Midway Design Review - November 2020

Active Windows Project

Team #15

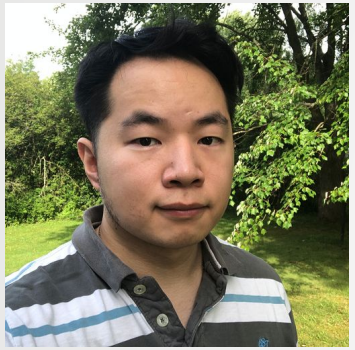
Michael Chan, Dingbang Chen, Nathan Johnson, Tien Li Shen

Advised by Professor Yao

University of Massachusetts Amherst

Team members

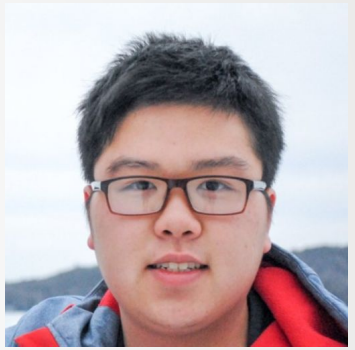
All



Michael Chan
EE

Dingbang Chen
CompE

Nathan Johnson
CompE



Tien Shen
CompE

Problem Statement

Nate

Building automation systems can help reduce operational costs and carbon emissions by improving energy efficiency. However, many current solutions are manufacturer specific and expensive, making widespread adoption difficult.

Our Solution

Nate

Our project aims to assist the non-profit Manhattan-2 company develop “electrical and communications standards that define how devices interconnect within the building of the future.”

This entails:

- Facilitate the development of an open-source software framework (Building Bus) to enable easy smart home device development
- Develop a new CAN transceiver circuit that emphasizes smart building network priorities, particularly higher-reliability and lower operational power compared to existing CAN transceivers

System Specifications

Mike

Networking Software:

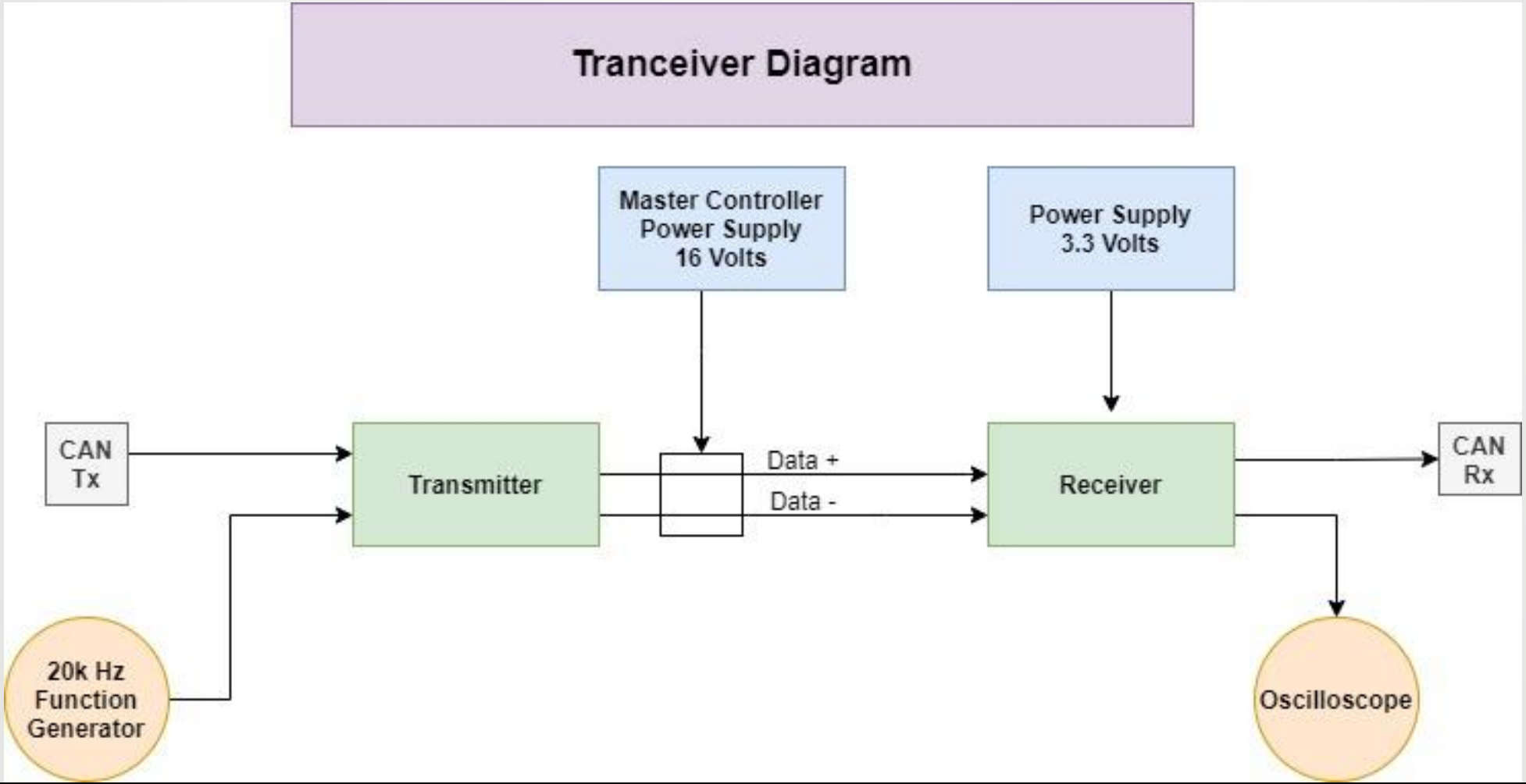
- Supports communication from master controller to devices.
- Support various function calls and commands
- Supports tree networking topology
- Processor sleeps when not processing network packets
- Identify each device with serial number/address
- Uses CAN bus communication protocol
- Uses only C/C++

