

MASTERs 2014

LAB Manual for 18020 EWN

*Easy Wireless Networking Using the
Arduino™ Compatible chipKIT™ Platform*

Table of Contents

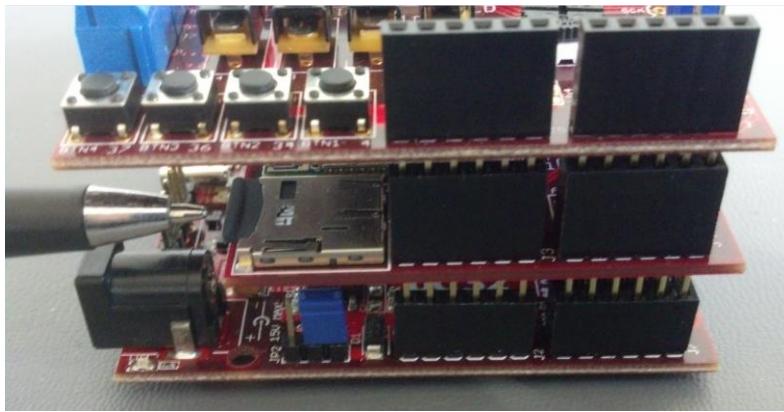
Lab 1: Build and Run the DEIPcK HTTP Example Server.....	Page 2
Lab 2 : Working with Static HTML Pages.....	Page 18
Lab 3: Working with Dynamic HTML Pages.....	Page 30



LAB 1

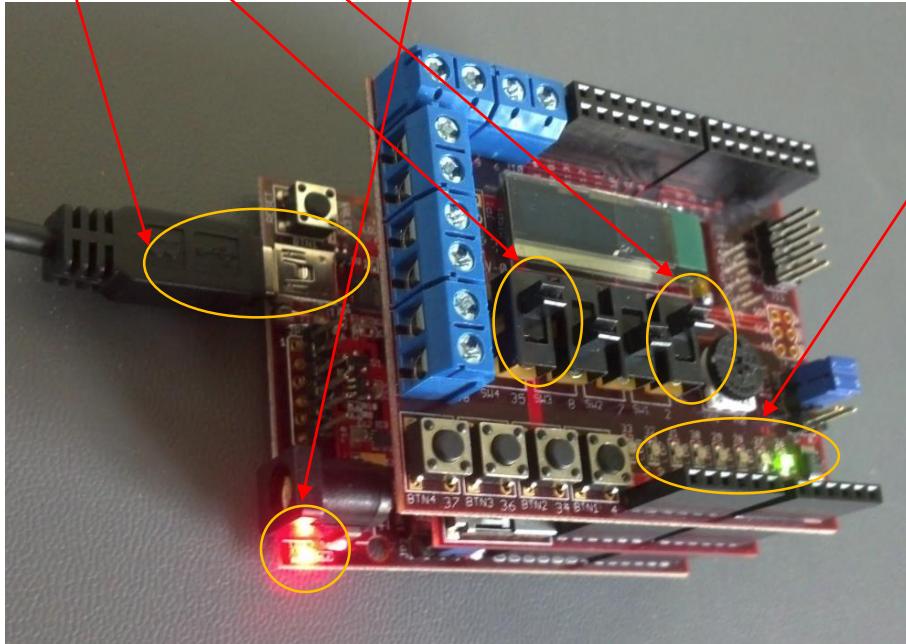
Build and Run the DEIPcK HTTP Example Server

1. In this exercise we will build the HTTP Example Server, load it, and run it without modification. Then you can look at some of the source files to see how the server uses the DEIPcK Network Stack.
2. Make sure the µSD card is fully inserted into the µSD reader.



LAB Manual For 18020 EWN

3. Plug the chipKIT™ uC32 into the USB cable and attach the USB cable to your computer. Set the switches SW4 and SW1 to ON. The red power light should come ON. Do not worry if any of the green LEDs come ON or not.

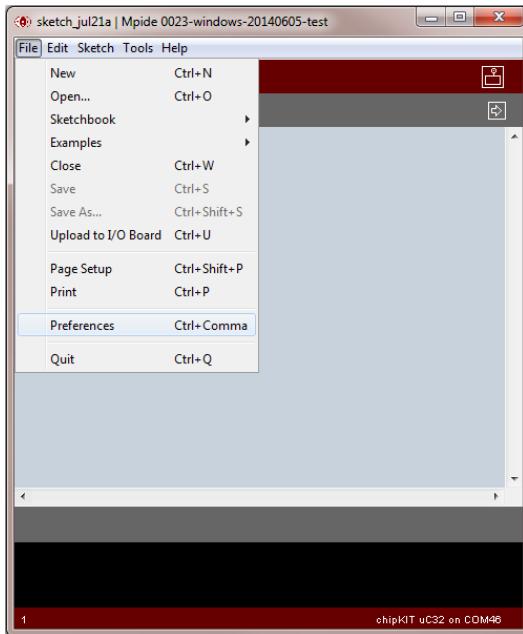


4. As a note, many of the signals on the Basic IO Shield conflict with the WiFi Shield. All buttons conflict and you should not press any of the buttons as that could reset the WiFi Shield. Likewise Switches 1 and 4 are shared with signals on the WiFi Shield and Switches 1 and 4 should remain ON at all times. We can use switches 2 and 3, and we will logically think of switch 2 as input 1, and switch 3 as input 2; this will be used later in this exercise. None of the LEDs conflict with the WiFi Shield and we can use all of the LEDs on the Basic IO Shield
5. On the computer desktop start MPIDE by clicking the MPIDE icon

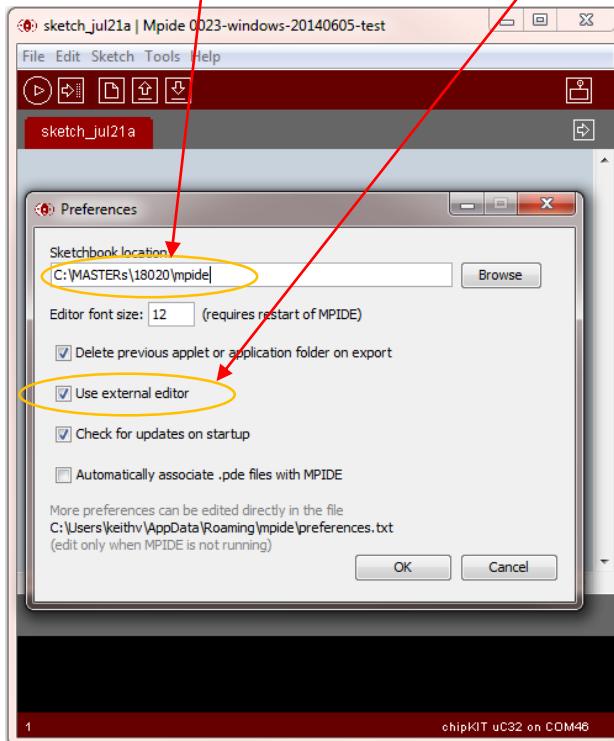


LAB Manual For 18020 EWN

6. Ensure that you are looking at the correct sketchbook folder. These computers are used by another class and your sketchbook directory maybe set to the wrong location. Go into Preferences

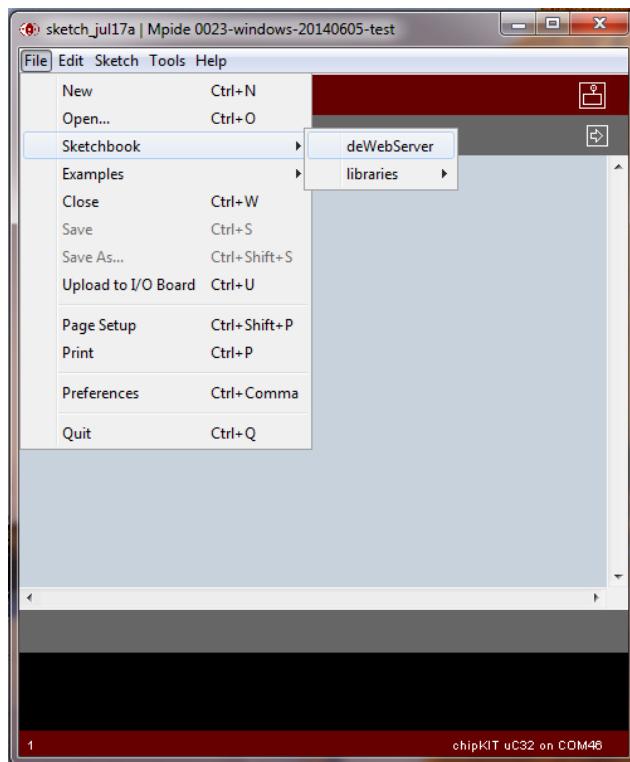


7. And make sure your sketchbook location is set to C:\MASTERS\18020\mpide; Verify that the class subdirectory is 18020! Also make sure the “Use external editor” is checked as we will be using Notepad for our editor.

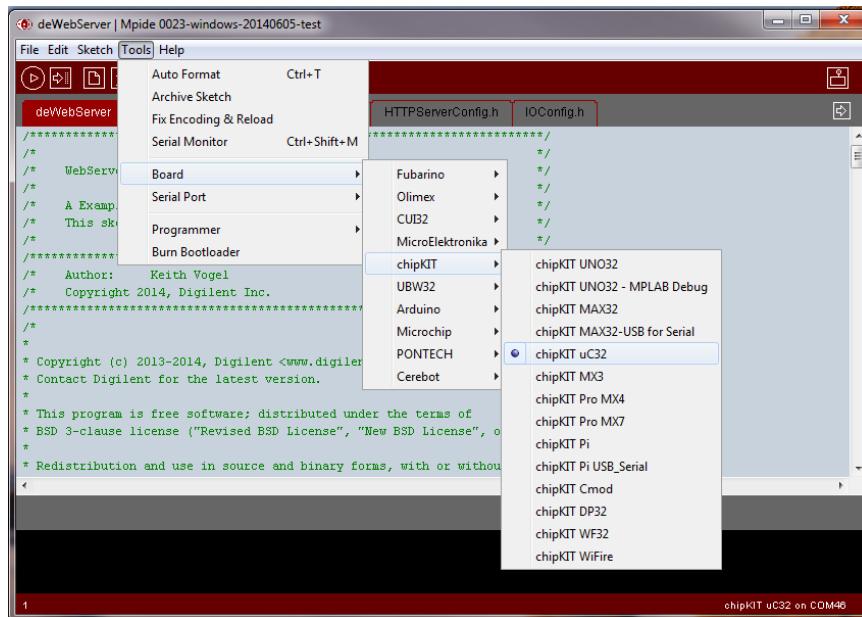


LAB Manual For 18020 EWN

8. Now when you open the Sketchbook location you should see 2 directories, deWebServer and libraries. Select deWebServer. Two MPIDE windows will be open, you can close the first window leaving only deWebServer open.

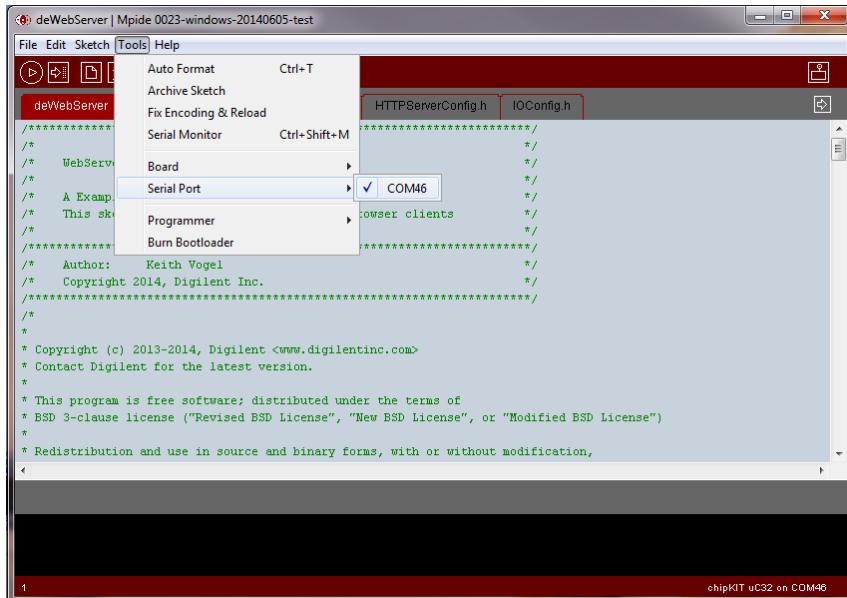


9. Ensure that the chipKIT™ uC32 board is selected under Tools->chipKIT

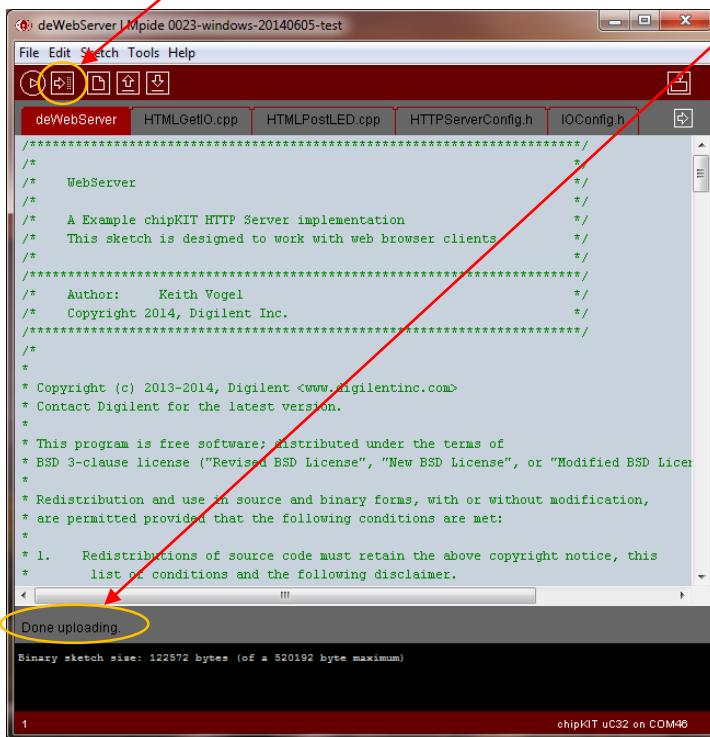


LAB Manual For 18020 EWN

10. Ensure the correct serial port is selected. Serial ports vary from machine to machine, board to board. So if you have more than one serial port showing, unplug the chipKIT™ uC32 and see which serial port disappears, re-plug it in and see which one reappears; and that is the serial port the chipKIT™ uC32 is on. To see the changes you will have to close and reopen the Tools->Serial Port menu.

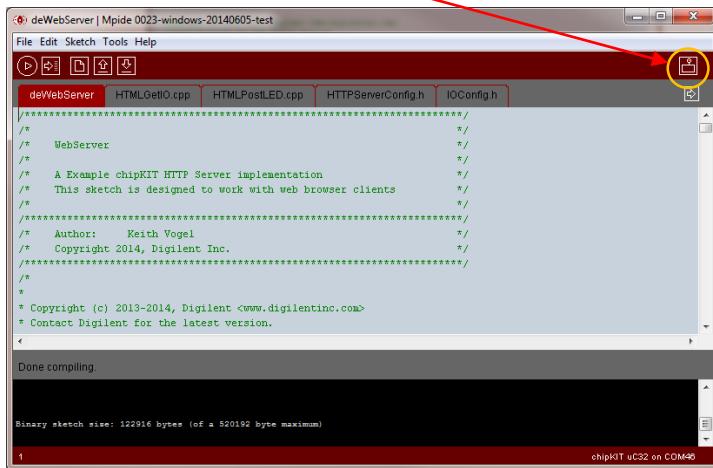


Compile and upload the sketch to your chipKIT™ uC32. Wait for the upload to finish.

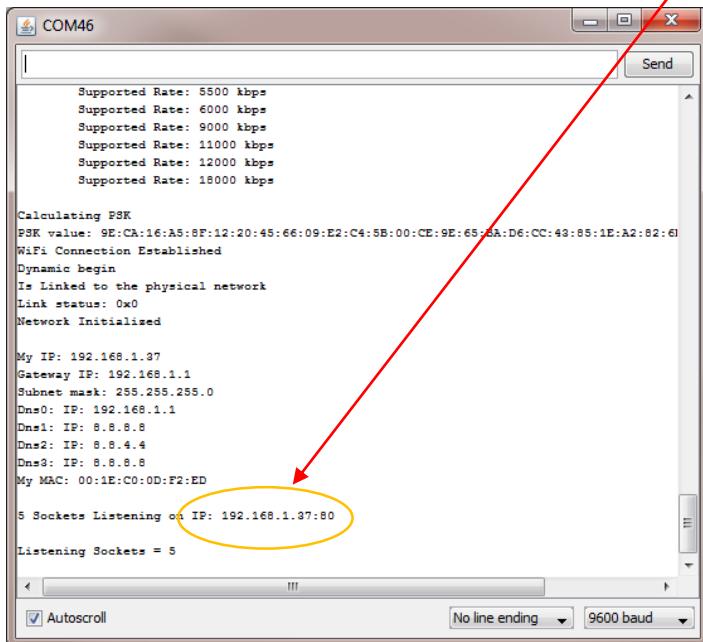


LAB Manual For 18020 EWN

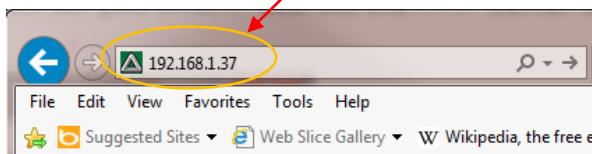
11. Open the Serial Monitor



12. And observe the output. The output will tell you what IP address the HTTP Server is listening on; this was assigned to you by the DHCP server on this network. The exact IP address will vary.

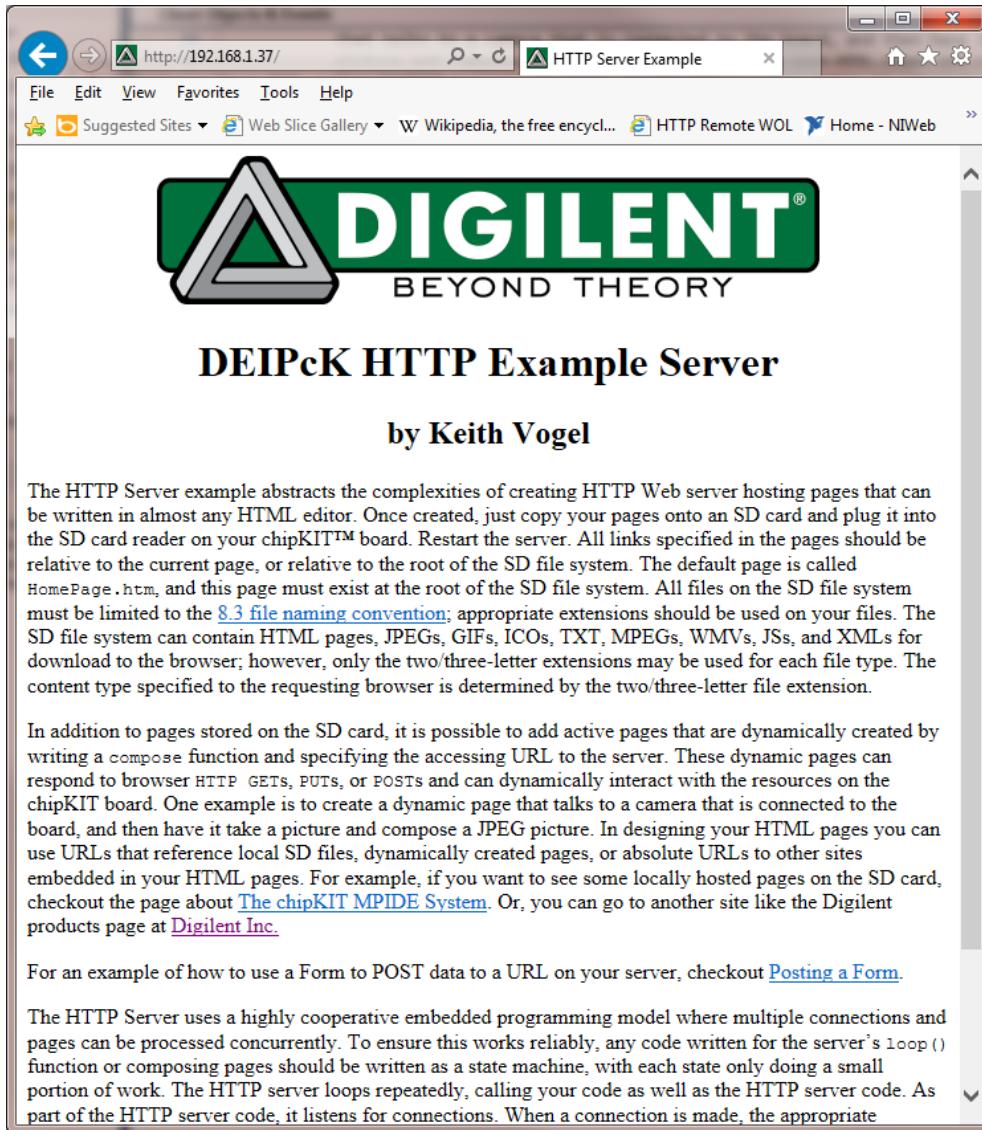


13. Start Internet Explorer and type in the IP Address in the Address line and enter. No need to enter the port number 80.



LAB Manual For 18020 EWN

14. Internet Explorer should load the HomePage.htm as served up off of the µSD card on the chipKIT™ uC32. You are now running the HTTP Server on the chipKIT™ uC32.



LAB Manual For 18020 EWN

15. In your Serial Monitor window you will see the uC32 processing the connections to render the HomePage.htm.

The screenshot shows a Serial Monitor window titled "COM46" with the following log output and annotations:

- TCP Socket Opened**: Points to the first log entry: "New Client detected".
- GET Request Default URL "HomePage.htm"**: Points to the second log entry: "Default page called".
- HTTP Response and Header Lines**: Points to the third log entry: "Read an HTML page off of the SD card".
- TCP Connected Socket**: Points to the fourth log entry: "Entering Client ID: 0xA00048FC".
- Default compose function called ComposeHTMLSDPage()**: Points to the fifth log entry: "SD FileName:HomePage.htm".
- GET Request Specific URL "Digilent.png"**: Points to the sixth log entry: "HTTP/1.1 200 OK".
- Number of bytes in Digilent.png**: Points to the seventh log entry: "Content-Type: text/html".
- ComposeHTMLSDPage() writing out Digilent.png**: Points to the eighth log entry: "Content-Length: 3959".
- Number of sockets listening for a connection**: Points to the ninth log entry: "End of directive".
- Timeout on an inactive socket**: Points to the tenth log entry: "Writing file:HomePage.htm".

Log Output:

```
New Client detected
Default page called
Read an HTML page off of the SD card
Entering Client ID: 0xA00048FC
GET / HTTP/1.1
SD FileName:HomePage.htm
HTTP/1.1 200 OK
Connection: close
Content-Type: text/html
Content-Length: 3959
End of directive
Writing file:HomePage.htm
Wrote page cleanly
Closing Client ID: 0xA00048FC
Listening Sockets = 3
Closing connection for client 0xA00048FC
3 Sockets Listening on IP: 192.168.1.37:80

Got a client: 0xA0004B28
New Client detected
Default page called
Read an HTML page off of the SD card
Entering Client ID: 0xA0004B28
GET /Digilent.png HTTP/1.1
SD FileName:Digilent.png
HTTP/1.1 200 OK
Connection: close
Content-Type: image/png
Content-Length: 19833
End of directive
Writing file:Digilent.png
Listening Sockets = 4
Wrote page cleanly
Closing Client ID: 0xA0004B28
Closing connection for client: 0xA0004B28
4 Sockets Listening on IP: 192.168.1.37:80

Listening Sockets = 5
Listening Sockets = 4
Got a client: 0xA0004D54
New Client detected
Timeout on client: 0xA0004D54
Closing connection for client: 0xA0004D54
4 Sockets Listening on IP: 192.168.1.37:80

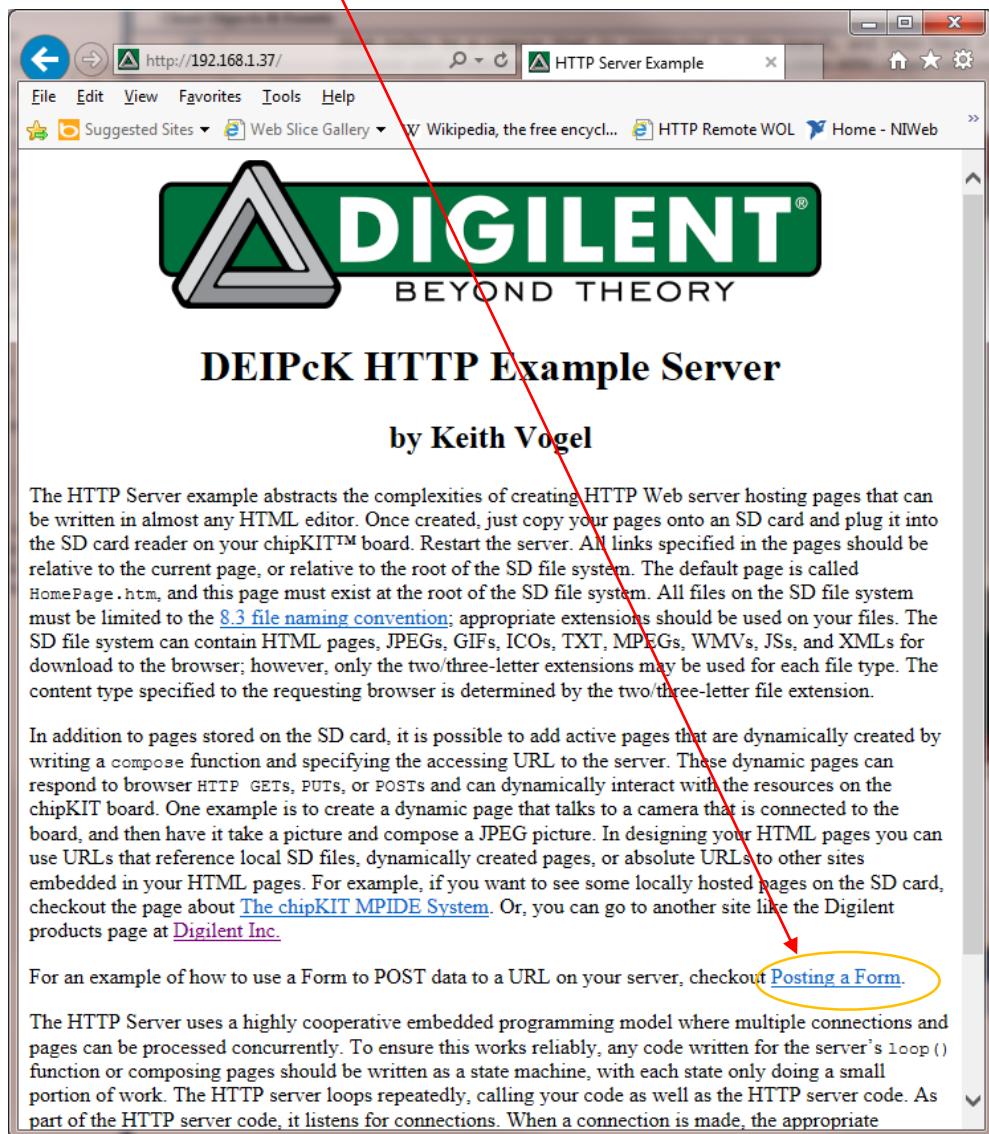
Listening Sockets = 5
```

Serial Monitor settings at the bottom:

- Autoscroll
- No line ending
- 9600 baud

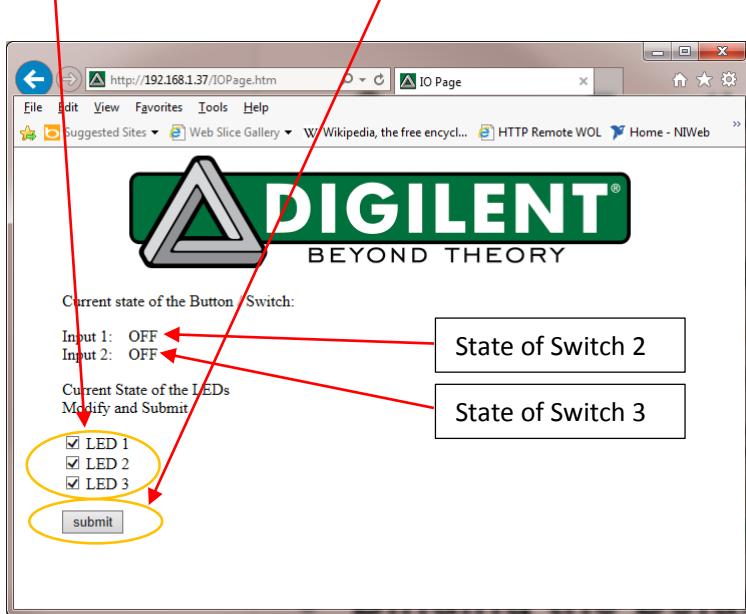
LAB Manual For 18020 EWN

16. In Internet Explorer, follow the link to “Posting a Form”

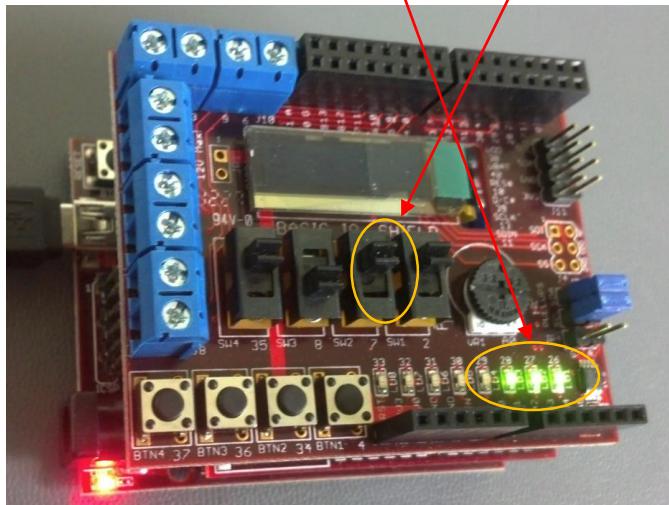


LAB Manual For 18020 EWN

17. Check all of the LEDs ON and submit the Post.

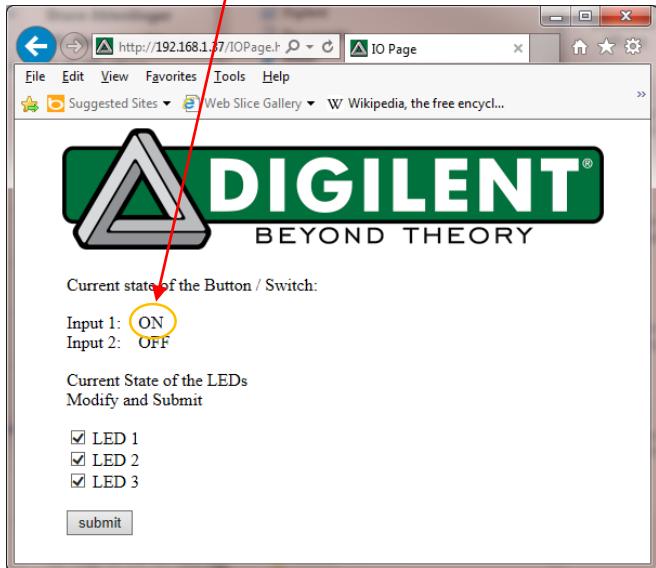


18. Notice LEDs 1, 2, and 3 came ON. Turn Switch 2 ON and hit submit again in Internet Explorer and see how the state of Input 1 changes on the web page.



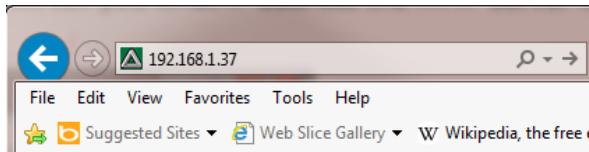
LAB Manual For 18020 EWN

19. Input 1 updates to ON because switch 2 is ON. Likewise, if you turn switch 3 ON, Input 2 would update to ON; you must hit the submit button before the page will update.



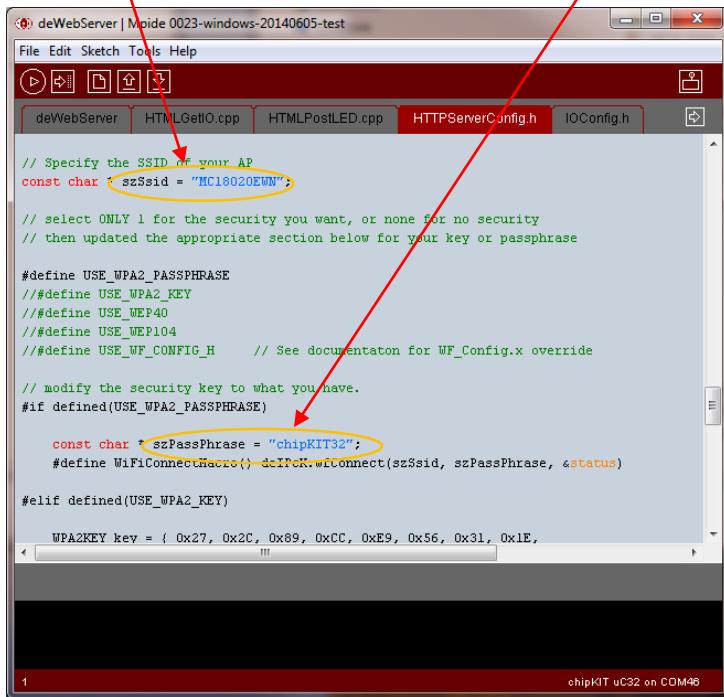
You can toggle switches 2 and 3 and/or change the state of LEDs 1,2,& 3 and the page and board will update each time you hit submit. This is a dynamically created page that is created on the fly by the HTTP Server based on the state of the switches on the uC32, or LEDs selected on the web page.

20. You can get back to the main page by typing in the original IP address in Internet Explorer's address line. From the main page you can explore the other pages hosted by the uC32 HTTP Server.

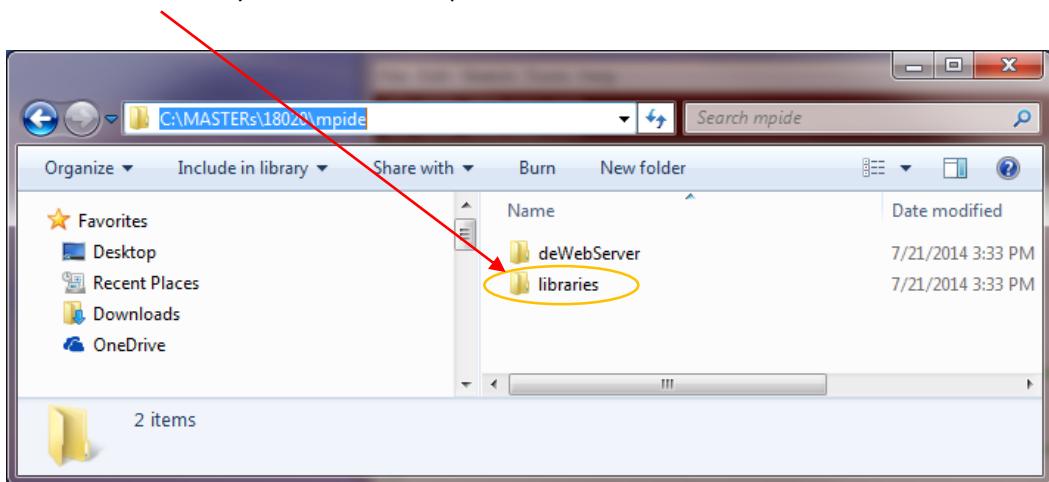


LAB Manual For 18020 EWN

21. In `HTTPServerConfig.h` is where the network parameters are set. For this exercise we preset the SSID to “MC18020EWN” and the WPA2 passphrase to “chipKIT32” as this is how our router is set up.

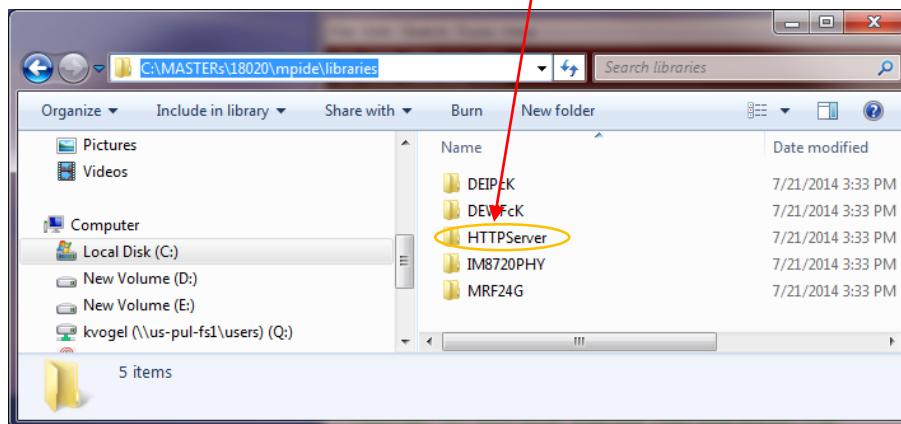


22. To see how the DEIPcK Network Stack code is used by the HTTP Server, you will need to look into the `HTTPServer` library source file `ProcessServer.cpp`. While looking at this source, please do not modify the source as it is part of the `HTTPServer` library code which we will be using throughout the class.
 23. The `HTTPServer` library is a 3rd party library, you need to go to the `libraries` subdirectory under your `Sketchbook` directory; this is where 3rd party libraries are installed.

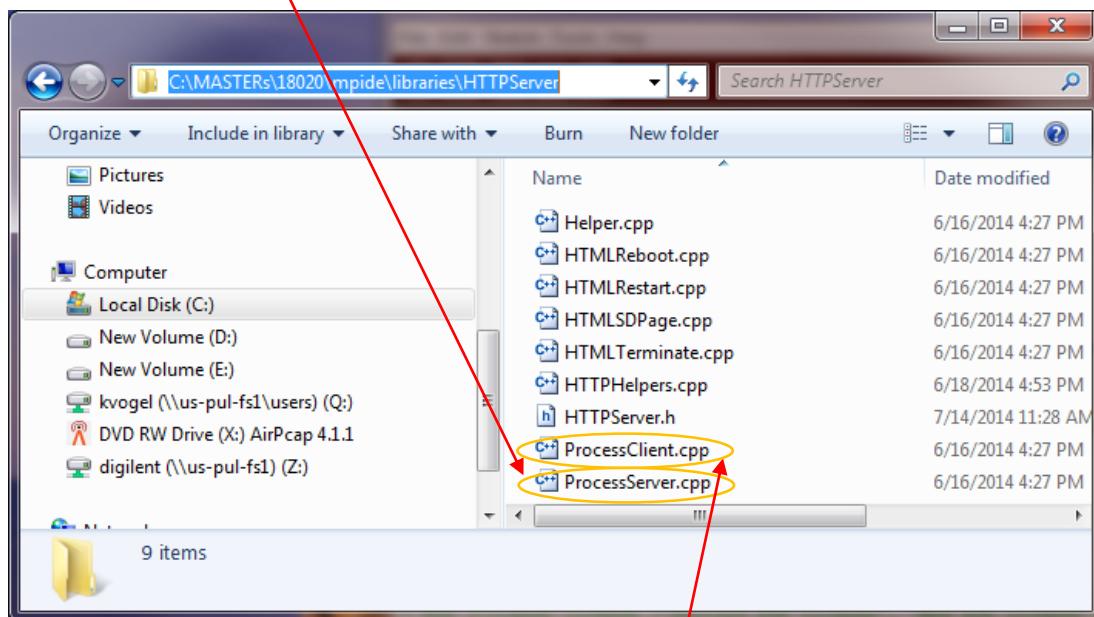


LAB Manual For 18020 EWN

24. In the libraries subdirectory you will see the HTTPServer library, this is where all of the HTTP Server library code exists. The other libraries are part of the DEIPcK Network libraries.



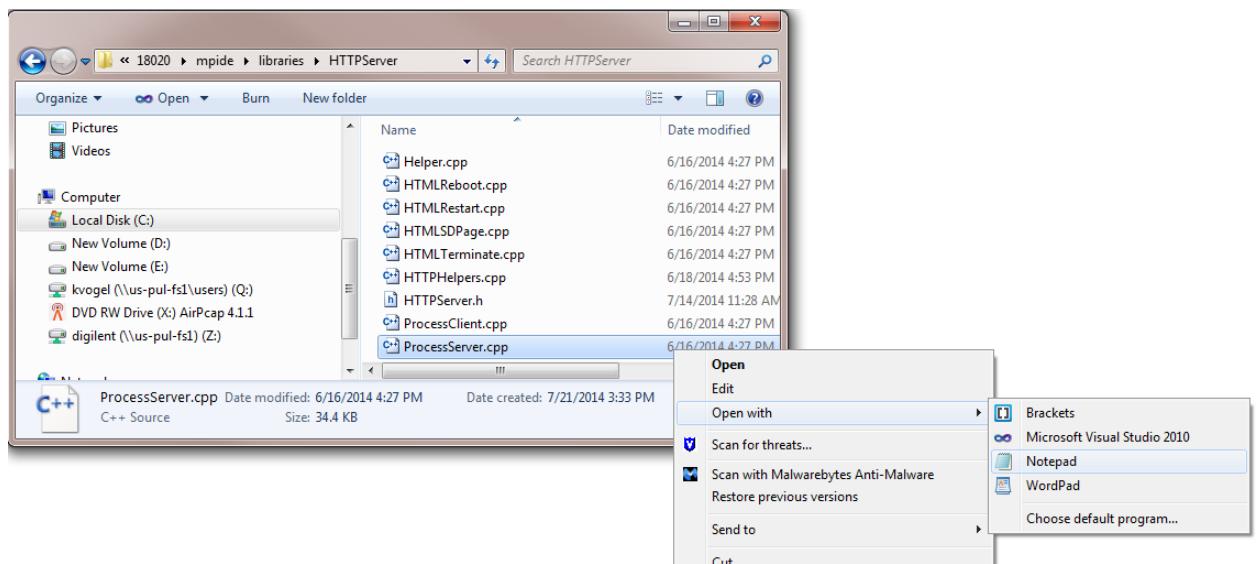
25. There you will find ProcessServer.cpp, this file contains the DEIPcK HTTP Server Network code.



Also in ProcessClient.cpp is where the socket management code is implemented.

LAB Manual For 18020 EWN

26. You can open these source files with notepad and take a look at the code. But please be careful not to edit the code as this is part of the library that we will be using.



LAB Manual For 18020 EWN

27. In Process Server.cpp, review the states from STARTLISTENING to CHECKING; this is an example of how to use the DEIPcK server code.

```

ProcessServer.cpp - Notepad
File Edit Format View Help
case STARTLISTENING:
    // we know we are initialized, and our broadcast udpclient is ready
    // we should just be able to start listening on our TcpIP port
    if(deIPcK.tcpServer.startListening(listeningPort, tcpServer))
    {
        for(int i = 0; i < chaxSocketsToListen; i++)
        {
            tcpServer.addSocket(rgTCPClient[i]);
        }
        state = LISTENING;
        RestartTimer();
        break;
    }
    // this will timeout if we don't start listening
case LISTENING:
    if((!tcpServer.isListening(&status)) > 0)
    {
        IPENDPOINT ep;
        Serial.print(i, DEC);
        Serial.print(" Sockets Listening on ");
        tcpServer.getListeningEndPoint(ep);
        GetIP(ep.ip, szTemp);
        GetPort(ep.port, szTemp);
        Serial.print(":");
        Serial.print(ep.port, DEC);
        Serial.println();
        state = CHECKING;
        SetLED(SLED::READY);
        stateTimeout = NONE;
        // reset the rest time
        // things are looking good
        CSCERest = csecInRest;
    }
    // something bad happened
    else if(IsIPStatusError(status))
    {
        state = NOTLISTENING;
        RestartTimer();
    }
    break;
case NOTLISTENING:
    // get a socket listening error and do something about it
    if(tcpServer.isListening(&status))
    {
        Serial.println("Not Listening");
        // the assumption is that the IP stack is okay
        // we will wait at listening until things get going again
        state = LISTENING;
        stateTimeout = RESTARTREST;
        // see if the IP stack is still running
        if(deIPcK.isIPReboot(&status))
        {
            // still not listening, only reason is that we
            // have no sockets available. However, some may have been
            // added but just haven't finished closing yet
            if(tcpServer.isListening() == 0)
            {
                Serial.println("All sockets in use, waiting for more sockets");
            }
        }
        // Test the IP Stack, restart
        else if(IsIPStatusError(status))
        {
            Serial.print("Lost IP stack, error: 0x");
            Serial.println(status, HEX);
            Serial.println("Restarting IP stack");
        }
    }
    // Test the IP Stack, restart
    else if(IsIPStatusError(status))
    {
        Serial.print("Lost IP stack, error: 0x");
        Serial.println(status, HEX);
        Serial.println("Restarting IP stack");
    }
}
ProcessServer.cpp - Notepad
File Edit Format View Help
CSCERest = CSCERest;
state = RESTARTREST;
RestartTimer();
}

// not fatal loss of the IP stack, maybe reconnecting to WiFi
{
    Serial.print("Non-fatal loss if IP Stack, status: 0x");
    Serial.println(status, HEX);
    Serial.println("Waiting reconnect");
}

Serial.println("");
RestartTimer();
break;

case CHECKING:
    // just some debug code to see how sockets reclaim
    static int cSockets = 0;
    int listening = tcpServer.isListening();
    if(cSockets != listening)
    {
        cSockets = listening;
        Serial.print("Listening Sockets = ");
        Serial.println(listening, DEC);
    }
}

if(tcpServer.availableClients() > 0)
{
    // find an open client
    // process the next client to be processed
    do
    {
        if(rgClient[i].pTCPClient == NULL)
        {
            // clear the packet
            memset(&rgClient[i], 0, sizeof(CLIENTINFO));
            if(rgClient[i].pTCPClient = tcpServer.acceptClient()) != NULL)
            {
                Serial.print("Got a client: 0x");
                Serial.println(uint32_t(&rgClient[i]), HEX);
                // set the timer so if something bad happens with the client
                // we can just timeout and not hang on the client
                // because we will just timeout if there is an error
                RestartTimer();
            }
            else
            {
                Serial.println("Failed to get client");
            }
        }
        break;
    }
    ++i %= chaxSocketsToListen;
    } while(i != inextClientToProcess);
else if(tcpServer.isListening() == 0)
{
    state = NOTLISTENING;
}
break;

case RESTARTNOW:
    stateTimeout = NONE;
    stateNext = TRYAGAIN;
    state = SHUTDOWN;
    break;

case TERMINATE:
    state = NONE;
    stateNext = DONOTHING;
    state = SHUTDOWN;
    break;
}

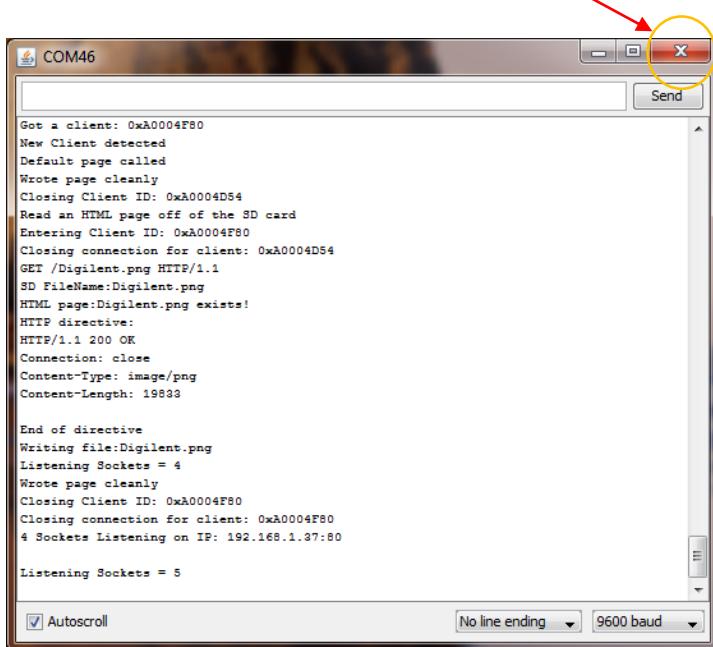
```

END LAB 1

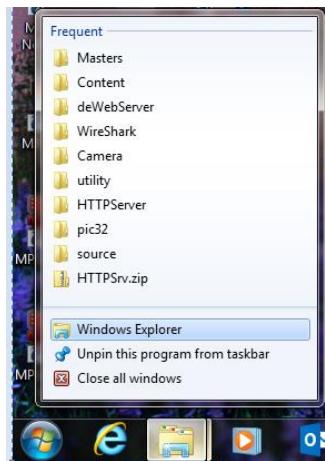
LAB 2

Working with Static HTML Pages

1. In this exercise we will update the HTML content on the µSD card, adding a new static HTML page to our server; but will not recompile or reload a new sketch on to the chipKIT™ uC32.
2. If the Serial Monitor is not closed, close the Serial Monitor.

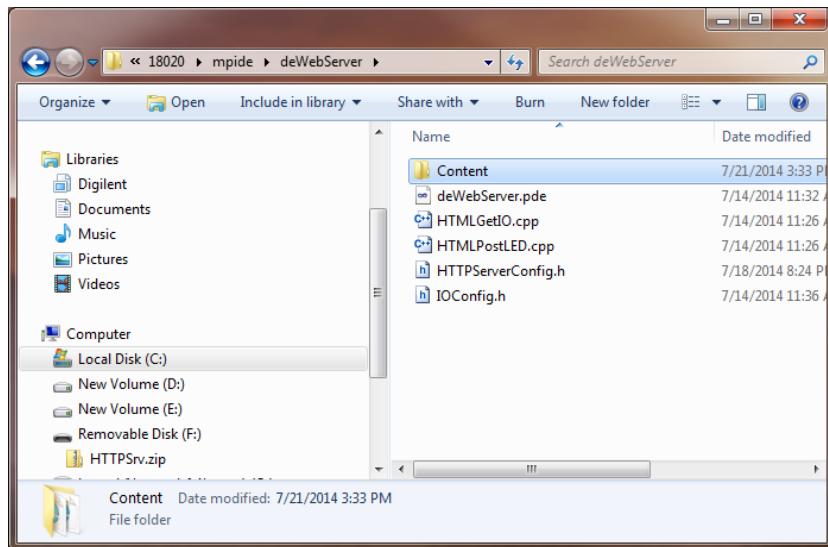


3. Open a Windows Explorer window

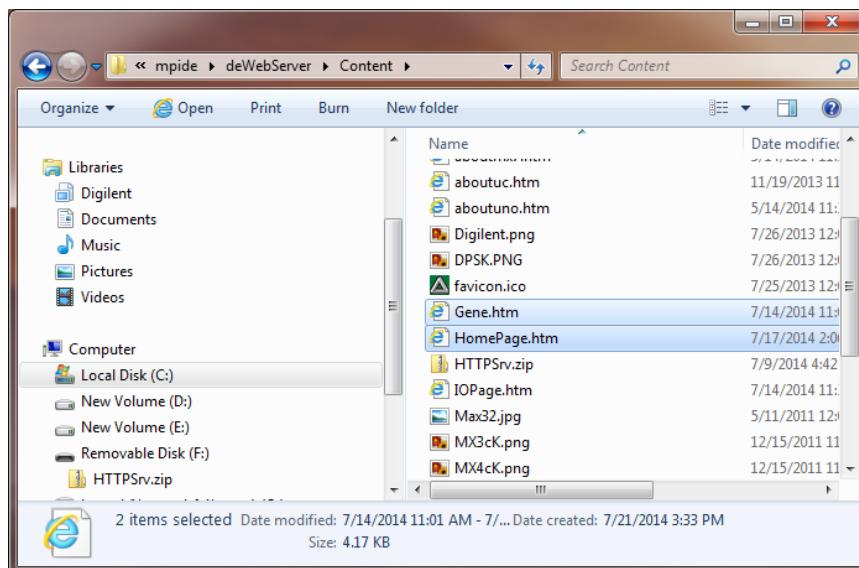


LAB Manual For 18020 EWN

4. Go to the deWebServer Sketch Directory. Under that directory is a subdirectory "Content". This subdirectory is not used by MPIDE or compiled in any way. It is only a subdirectory that contains the HTML content that is copied to the µSD card. Except for one file, Gene.htm, this is exactly what is currently on your µSD card.

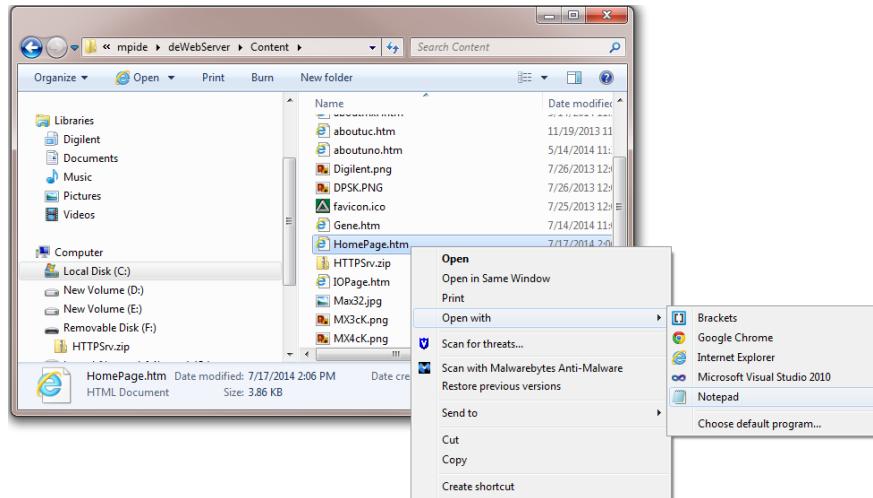


5. In that subdirectory we are going to modify HomePage.htm to reference Gene.htm. Gene.htm is exactly the html page as shown in the presentation. When your current µSD card was created, Gene.htm was not put on your card as nothing referenced it. However, now we are going to add a reference to that page from our Home Page, HomePage.htm.

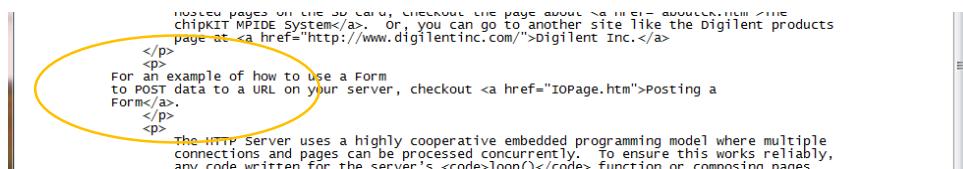


LAB Manual For 18020 EWN

6. Open HomePage.htm with Notepad.

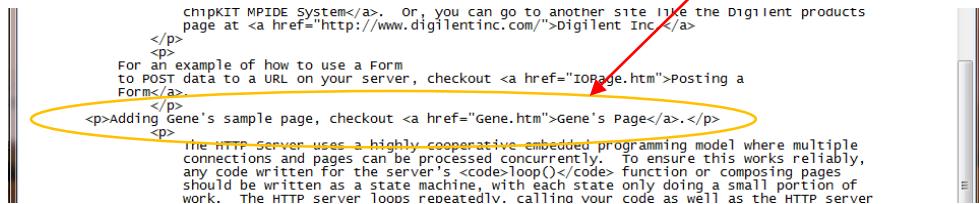


7. Scroll down into the file to where you see the break in the indentation of the text.



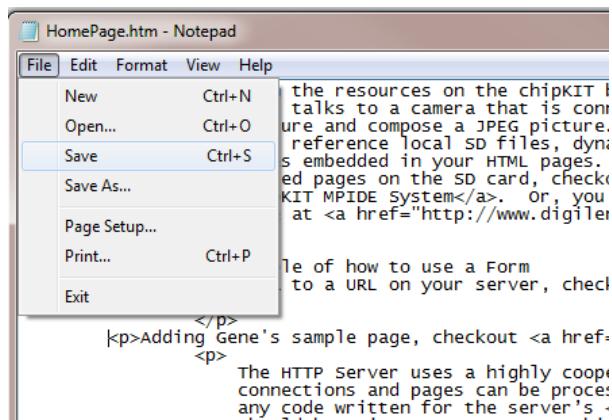
8. Modify HomePage.htm and add the href to Gene.htm page. You can use the following HTML to cut and paste into the text file. We are adding a new paragraph, so ensure you put it between the existing paragraph tags.

