

Project 2

Internet-enabled control and monitoring device

Objective

"to build a programmable thermostat with an embedded web-server for remote control and monitoring."

- ▶ **Remotely Accessible Thermostat**
 - Relay interface for controlling HVAC
- ▶ **Both Online & Visual Interface**
 - For remote & upfront control
- ▶ **Automated Logging & Monitoring**
 - Temperature History, Uptime, Graphing

Hardware

Hardware Requirements

- ▶ **PIC with Ethernet Capabilities**

- Ethernet Development Board

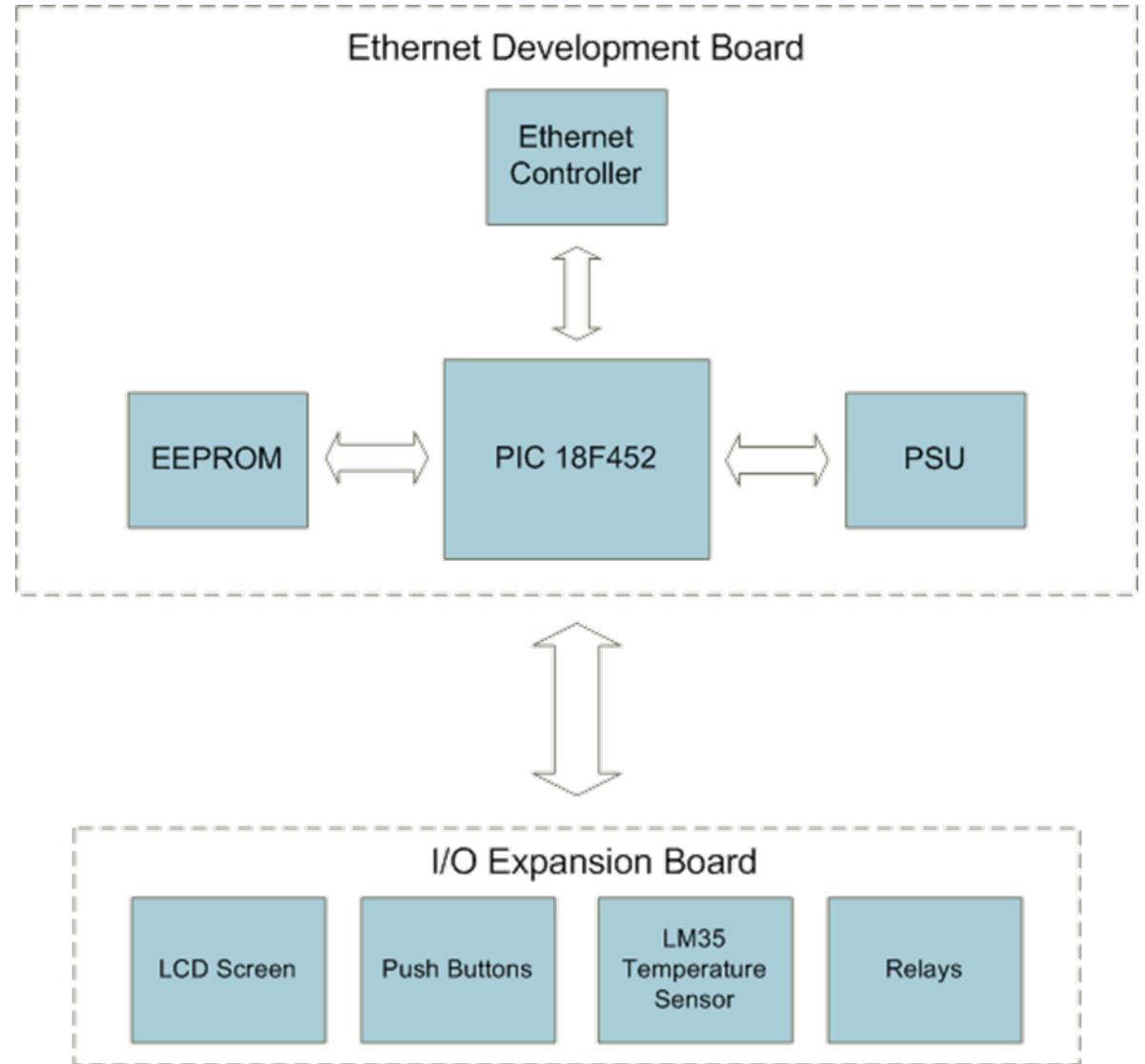
- ▶ **Inputs & Outputs**

- Temperature Sensor
 - Relays
 - Visual & Tactile Interface

- ▶ **Interfacing Boards**

- Linking Development board and I/O Board

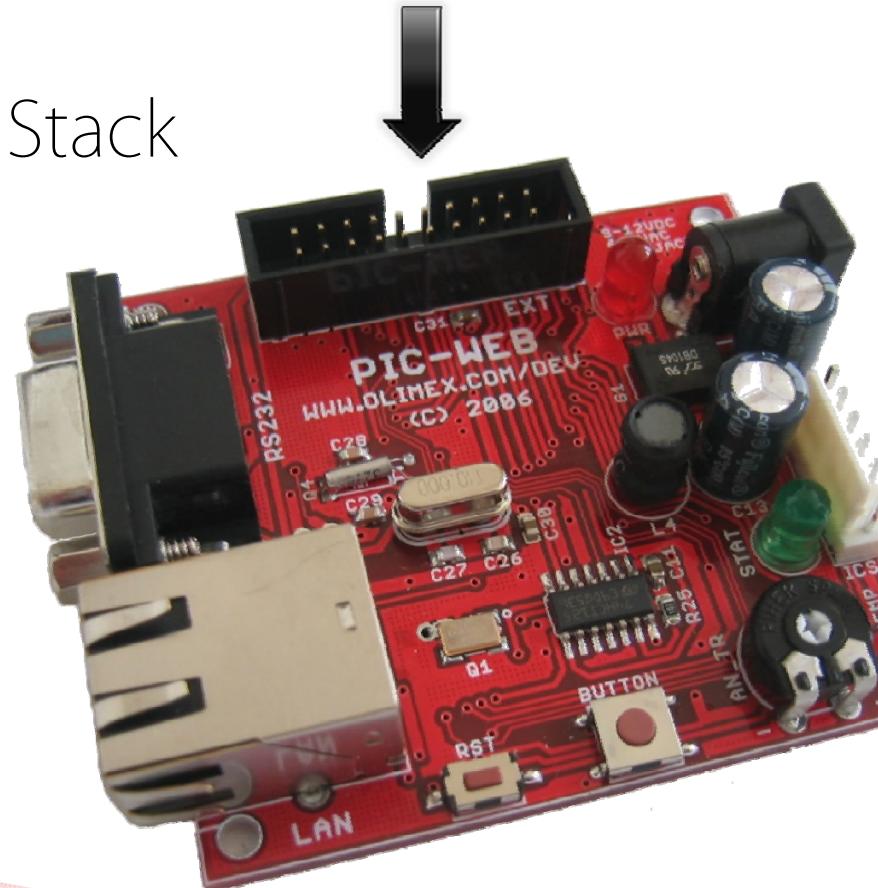
High Level Block Design



Ethernet Development Board

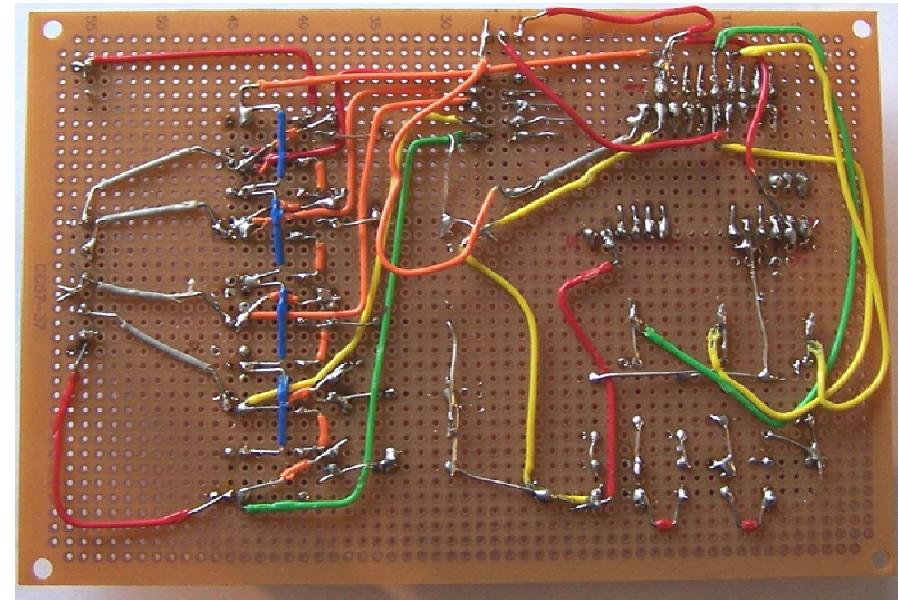
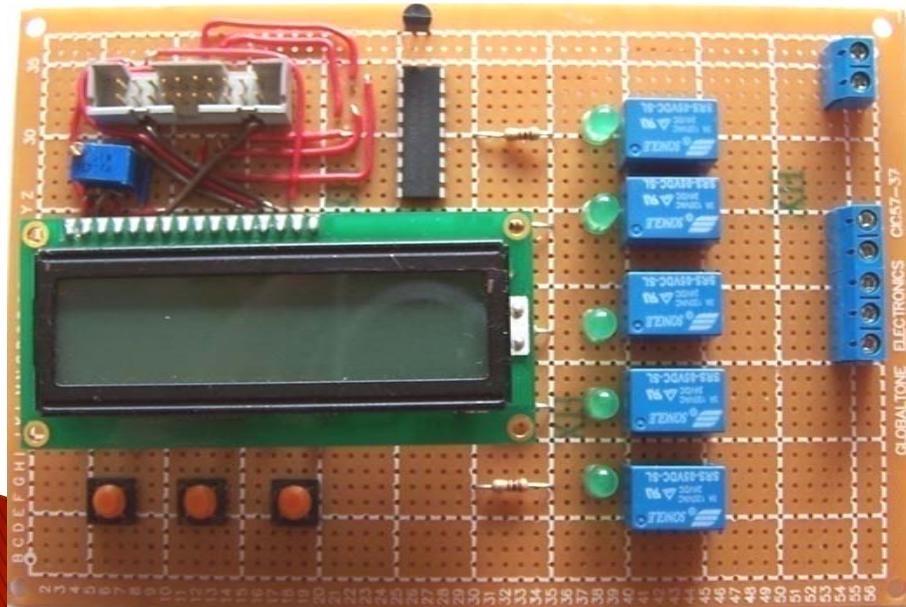
► Olimex PIC-WEB