Physical Layer:

- Provides a maximum of 5mA of power to device transmitters
- Defines a logic 1 and logic 0
- Supports CAN bus (Wire-AND)
- No damage to devices in event of accidental short

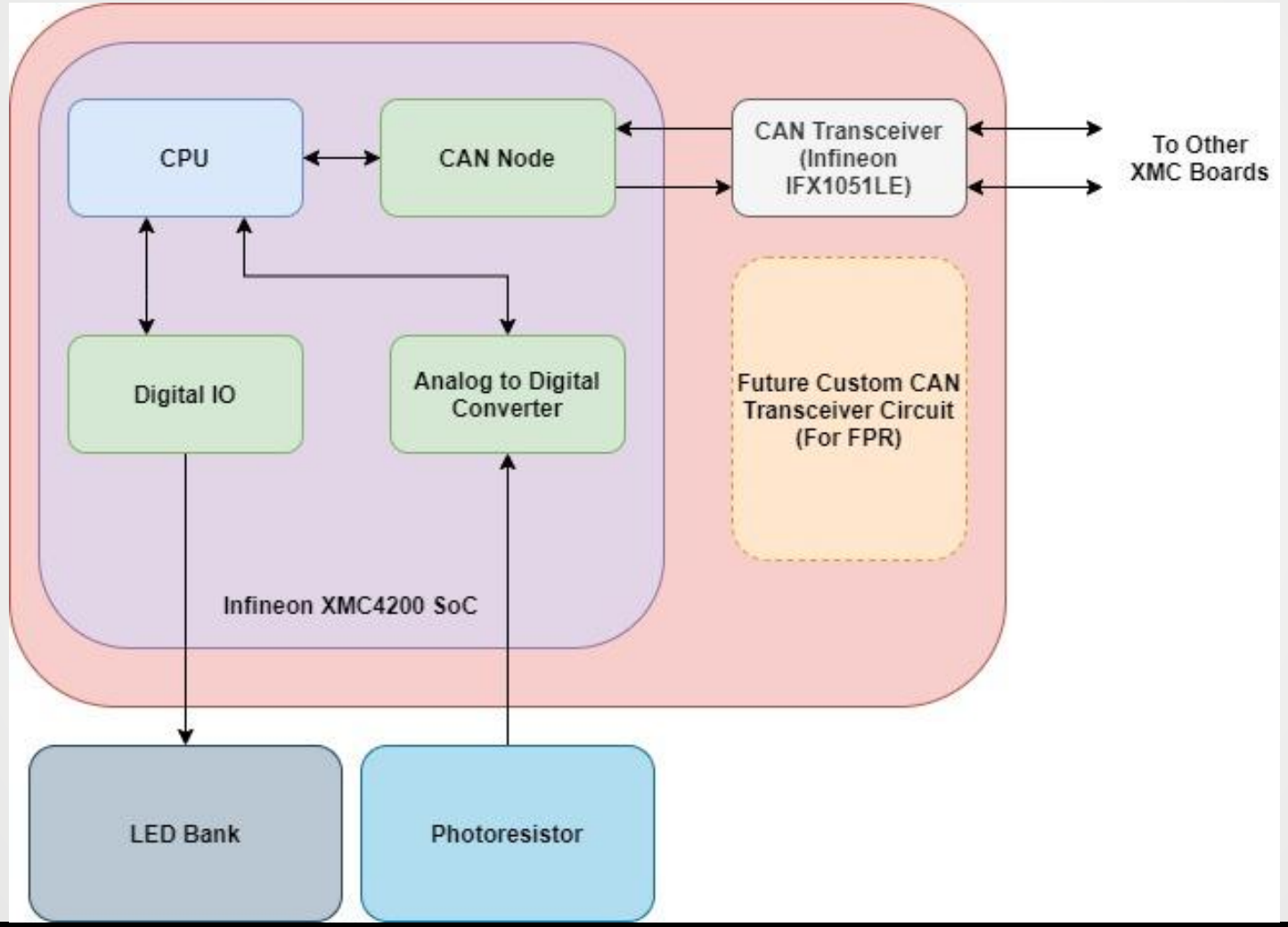
Updated System Design (Software & Hardware)

Mike



Updated System Design (Software & Hardware)