<p>Adding Gene's sample page, checkout Gene's Page.</p>

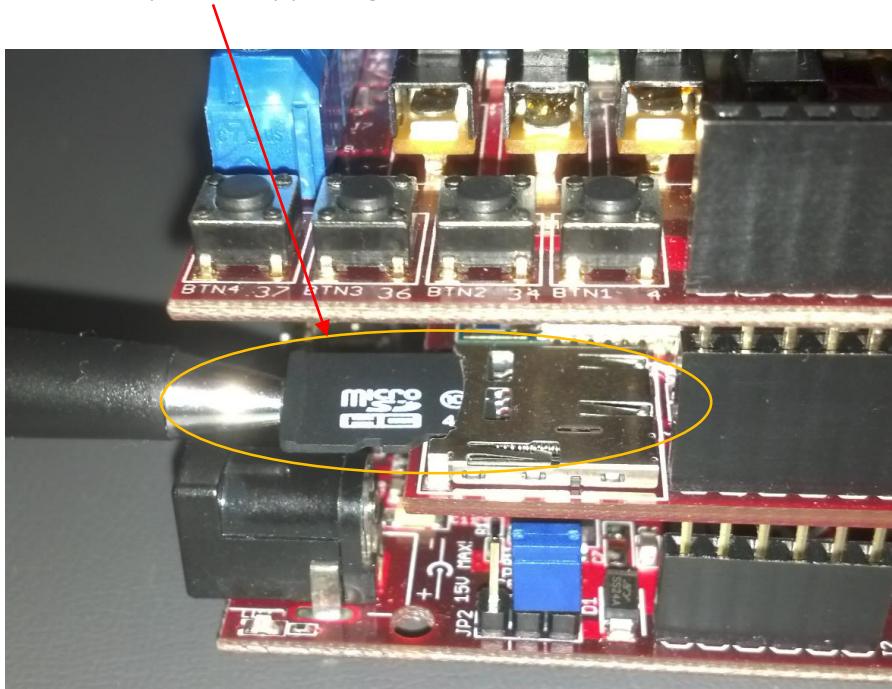


LAB Manual For 18020 EWN

9. Save and exit from Notepad

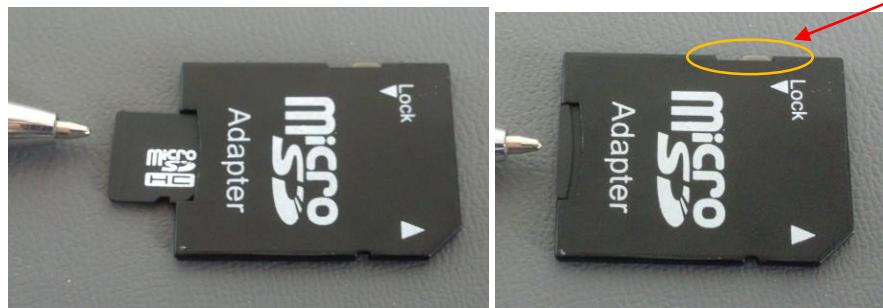


10. Remove the µSD card by pushing in on the card until it clicks out.



LAB Manual For 18020 EWN

11. Insert the µSD card fully into the Micro SD Adapter. Also make sure your adapter is unlocked.



12. Insert the Micro SD Adapter fully into the SD slot on your computer.

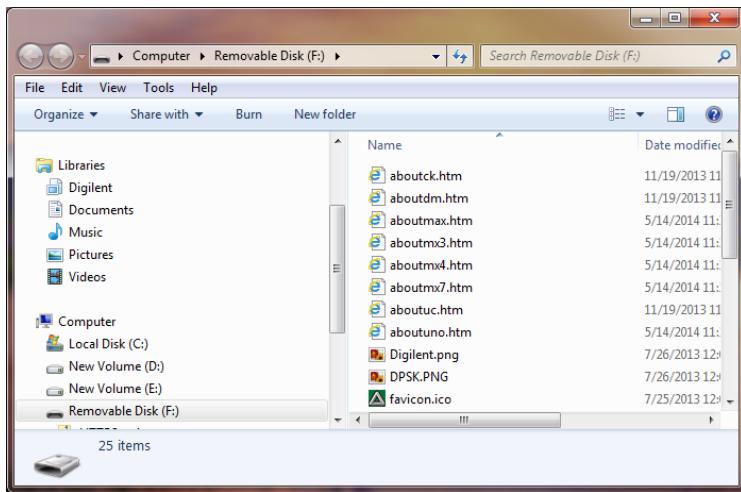


13. Windows should notify you of the Removable Disk, Open the folder and view the files.

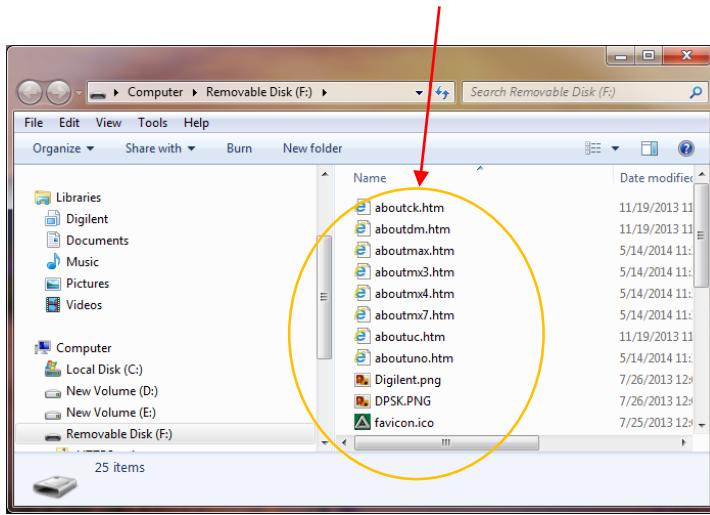


LAB Manual For 18020 EWN

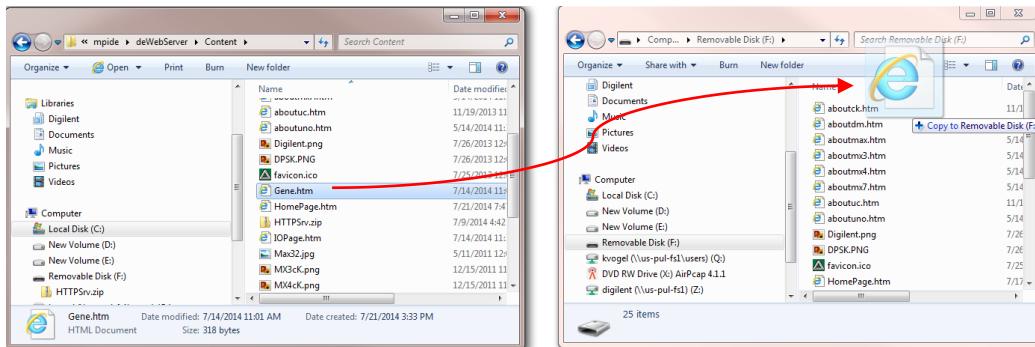
14. If windows does not AutoPlay to the above dialog, open the directory manually from Windows Explorer



15. You should see the HTML files on the µSD card.

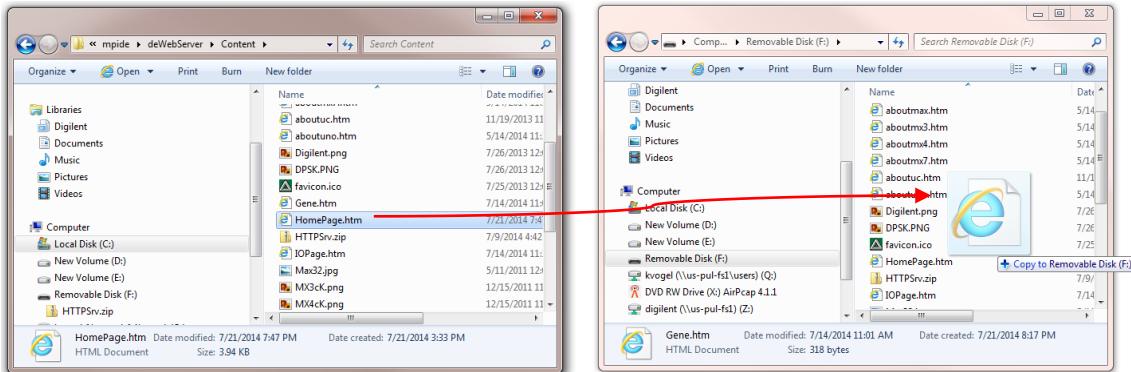


16. Now drag and drop Gene.htm from your Content directory to the root of the µSD card.

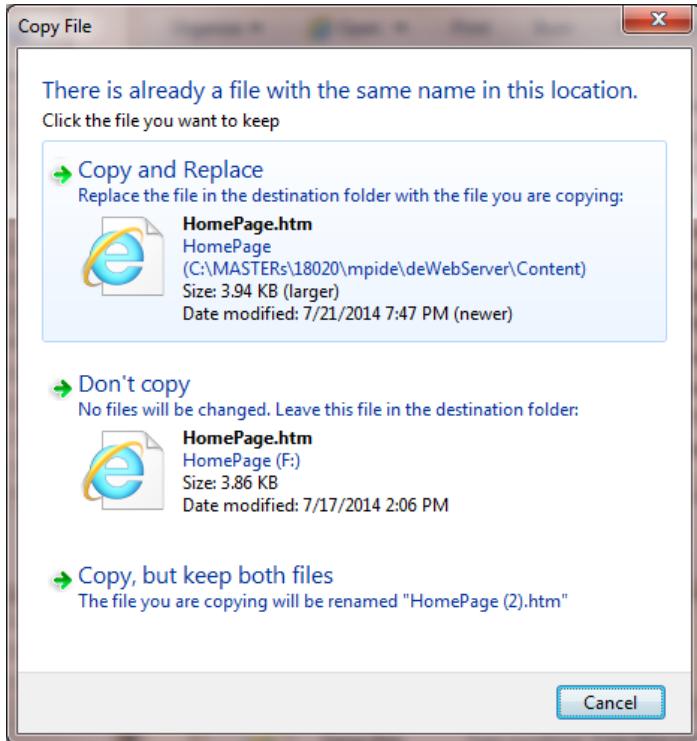


LAB Manual For 18020 EWN

17. Do the same with HomePage.htm.

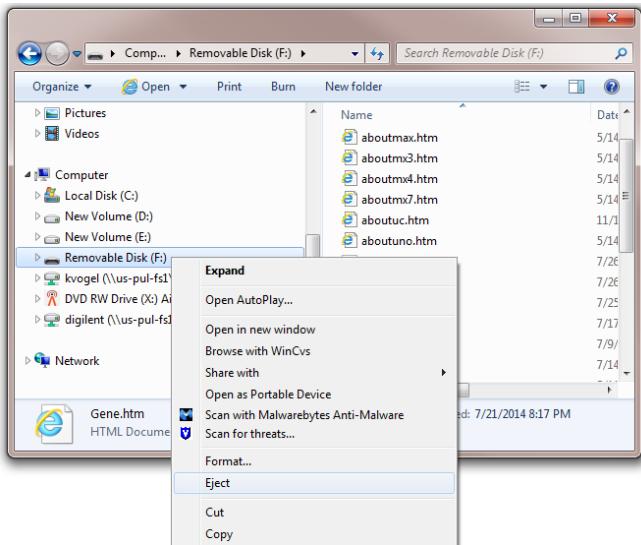


18. Remember that HomePage.htm already existed on the µSD card, so you will need to replace the file.

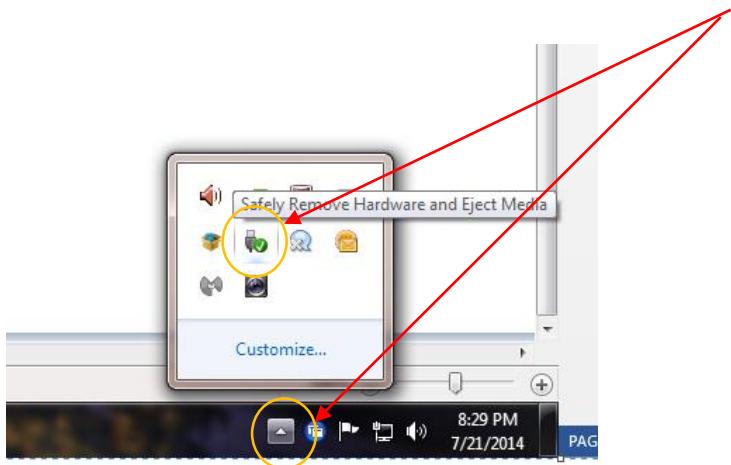


LAB Manual For 18020 EWN

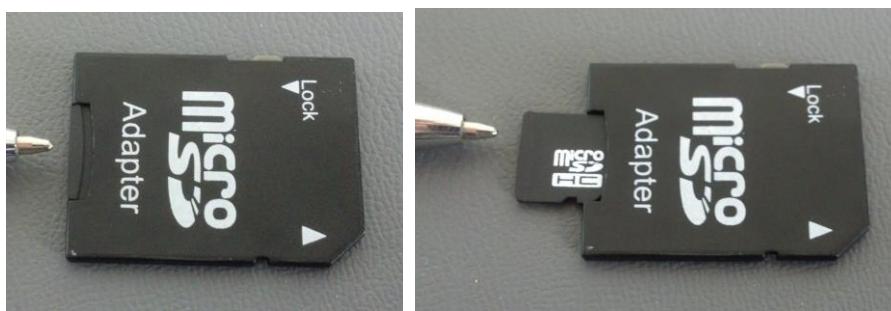
19. Remember to Eject the Removable µSD card to ensure all data was written to the card.



