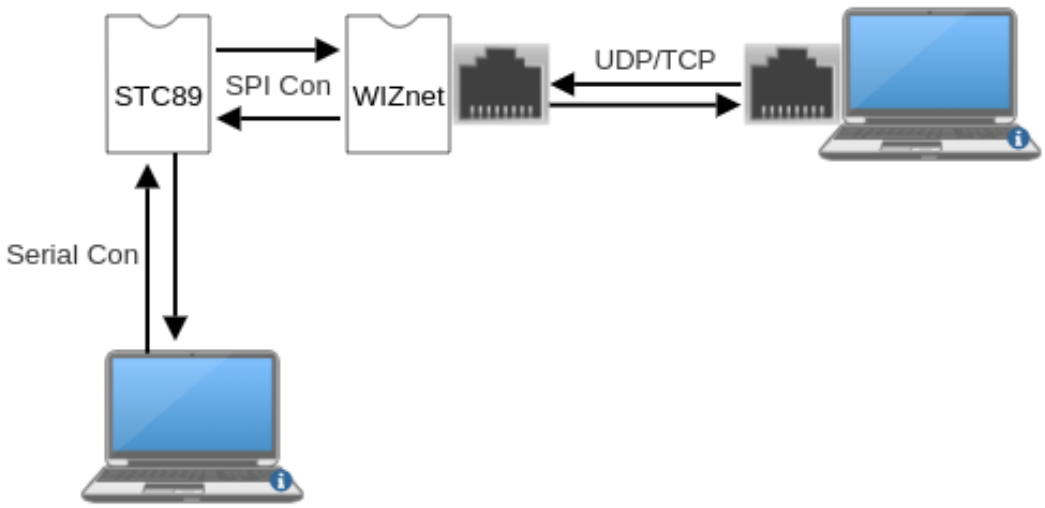


UDP/TCP RTU 8051 + W5500

Summary:
The goal of this project is the design of a simple UDP/TCP responder. An STC89/STC12 on a demo board will handle SPI transmissions between itself and a WIZNET LAN development board; it will also be connected via serial terminal to a laptop that will be used to configure parameters such as port and IP.

Required Components:

- WIZnet board (W5500)
- STC89/STC12 Demo Board or 8051 based chipset
- Wires/Transmission support equipment
- 2 LED diodes

Procedure:

Research and locate data sheets for all of the components above.

1. In your linux distro, install SDCC, and use python pip3 to install stcgal
   - Here are 2 different examples of ways to write data to the MCU:
     - Using a make file: make && stcgal -p /dev/ttyUSB0 -P stc89 -a main.ihx
     - Using sdcc: sdcc stcboot.c i2c.rel lcd_1602.rel pcf.rel && stcgal -P stc89 stcboot.ihx
   - Read STCgal Documentation

To get the chip into 6T Mode. Change stcgal options to include cpu_6t_enabled=true

- Make sure to set the chip into 6T mode (6 Clock)

Part 1 done on 5/4

- When using sdcc use –model-small use --model-medium when medium is done, switch to small

2. Set-up an SPI Protocol and Serial Communication
   - Set up Serial Communication
     - Read data from Serial interface
     - Display data to Serial interface

Serial Communication Setup complete - read and write

   - Set up basic SPI communication functionality in **C**
     - Set up WIZnet communication using previously developed SPI
       - Read/Write to WIZnet
       - Set SOCKETS for WIZnet (UDP/TCP)
       - Set WIZnet registers for IP Add, MAC, Port, Subnet, and Gateway
     - Verify Ethernet Connectivity via Ping or similar

3. Set up WIZnet and Demo Board to receive UDP packets memory and buffer optimization
   - Using the Ethernet functionality
     - Setup STC89 functionality to be able to read/write UDP packets
       - Be able to read from RX buffer
       - Be able to write to TX buffer
       - Verify functionality using PacketSender or similar
   - Create Python Script to send/receive UDP packets
     - Protocol for Packets
       - Sending messages should follow the format of ":<#message>"
         - Where # is a RTU address 0-9
         - Where message is any characters a-z
       - Receiving messages should follow the format of ":[#MESSAGE]"
         - Where # is the address of the RTU replying
         - Where MESSAGE is an echo of message but all uppercase
     - Configure STC89 to receive/return packets
       - Confirm if RTU has the specified address
       - Confirm that message is in correct format
       - Return message in proper format with address of RTU

4. Configure Serial Communication to change WIZnet Network configuration
   - '?' will bring up Config Menu
     - Set/Change RTU Address (0-9): USING RTU=
     - Set/Change IP Address: USING IP=
     - Set/Change Subnet Mask: USING SUB=
     - Set/Change Gateway: USING GATE=

    - Set/Change MAC Address: USING MAC=
- To change any of the above use the following format as an examples:
    - RTU=# (0-9)
    - IP=###.###.###.### -> IP=192.168.16.111
        - SUB= and GATE= follow the same format
    - MODE= UDP or MODE=TCP
    - MAC=0f0f0f0f0f0f