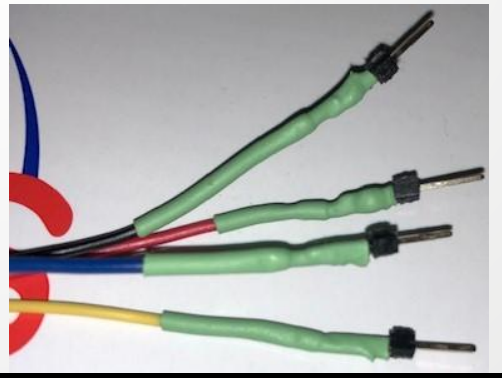
Nate

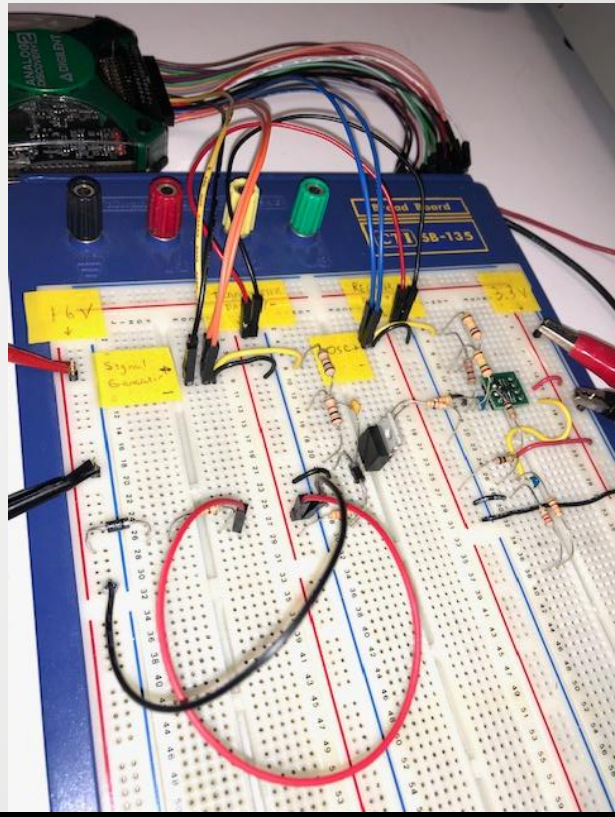


MDR Accomplishments: Michael Chan

Mike

- **Physical Layer**
  - Generated and simulated transceiver circuit using TINA software (Network Power, Transmitter, and Receiver)
  - Soldered comparator chip on to adapter for breadboard testing
  - Soldered header pins on 18 and 22 gauge stranded wire for testing
  - Build and tested transceiver circuit on breadboard
  - Generated spreadsheet data using analog discovery 2 (Function generator/ Oscilloscope)





MDR Accomplishments: Dingbang Chen

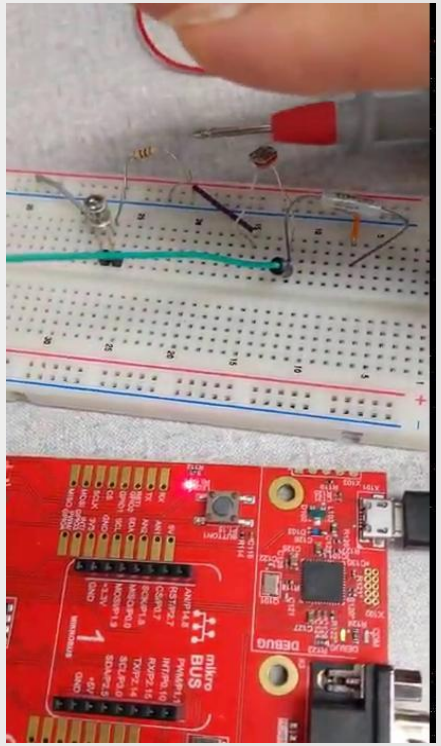
Chen

- **DAVE IDE**
  - Configured Building Bus program's path and environment into the DAVE .
  - Solved problem setting up the C/C++ compiler and missing segments in different classes.
  - Compiled the entire Building Bus source code on DAVE IDE.
  - Wrote a test class in the building bus project to test the project can be compiled and built on the XMC4200 development board.
  - Pushed latest code in the shared file and Github repository
- **Budget Management**
  - Kept track of the budgets spending.
  - Purchased and delivered parts to teammates

MDR Accomplishments: Tien Li Shen

Tien

- **Analog to Digital Converter:**
  - Built a photoresistor voltage divider circuit as an optical sensor for the XMC4200 development board.
  - Programmed the XMC4200 development board to use its on-chip ADC to measure voltage from the sensor circuit.
  - Used a multimeter to study voltage behavior of the photoresistor circuit and to confirm the accuracy of XMC4200 ADC measurement.
  - Built a mini project where the XMC4200 development board continuously reads sensor measurement and turns on or off the on-board LED based on the measurement.
- **Skeleton code for the Tasks/Chores/Task Manager software feature.**



Mini Demo with ADC/Photocell

MDR Accomplishments: Nathan Johnson

Nate

- **XMC-4200 SoC CAN Communication**
  - Loopback mode (internal SoC CAN network) bringup
  - Adapted provided example project for CAN communication to our purposes
  - Changed example code from using polling based message reception to interrupt based reception
  - Verified and debugged CAN communication issues using logic analyzer

- **MDR demo final software integration**
  - Combined Tien's ADC code with my CAN communication code
  - Fortunately the two fit together without issue, due to good planning ahead of time

Hardware Plan for FPR

Tien

- **Design custom PCB of current CAN Transceiver**
- **Manufacture 4-6 custom CAN transceivers**
- **5x XMC4200 Development boards**
- **Demo plan:**
  - Use 5x XMC4200 development board with custom CAN transceivers to demonstrate a more complex network and software features.
  - Additional motors are ideal features for FPR demo, but it not the primary objective of the Team 15. We wish to stick with LEDs to demonstrate outputs for now.