20. If you don't have an Eject menu item, then eject the hardware safely with the hardware manager.

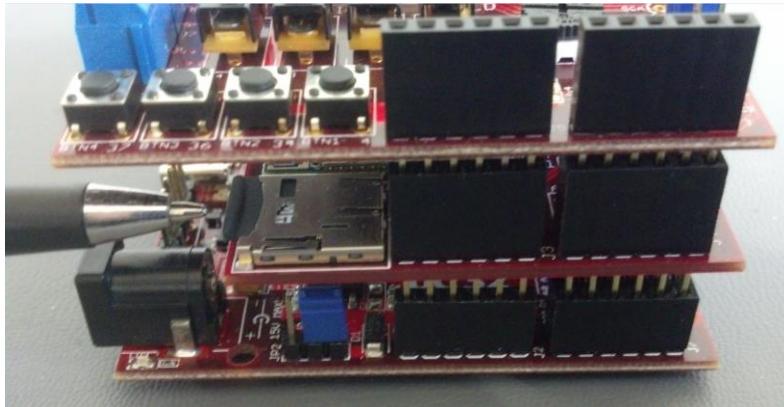


21. Remove the Micro SD Adapter from the computer and remove the µSD card from the Micro SD Adapter.

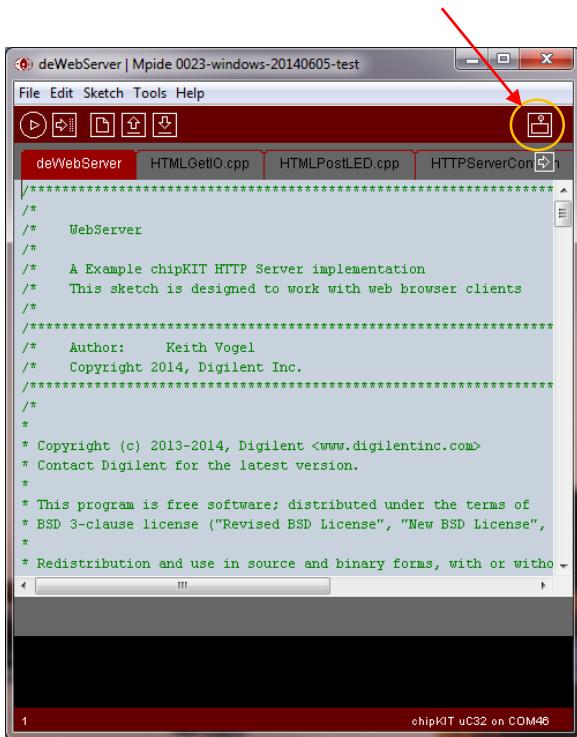


LAB Manual For 18020 EWN

22. Fully reinserted the µSD card into the chipKIT™ uC32 µSD reader.



23. Restart the Serial Monitor. It is not necessary to recompile or upload the sketch as the HTTP Server code did not change. All that we did was update the static HTML pages on the µSD card.



LAB Manual For 18020 EWN

24. You should see the HTTP Server start as before, wait for the IP address so you know what to type into the browser address line; it should be the same address as before but does not have to be.

```
Supported Rate: 5500 kbps
Supported Rate: 6000 kbps
Supported Rate: 9000 kbps
Supported Rate: 11000 kbps
Supported Rate: 12000 kbps
Supported Rate: 18000 kbps

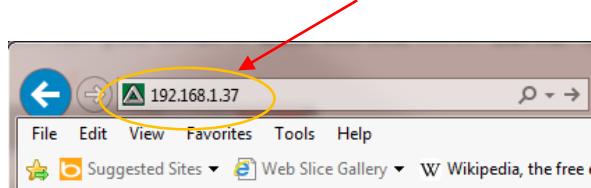
Connecting to WiFi Network
Wait up to 40 seconds to establish the connection
WiFi Connection CreatedDynamic begin
Is Linked to the physical network
Link status: 0x0
Network Initialized

My IP: 192.168.1.37
Gateway IP: 192.168.1.1
Subnet mask: 255.255.255.0
Dns0: IP: 192.168.1.1
Dns1: IP: 8.8.8.8
Dns2: IP: 8.8.4.4
Dns3: IP: 8.8.8.8
My MAC: 00:1E:C0:0D:F2:ED

5 Sockets Listening on IP: 192.168.1.37:80
Listening Sockets = 5

Autoscroll No line ending 9600 baud
```

25. Start Internet Explorer and type in the IP Address in the Address line and enter.



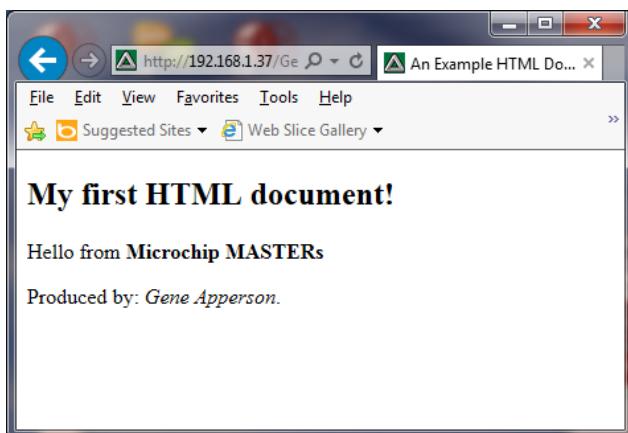
LAB Manual For 18020 EWN

26. Internet Explorer should load the HomePage.htm as before.



But now we have a new reference to Gene's Page.

27. Click on the link and we get the new page.



28. We have added a new static HTML page without updating the HTTP Server code.

END LAB 2

LAB 3

Working with Dynamic HTML Pages

1. In this exercise we will see how to work with Compose Functions and we will update the web server to set the state of all 8 LEDs on the Basic IO Shield. There are 2 pages to deal with on the same URL. One page to POST an LED change to the URL (implemented in HTMLPostLED.cpp), and a second page to GET the state of the switches and buttons off of the URL (implemented in HTMLGetIO.cpp). Both of these pages operate on the same URL but different HTTP Methods, POST v.s. GET. There are many ways to implement a Compose Function, this is only an example.
2. IOPage.htm is our URL resource that is both the Page that displays the current state of the uC32 Switches and LEDS and is also the same resource URL that gets modified when you POST which LEDs to turn ON or OFF. We do a GET /IOPage.htm to see what the current state of the Switches and LEDs are, and a POST /IOPage.htm to set the LEDs.
3. IOPage.htm is a template HTML page read off of the µSD card by the ComposeHTMLGetIO() Compose Function. The Compose Function will dynamically update the current state of the Switches and LEDs by replacing each of the comment fields (with a ~ in it), with the current state of the Switch or LED.

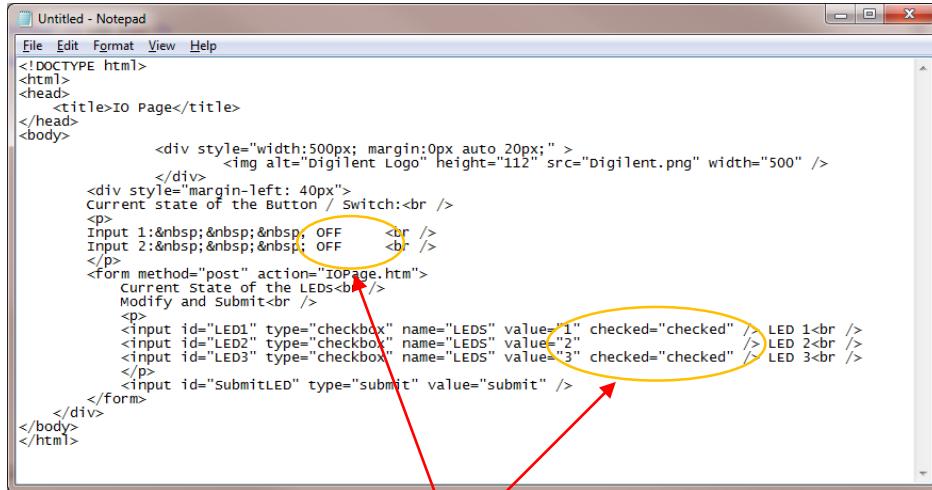
The screenshot shows a Windows Notepad window titled "IOPage.htm - Notepad". The code is a template HTML page with several parts highlighted:

- A yellow oval highlights the section: `<!-->` Current state of the Button / Switch:
`
`
- Two red arrows point from the text "Current state of the Button / Switch:" to the value "1" in the code: `<input id="LED1" type="checkbox" name="LEDS" value="1" >`
- A yellow oval highlights the section: `<!-->` Current State of the LEDs:
`
` Modify and Submit
`
`
- Two red arrows point from the text "Current State of the LEDs:" to the value "1" in the code: `<input id="LED1" type="checkbox" name="LEDS" value="1" >`
- Two red arrows point from the text "Modify and Submit" to the code: `<input id="submittedLED" type="submit" value="submit" />`

```
<!DOCTYPE html>
<html>
<head>
    <title>IO Page</title>
</head>
<body>
    <div style="width:500px; margin:0px auto 20px;">
        
    </div>
    <div style="margin-left: 40px">
        Current state of the Button / Switch:<br />
        <br />
        Input 1:&nbsp;&nbsp;&nbsp; <!--><br />
        Input 2:&nbsp;&nbsp;&nbsp; <!--><br />
    </div>
    <form method="post" action="IOPage.htm">
        Current State of the LEDs:<br />
        Modify and Submit<br />
        <br />
        <input id="LED1" type="checkbox" name="LEDS" value="1" > <!--> /> LED 1<br />
        <input id="LED2" type="checkbox" name="LEDS" value="2" > <!--> /> LED 2<br />
        <input id="LED3" type="checkbox" name="LEDS" value="3" > <!--> /> LED 3<br />
    </form>
</div>
</body>
</html>
```

LAB Manual For 18020 EWN

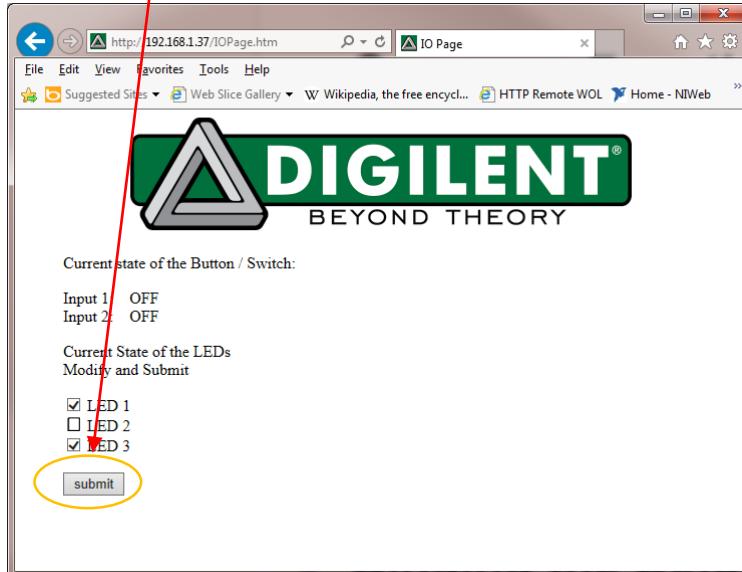
4. The actual HTML sent to the browser after HTMLGetIO renders it looks like:



```
<html>
<head>
<title>IO Page</title>
</head>
<body>
    <div style="width:500px; margin:0px auto 20px;">
        
    </div>
    Current state of the Button / Switch:<br />
    <p>
        Input 1:&nbsp;&nbsp; OFF <br />
        Input 2:&nbsp;&nbsp; OFF <br />
    </p>
    <form method="post" action="IOPage.htm">
        Current state of the LEDs<br />
        Modify and Submit<br />
        <p>
            <input id="LED1" type="checkbox" name="LEDS" value="1" checked="checked" /> LED 1<br />
            <input id="LED2" type="checkbox" name="LEDS" value="2" /> LED 2<br />
            <input id="LED3" type="checkbox" name="LEDS" value="3" checked="checked" /> LED 3<br />
        </p>
        <input id="submitLED" type="submit" value="submit" />
    </form>
</div>
</body>
</html>
```

