction
• Extensive power-usage analysis of the system
• More fully develop laser network stack
Demo