5. Replicate UDP functionality in TCP
- Add TCP functionality to STC89
    - Keep all same formatting and functionality as UDP mode
- Add TCP functionality to Python Script
    - Let user change connection mode
    - Keep all same formatting and functionality as UDP mode

6. Combine UDP and TCP
- Create an implementation where UDP and TCP can be polled simultaneously form the python script.

7.LEDS/Python Curses
- Add 3 LEDs to the STC89 Demo Board
    - TX LED, shows response activity
    - RX LED, shows receive activity
- Add Curses to your python script
    - For this the layout should show the following:
        - Total number of sent packets
        - The received packet
        - Errors
        - Last message received
        - Current mode
        - Prompt same as before
- Also the PING command should now poll until the user terminates the command
    - Make this run as fast as possible
    - These polls will follow similar format as used before
        - The message should be random number of characters (a-z) between 8-16
    - Use a logic analyser and an output pin to measure the response time of the WIZnet
        - Set pin high when you get message and low after you sent the response

        - Document the response time
            - This should not be more than ~250 ms
- Add a Report function that will poll 100 times and generate a text file:
    - Max Non-Error Response Time
    - Min Non-Error Response Time
    - Number of errors
        - Log reason of error (i.e) timeout or incorrect response

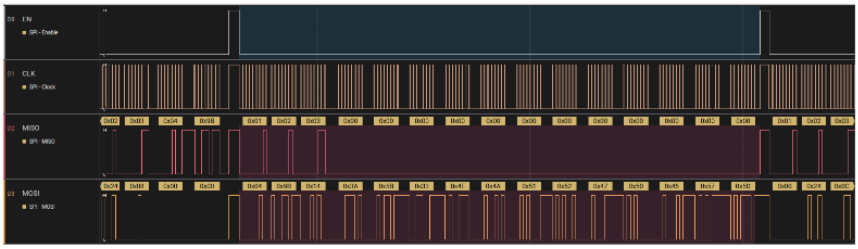
8. Interrupt Driven Polling
- Polling the STC 8051 should be done via W5500 interrupts. Wake up the board via interrupt before starting to listen for packets, to reduce the load on the chip.
- Read the Wiznet W5500 Datasheet to learn more about interrupts driven polling.

9. SPI Assembly Rewrite
- After completing and testing all points above, rewrite the SPI code into assembly for further optimization
    - After this test all components for correct functionality
    - Make this run as fast as possible with little to no delays
    - Use a logic analyser and an output pin to measure the response time of the WIZnet
        - Set pin high when you get message and low after you sent the response
        - Document the response time
            - This should not be more than ~150 ms
- Compare results of C version of SPI to ASM version of SPI

10. Documentation
- Document the speed comparisons of C version of SPI and ASM version of SPI and fingerprint the performance with logic analyzer and other tools.
- Include Graphs of Data Transfer Speed, and Network latency between both versions of SPI.

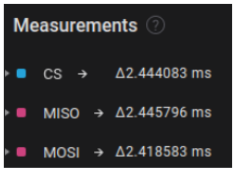
Example Graph:

Graph 1: SPI Data Transfer Speed in *C*
UDP

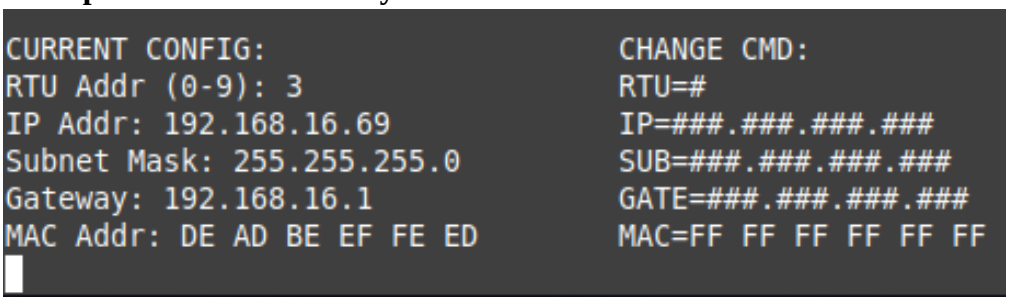


For MISO Signal:
ΔT: Time between data points ≈ 0.00143 seconds.
Edges: 8 falling and 8 rising.
Frequency Range: 2362.67 Hz to 8264.46 Hz.
Average Frequency: 5702.84 Hz.
Timing Variation: Standard deviation ≈ 0.00011 seconds.

For MOSI Signal:
ΔT: Time between data points ≈ 0.00143 seconds.
Edges: 8 falling and 8 rising.
Frequency Range: 2178.25 Hz to 31788.08 Hz.
Average Frequency: 5874.13 Hz.
Timing Variation: Standard deviation ≈ 0.00016 seconds.



Example of Serial Menu Lay



Example of Python Curses Menu: