Data Integration in Multicarrier Spread Spectrum

by
Afshin Edrissi

Credits:
Dr. C. Furse
Dr. B. Farhang-Boroujeny
Suketu Naik

TOPICS

- Introduction
  - What is the project about
  - What makes it different
  - Problems
- Implementation
  - Block diagrams and graphs
  - Goals

Introduction

- We want to detect the location of a fault!
  - Types of fault
    - Open
    - Short
    - Other faults (water dripping, bad connection,…)
  - Some common methods
    - TDR (Time Domain Reflectrometry)
    - FDR (Frequency Domain Reflectrometry)

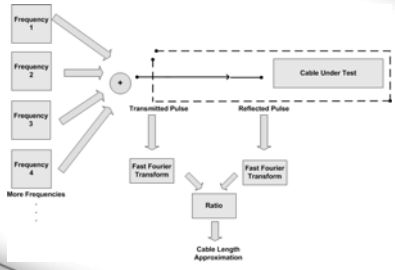
Introduction

- What is different in MCR (Multicarrier reflectrometry)
  - Speed
  - SNR is very low
  - Reliable
  - Data transmission (Networking capabilities)

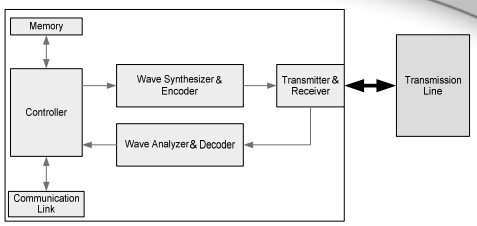
Introduction

- Problems
  - Speed! Need to sample over 1GHz
  - Dispersion effect of difference frequencies
  - Power consumption
  - $$$ can be very expensive!
  - Complexity

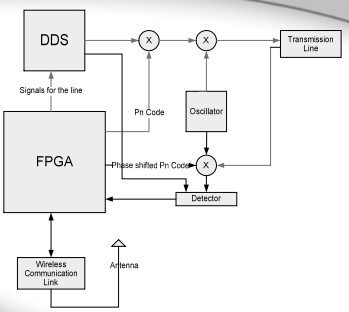
Implementation



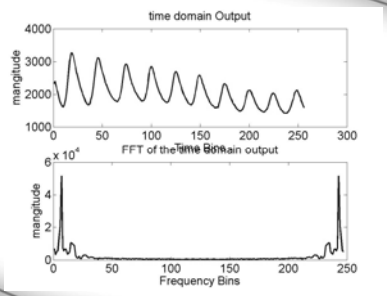
Implementation



Implementation



Implementation



Implementation

- Goals
  - Create a single IC
    - Size
    - Power consumption
  - Create network proto-controls
    - Future network between smart sensors
    - Capable of analyzing wires with branches instead of a single wire

Data modulation in Smart Sensor

- Why data? Aren't they smart enough?
  - Analyzing branches of transmission line
  - Increasing the accuracy on finding fault locations
  - Communication to the outside world through other sensors
  - Fault detections of other sensors

Data

- General formula of a signal $\sum A\cos(\omega t+\phi)$
- To transmit a data
  - Change Amplitude
  - Change Frequency
  - Change Phase
  - OR any combinations of the above

Data

- Phase shift can give us higher SNR
- But it needs more precise electronics and higher processing power
- By phase modulation, we no longer can use estimation for signal detection

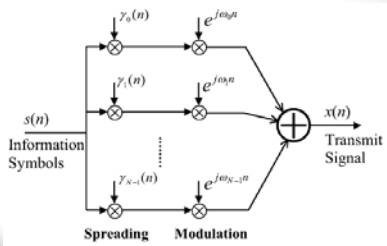
MCSS

- MCSS (Multicarrier Spread Spectrum)
  - Combination of two existing systems
    - CDMA (Code Division Multiply Access)
    - FDMA (Frequency Division Multiply Access)

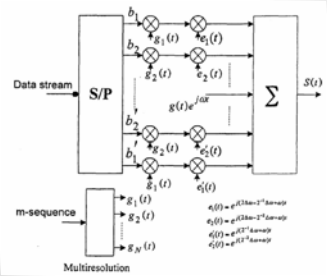
MCSS

- What is the advantage of the MCSS vs. the mentioned systems?
  - Higher SNR if the “Noise” is known
    - To our system, the biggest noise is the existing data communication on the line
    - By Increasing the SNR, its possible to lower the transmitted signal, thus less interference with the existing systems

MCSS – Transmitter



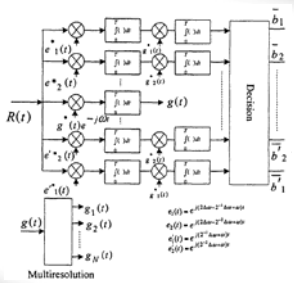
MCSS - Transmitter



MCSS – Receiver

- Since we need high accuracy at the receiver’s input, for prototyping we will use the special oscilloscope's ADC which is designed for microwave frequencies
- After receiving the data, we will need to do signal processing and extract the data from reflected waves that contain the fault location

MCSS – Receiver



Project Goal

- The goal of my project is to successfully transmit data from one sensor to the other without interfering with other existing signals on the line

Project Tasks

- Analysis on data transmittivity between smart sensors on Aircraft wires
- Analysis of data modulation in the MCSS system
- Design and implementation of data modulation in the MCSS system

Project Tasks

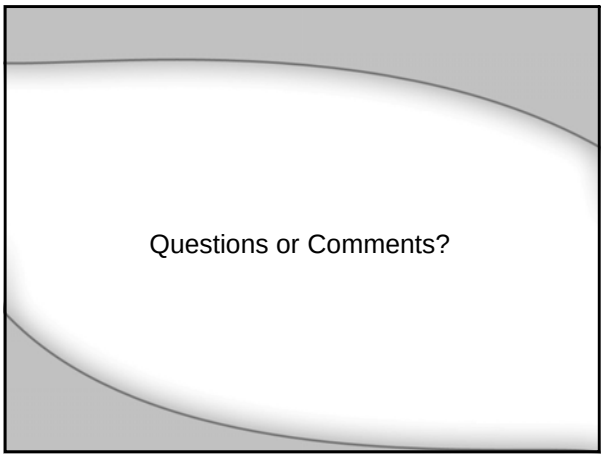
- Testing
- Documentation

Project Schedule

- 2 semester project
  - Fall
    - Complete all the analysis and create an efficient data modulation
    - Know the MCSS system thoroughly to design/modify it for data modulation
    - Pick the hardware/software for implementation
    - Order the necessary parts

Project Schedule

- 2 semester project
  - Spring
    - Design the actual HW/SW
    - Start to integrate components together
    - Testing the system
    - Writing the final report
- Note: there is no BOM at the current time


Questions or Comments?