- Ethernet/RS232
- Works with PicKit2
- Runs Microchip's TCP/IP Stack
- 20 Pin extension header



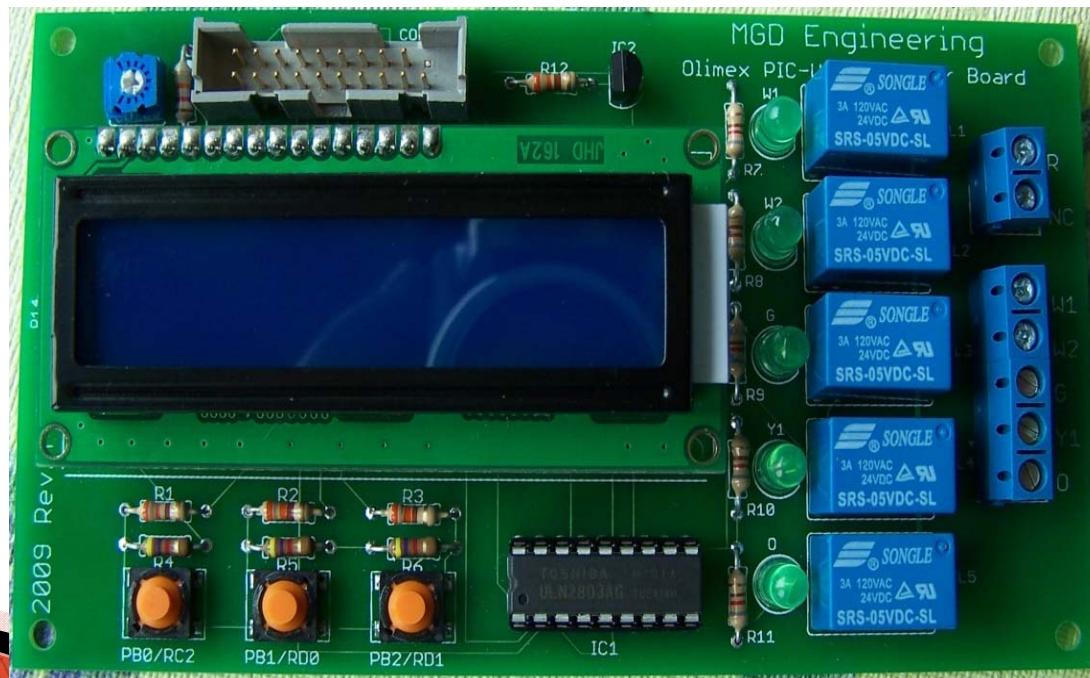
Assembling the I/O Board

- ▶ Build on perforated board
- ▶ Overcrowded with wires
- ▶ Functional prototype to debug code



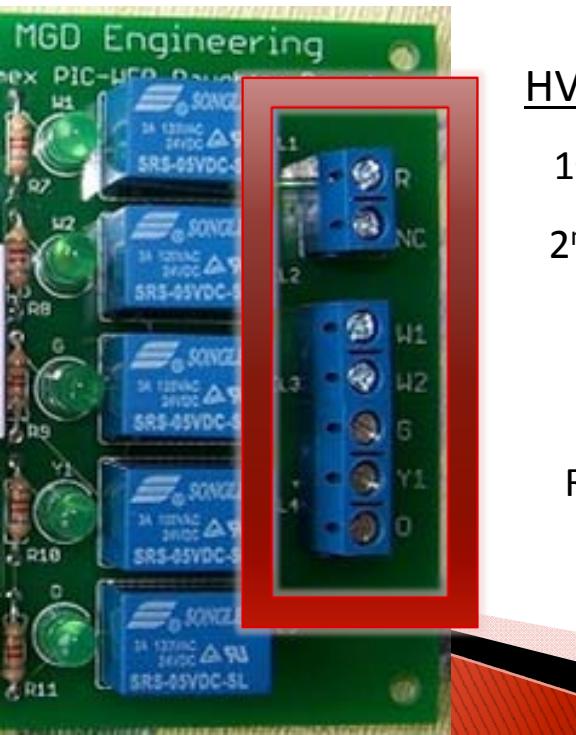
Designed I/O Board

- ▶ Dual-Layer PCB was manufactured
- ▶ All I/O's needed for HVAC control
- ▶ Visual interface of traditional Thermostat



Thermostat Hardware

- ▶ Designed to be used with 24VAC HVAC System
 - Single stage Cooling / Dual Stage Heating
 - Follows ASHRAE naming and color code



HVAC Component

1st Stage Heating

2nd Stage Heating

Blower / Fan

Compressor

Reversing Valve

24V Common

ASHRAE Naming & Color

W1
W2
G
Y1
O
R

Software

Software Requirements

► HVAC Logic

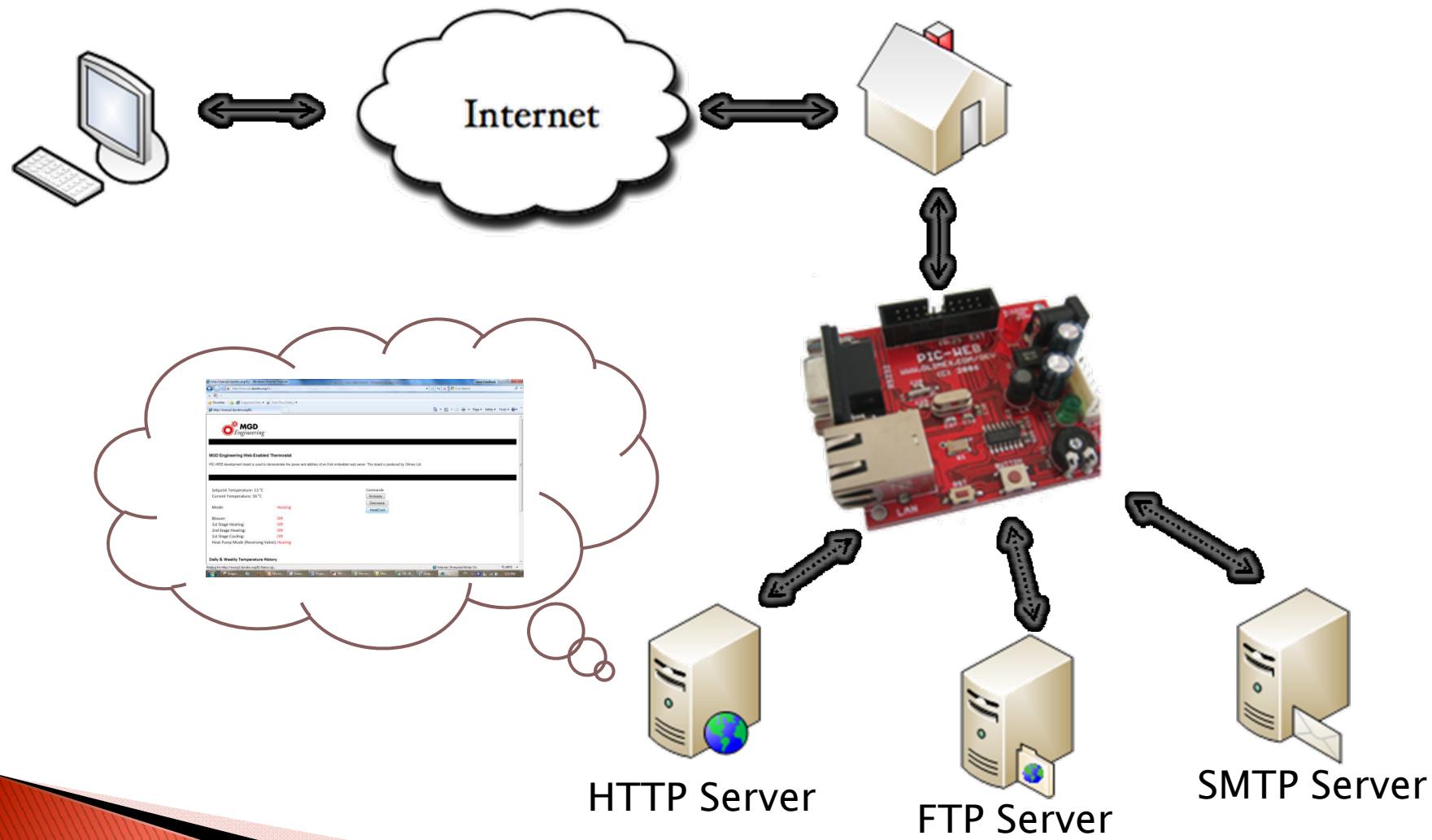
- Temperature Sensing
- Call for Heating/Cooling
- Conditional Logic

► Web-Interface Logic

- Microchip TCP/IP Stack
- Dynamic Web Pages
- Http & Ftp Servers

► Seamless combination of both HVAC & Web

Communicating over Web



http://marcp2.dyndns.org:81/

Favorites Suggested Sites Web Slice Gallery

http://marcp2.dyndns.org:81/ Page Safety Tools ?