Software Plan for FPR

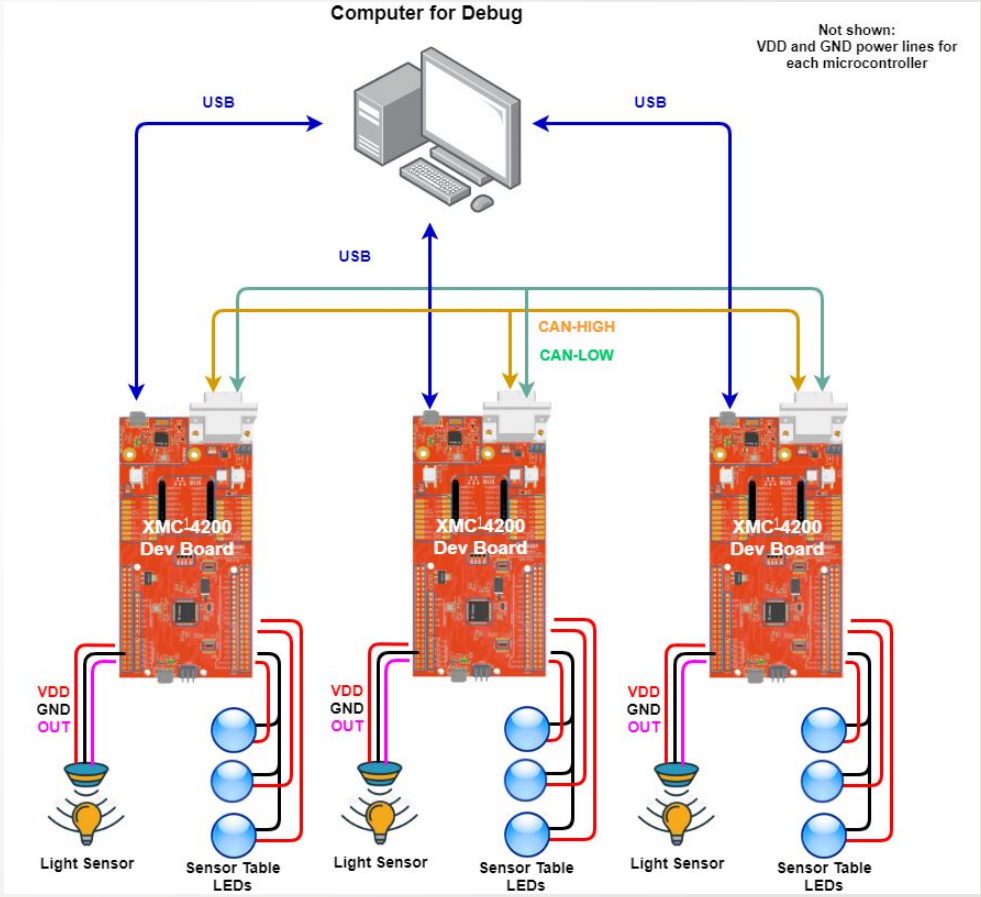
Chen

- **Implement missing features on the Building Bus framework**
  - Tasks, chores, and task managers
  - Publish/subscribe
  - Sensor table
- **Compile and upload Building Bus framework onto XMC4200 development board**
  - Existing code was not designed for embedded systems and will likely require significant modification for it to do so
- **Use the Building Bus framework's API to build the software for FPR demo**
- **Build scalable network capable of more advanced and robust features.**
  - Message forwarding between non-adjacent nodes
  - Packet segmentation
  - Device "ports" for addressing particular processes/peripherals on the device

List of hardware and software (Network)

Tien

- **Hardware**
  - 3x Infineon XMC4200 development boards
  - 9x LED
  - 9x 220 ohm resistors
  - 3x Photoresistor
  - 3x 10.4k ohm resistors
  - Multimeter
  - Logic analyzer
- **Software**
  - Infineon DAVE IDE/Toolchain
    - APPs: CAN_NODE, DIGITAL_IO, ADC_MEASUREMENT, SYSTIMER
  - Microsoft Visual Studio
    - Building Bus framework



List of hardware and software (Physical Layer)

Mike

- Analog Discovery 2 (Function Generator/ Oscilloscope)
- Dual DC Power supply (16v / 3.3v)
- Network Power (diode, resistor)
- Transmitter (diode, resistors, capacitor, transistor)
- Receiver (resistors, capacitors, comparator)
- 500 ft - 18/4 gauge wire
- 500 ft - 22/4 gauge wire

Project Expenditures (Current and Projected)

Chen

- **Current**
  - 3 XMC4200 Dev. Board ---------- $178.86
  - Transceiver components ---------- $ 18.92
  - 3 C++ Books and 2 Spools of wire ---------- Donated by Manhattan 2

- **Future**
  - 2 XMC4200 Dev. Board ---------- $119.24
  - Custom PCB and components (projected) ---------- $75.00

Project Management

All

Michael Chan

- ❑ Team Coordinator
- ❑ Physical Layer
- ❑ Tina Software Simulation
- ❑ Integrate Physical Layer and CAN bus network

Nathan Johnson

- ❑ Message Segmentation
- ❑ Message Forwarding
- ❑ Software Team Lead

Dingbang Chen

- ❑ Budget Management Lead
- ❑ Replicate MDR functionality using Building Bus framework
- ❑ Ensure Building Bus code ports to XMC4200 microcontroller cleanly

Tien Shen

- ❑ Altium Lead
- ❑ Expand sensor elections
- ❑ Tasks/chores/Tasks manager
- ❑ Build Team 15 Website + Poster

Gantt Chart

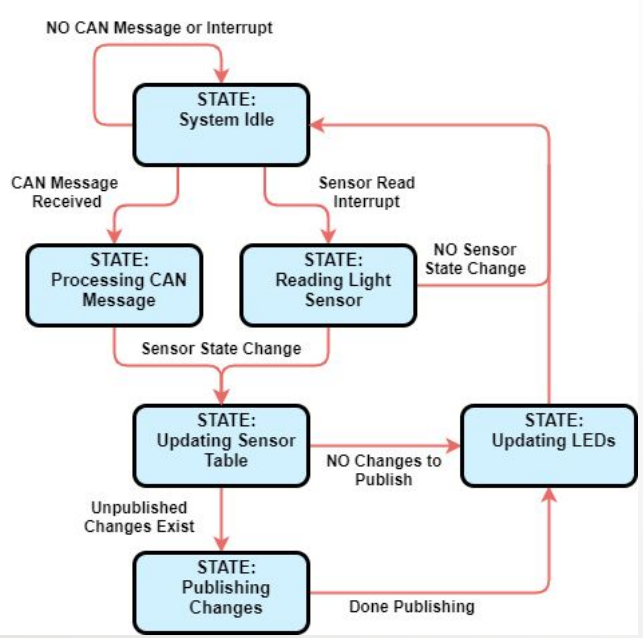
All

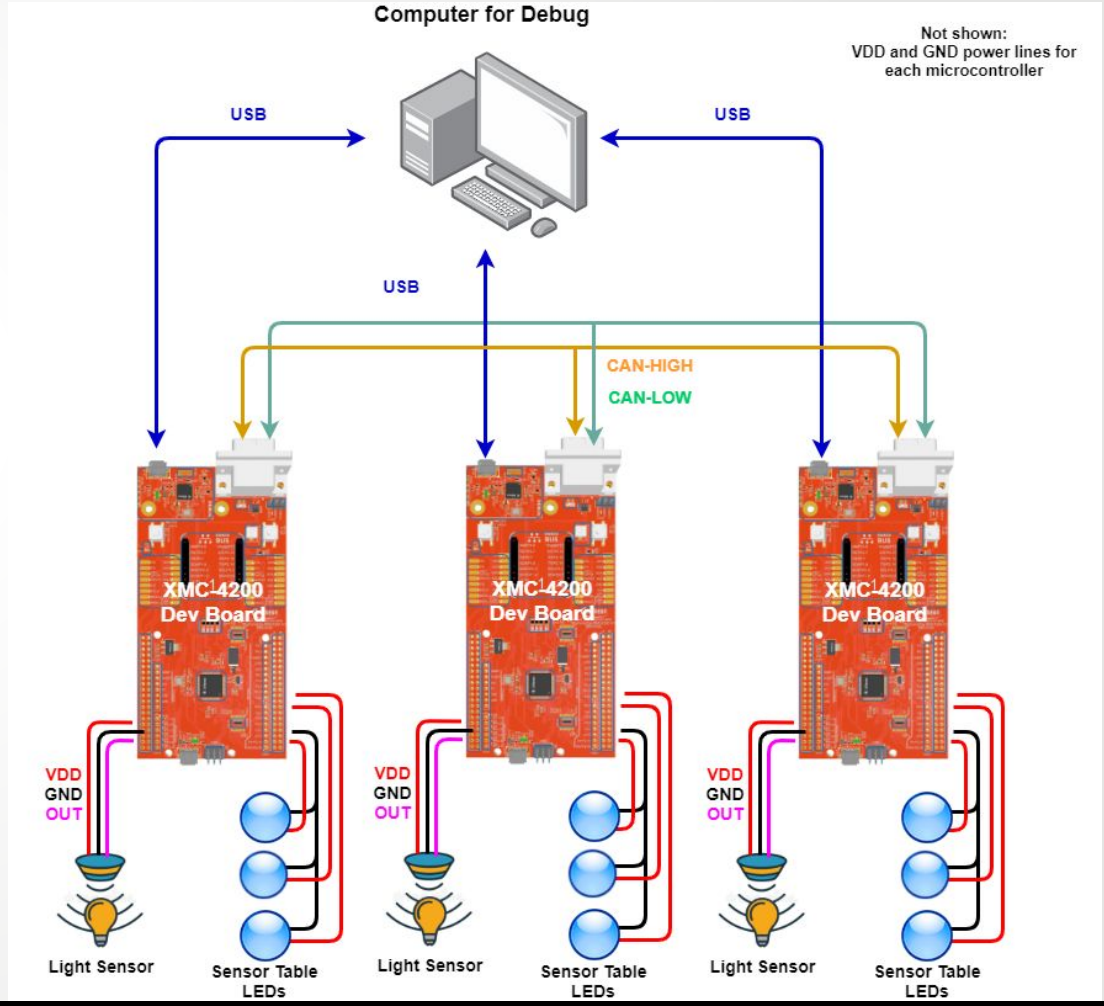
TASK TITLE	TASK OWNER	START DATE	DUE DATE	WEEK 1					WEEK 2					WEEK 3					WEEK 4					WEEK 5					WEEK 6				
				M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F	M	T	W	R	F
																												CDR Week				
SDP21 Poster	All	3/15/21	4/19/21																													
SDP21 Report	All	3/15/21	4/19/21																													
SDP21 Project Website	Tien	3/29/21	4/18/21																													
Altium Project	Tien	2/15/21	3/22/21																													
Tasks, Chores, Task Manager	Tien	2/1/21	2/21/21																													
Upload BB code to XMC4200	Chen	2/1/21	2/22/21																													
Expand Sensor Table	Chen	2/22/21	3/15/21																													
Publish/Subscribe	Nathan	2/8/21	3/15/21																													
Message segmentation	Nathan	2/1/21	2/22/21																													
Message forwarding	Nathan	2/22/21	3/15/21																													
Integrate physical Layer and CAN network	Michael	2/15/21	3/15/21																													
Build Power Supplies (16v and 3.3v)	Michael	2/1/21	2/15/21																													
Test Physical Layer (Multiple Transceivers)	Michael	2/1/21	3/1/21																													
				1 Feb 21					8 Feb 21					15 Feb 21					22 Feb 21					1 Mar 21					8 Mar 21				

Current Network MDR Demo:

All

- **Demonstrates CAN bus communication**
  - Uses onboard CAN transceiver IC (Infineon IFX1051LE)
- **Demonstrates a simple sensor table**
- **Small code base with very few features**
  - Important because these building blocks are essential for more complex features





Back-up Demo Video

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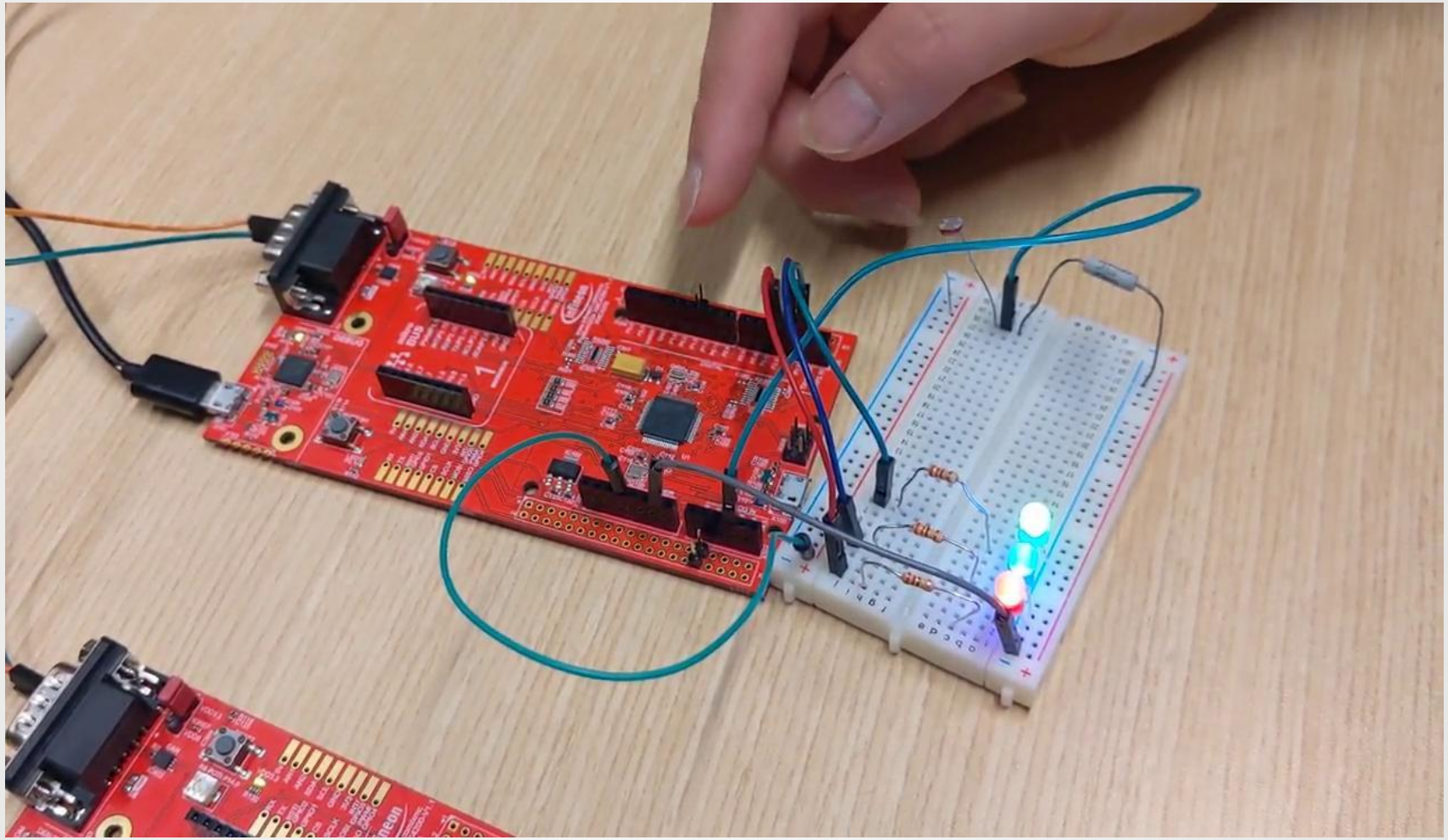

Thank you for your time

Questions?