MGD Engineering

MGD Engineering Web-Enabled Thermostat

PIC-WEB development board is used to demonstrate the power and abilities of an 8-bit embedded web server. This board is produced by Olimex Ltd.

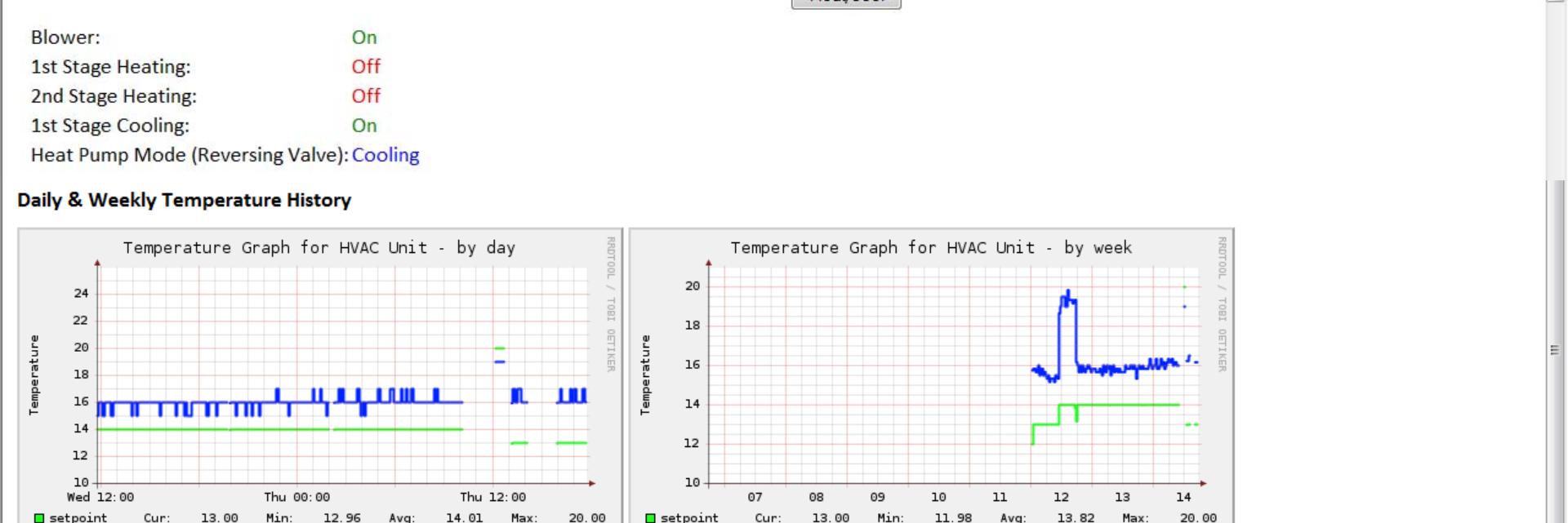
Setpoint Temperature: 13 °C
Current Temperature: 16 °C

Mode: Cooling

Blower: On
1st Stage Heating: Off
2nd Stage Heating: Off
1st Stage Cooling: On
Heat Pump Mode (Reversing Valve): Cooling

Commands

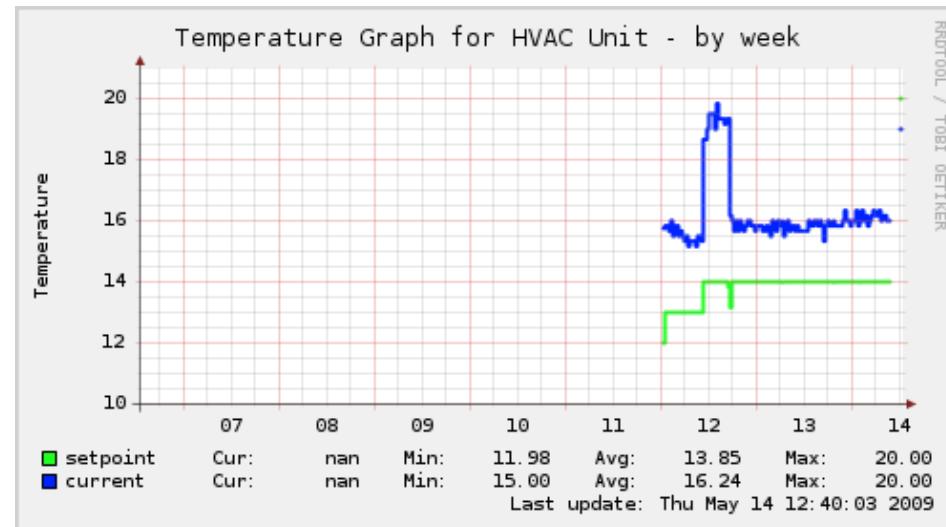
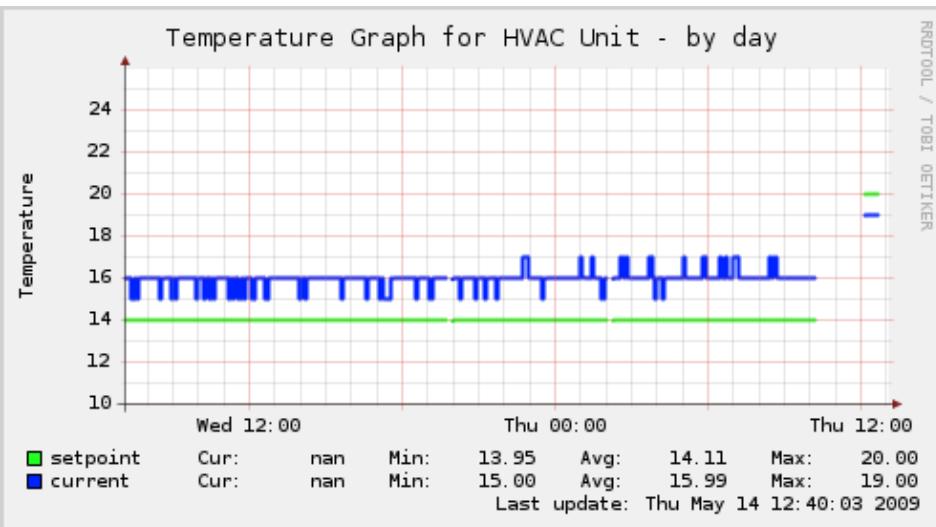
Increase
Decrease
Heat/Cool



Remote Monitoring

Remote logging and graphing

- ▶ Monitoring offloaded to an external system
- ▶ Using an external server
 - Graphing of Temperature History
 - Reduce energy consumption/cost over time
- ▶ Possibility to monitor multiple thermostats



Remote Monitoring and Graphing

monit: service manager - Mozilla Firefox Send Feedback

File Edit View History Bookmarks Tools Help

http://www.nickdinelservers.com:2812/ Google

Intraflex ÉTS MB Schedule MGD Engineering TPB SparkFun Electronics Hack a Day Montreal, Quebec Munich, Germany marcpc2.dyndns.org:81 monit: service manager Munin :: overview

Home > monit 4.8.1

Monit Service Manager

Monit is running on marktemp with *uptime, 2d 18h 25m* and monitoring:

System	Status	Load	CPU	Memory
marktemp	running	[0.00] [0.00] [0.00]	0.0%us, 0.0%sy, 0.0%wa	7.3% [37980 kB]

Host	Status	Protocol(s)
hvac1.kitchen	online with all services	[ICMP Echo Request]
hvac2.livingroom	online with all services	[ICMP Echo Request]
hvac3.bedroom	online with all services	[ICMP Echo Request]
hvac4.basement	ICMP failed	[ICMP Echo Request]

Results/Recommendations

- ▶ Offloading the HVAC logic to a separate PIC
- ▶ Using Digital temperature sensor
- ▶ Possibility of going over wireless (WiFi)
- ▶ Improving code, learn patterns,
heating/cooling schedule
- ▶ Combining all into one single board

Questions/Comments?

Supporting Slides



Designing the I/O Board

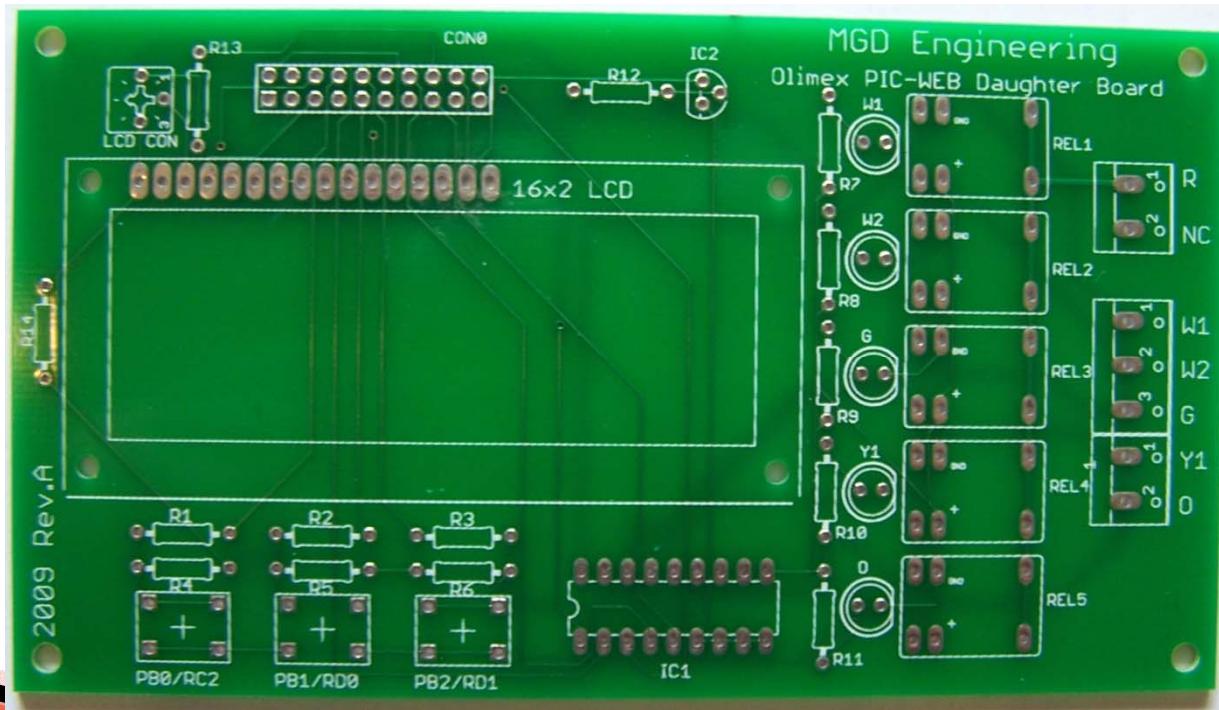
<u>Pin #</u>	<u>Pin Name</u>	<u>Use</u>	<u>Dev Board</u>
1	RA2/AN2/VREF-	RA2	LCD Data 1
2	RA3/AN3/VREF+	RA3	LCD Data 2
3	RA4/TOCKI	RA4	LCD Data 3
4	RA5/AN4/#SS/LVDIN	RA5	LCD Data 4
5	RE0/RD#/AN5	RE0	LCD R/S
6	RE1/WR#/AN6	RE1	LCD Enable
7	RE2/CS#/AN7	RE2	LM35 Temp Sensor
8	RC2/CCP1	RC2	Push Button 0
9	RD0/PSP0	RD0	Push Button 1
10	RD1/PSP1	RD1	Push Button 2
11	RD2/PSP2	RD2	Terminal Block 1 w/ LED
12	RD3/PSP3	RD3	Terminal Block 2 w/ LED
13	RD4/PSP4	RD4	Terminal Block 3 w/ LED
14	RD6/PSP6	RD6	Terminal Block 4 w/ LED
15	RD7/PSP7	RD7	Terminal Block 5 w/ LED
16	RST	RST	
17	+5V	+5V	
18	+5V	+5V	
19	GND	GND	
20	VIN	VIN	

LCD Temp Sensor Push Buttons Relays

Designing a PCB

► CAD Designed PCB was needed

- School equipment limited to single layer board
- Dual layer board needed to be outsourced



Internet Enabled Thermostat

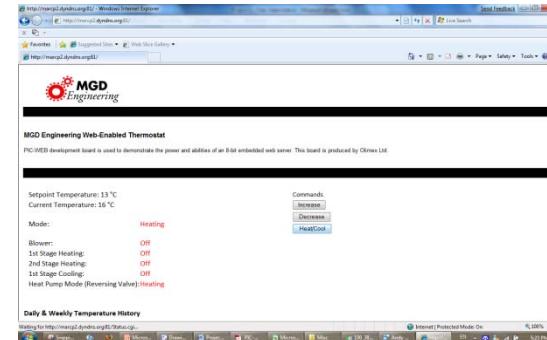
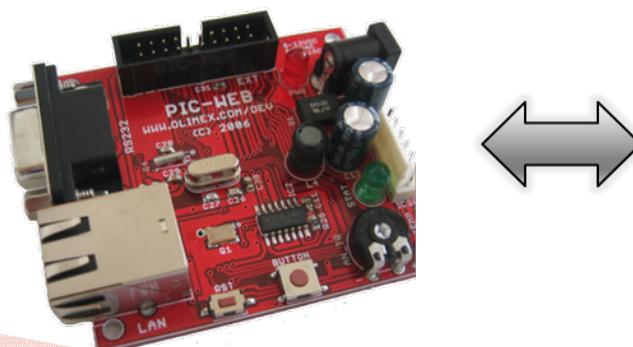
- ▶ **Current market is limited**
 - Limited availability, inflated prices
 - Part of a complex home automation package
 - Starting at \$350 for base model, recurring cost
- ▶ **Home Automation Market is growing**
 - Expected International growth \$2.4 Billion by 2010
- ▶ **Reduction of Energy Consumption**

Getting Online

► Microchip's TCP/IP Stack

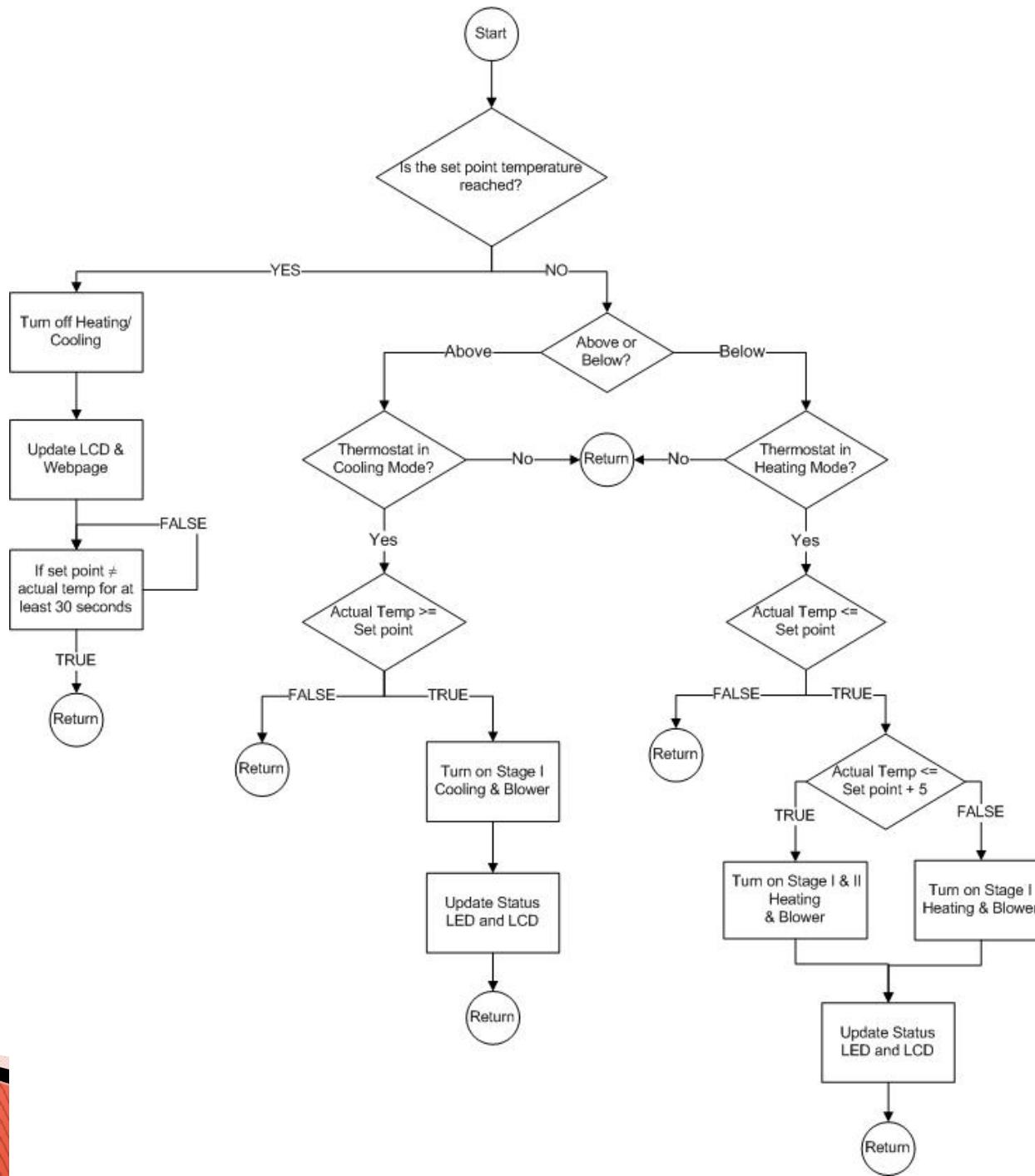
- Manages TCP/IP Settings for the board
- HTTP Server – For Hosting the Website
- FTP Server – For Transferring Updates over the WEB
- SMTP Server – For Sending/Receiving e-mails

► Constant communication between Website & PIC

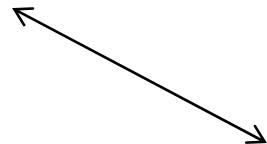


HVAC Logic & Web-Interface

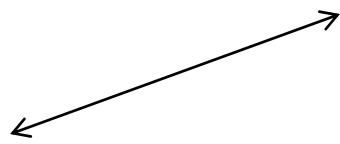
- ▶ With TCP/IP Stack, 2000 lines of code
- ▶ Main Code consist of:
 - LCD Interface
 - Push Button Interface
 - Reading Analog Temperature
 - Temperature Conditional Logic
- ▶ TCP/IP Settings for proper access to web
- ▶ Sending data back/forth with website



Getting Online



Internet



HTTP Server

Internet