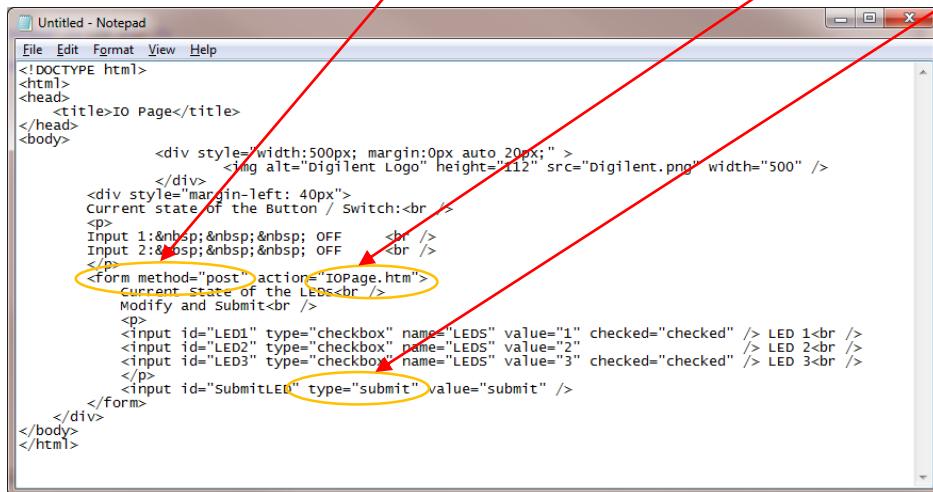
Notice how the comment fields were all replaced with the state of the Switches and LEDS. Also notice how the fields were all space filed so the actual size of the template file did not change. This allows the Compose Function to read the size of the IOPage.htm template file off of the µSD card and use the file size as the “Content Length” when generating the HTTP Header. The extra spaces are ignored and have no relevance in the HTML rendering.

5. When we submit the page, we POST a FORM to the same URL resource, IOPage.htm. This tells the uC32 server to update that resource with the new LED status.



LAB Manual For 18020 EWN

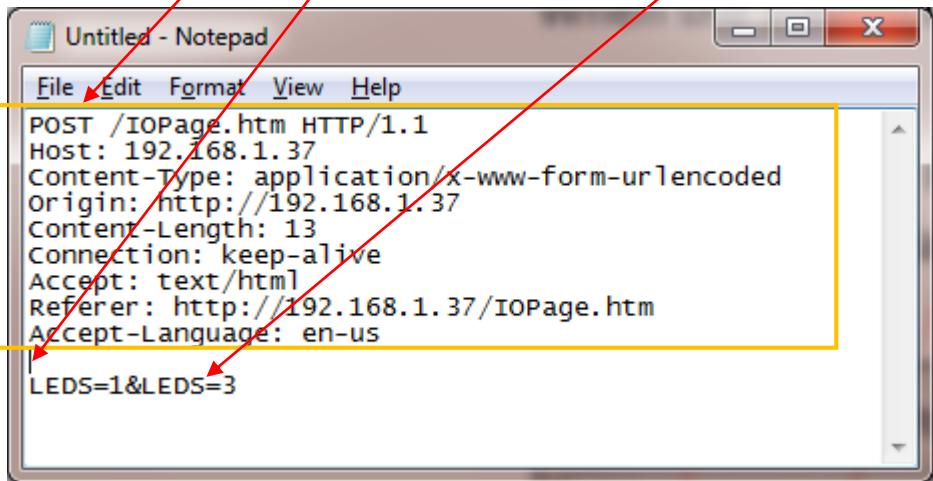
6. You can see in the HTML, the FORM tag and resource to update (IOPage.htm), and the submit.



The screenshot shows a Windows Notepad window titled "Untitled - Notepad". The content is an HTML file named "IOPage.htm". The code includes a title, a logo image, and a form section. The form has a method of "post" and an action of "IOPage.htm". It contains three checkboxes labeled LED1, LED2, and LED3, each with a value of 1, 2, or 3 respectively. A submit button is also present. Red arrows point from the question text to the FORM tag, the action attribute, and the submit button.

```
<!DOCTYPE html>
<html>
<head>
    <title>IO Page</title>
</head>
<body>
    <div style="width:500px; margin:0px auto 20px;">
        
    </div>
    Current state of the Button / Switch:<br />
    <p>
        Input 1:&nbsp;&nbsp; OFF <br />
        Input 2:&nbsp;&nbsp; OFF <br />
    </p>
    <form method="post" action="IOPage.htm">
        Current state of the LEDs:<br />
        Modify and submit:<br />
        <br>
        <input id="LED1" type="checkbox" name="LEDS" value="1" checked="checked" /> LED 1<br />
        <input id="LED2" type="checkbox" name="LEDS" value="2" /> LED 2<br />
        <input id="LED3" type="checkbox" name="LEDS" value="3" checked="checked" /> LED 3<br />
        </p>
        <input id="submitLED" type="submit" value="submit" />
    </form>
</div>
</body>
</html>
```

7. When the Form is POSTed, something like the following will be sent from the browser to the uC32. Notice the HTTP header, a blank line, and then the posted FORM data in the HTTP Body.



The screenshot shows a Windows Notepad window titled "Untitled - Notepad". The content is a raw HTTP POST request. It starts with the method "POST", the URL "/IOPage.htm", and the protocol "HTTP/1.1". This is followed by several headers: "Host: 192.168.1.37", "Content-Type: application/x-www-form-urlencoded", "Origin: http://192.168.1.37", "Content-Length: 13", "Connection: keep-alive", "Accept: text/html", "Referer: http://192.168.1.37/IOPage.htm", and "Accept-Language: en-us". A yellow box highlights these headers. Below them is a blank line, and then the posted FORM data "LEDS=1&LEDS=3". A red arrow points from the question text to the "File" menu in the Notepad window.

```
POST /IOPage.htm HTTP/1.1
Host: 192.168.1.37
Content-Type: application/x-www-form-urlencoded
Origin: http://192.168.1.37
Content-Length: 13
Connection: keep-alive
Accept: text/html
Referer: http://192.168.1.37/IOPage.htm
Accept-Language: en-us

LEDS=1&LEDS=3
```

LAB Manual For 18020 EWN

8. The POSTed data will give us all of the names of active items in the FORM, and their active values.
In our case we only have 1 item in the FORM (LEDS), and their potential values (1, 2 and 3).

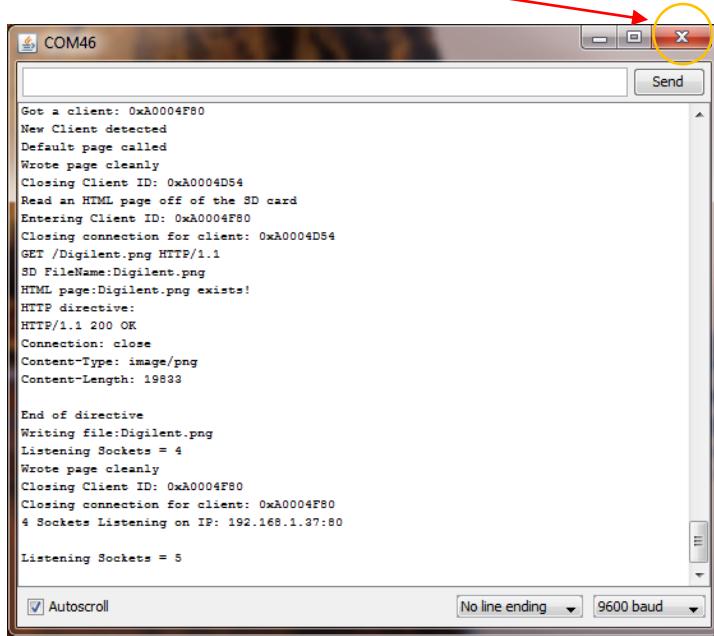
```
<html>
<head>
<title>IO Page</title>
</head>
<body>
    <div style="width:500px; margin:0px auto 20px;">
        
    </div>
    <div style="margin-left: 40px">
        Current State of the Button / Switch:<br />
        <p>
            Input 1:&nbsp;&nbsp;&nbsp; OFF    <br />
            Input 2:&nbsp;&nbsp;&nbsp; OFF    <br />
        </p>
        <form method="post" action="IOPage.htm">
            Current State of the LEDs<br />
            Modify and Submit:<br />
            <p>
                <input id="LED1" type="checkbox" name="LEDS" value="1" checked="checked" /> LED 1<br />
                <input id="LED2" type="checkbox" name="LEDS" value="2" /> LED 2<br />
                <input id="LED3" type="checkbox" name="LEDS" value="3" checked="checked" /> LED 3<br />
            </p>
            <input id="submitLED" type="submit" value="submit" />
        </form>
    </div>
</body>
</html>
```

9. Here is what our Form POST looks like, we can see that the FORM POSTed that the "LEDS" item is active with active values of 1 & 3; or more specifically LED1 and LED3 are checked.

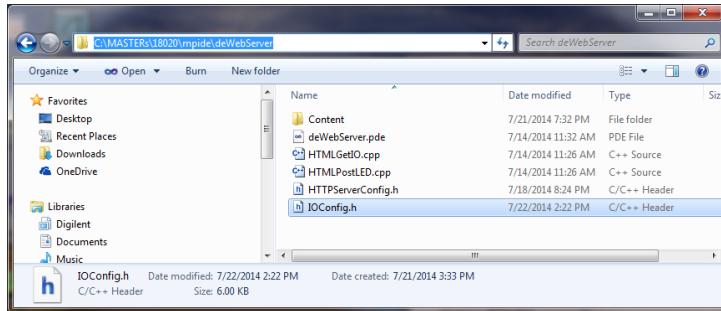
```
POST /IOPage.htm HTTP/1.1
Host: 192.168.1.37
Content-Type: application/x-www-form-urlencoded
Origin: http://192.168.1.37
Content-Length: 13
Connection: keep-alive
Accept: text/html
Referer: http://192.168.1.37/IOPage.htm
Accept-Language: en-us
| LEDS=1&LEDS=3
```

LAB Manual For 18020 EWN

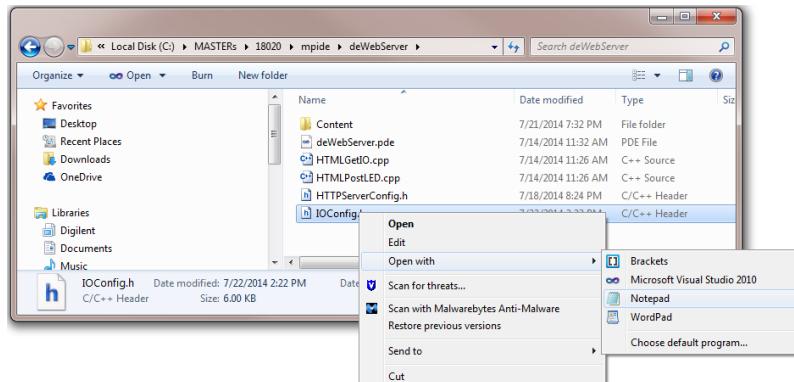
10. Now let's update our server to allow for all of the LEDs on the Basic IOShield to be modified by the POST. To start, if the Serial Monitor is not closed, close the Serial Monitor.



11. Navigate to the deWebServer Sketch folder, C:\MASTERs\18020\mpide\deWebServer

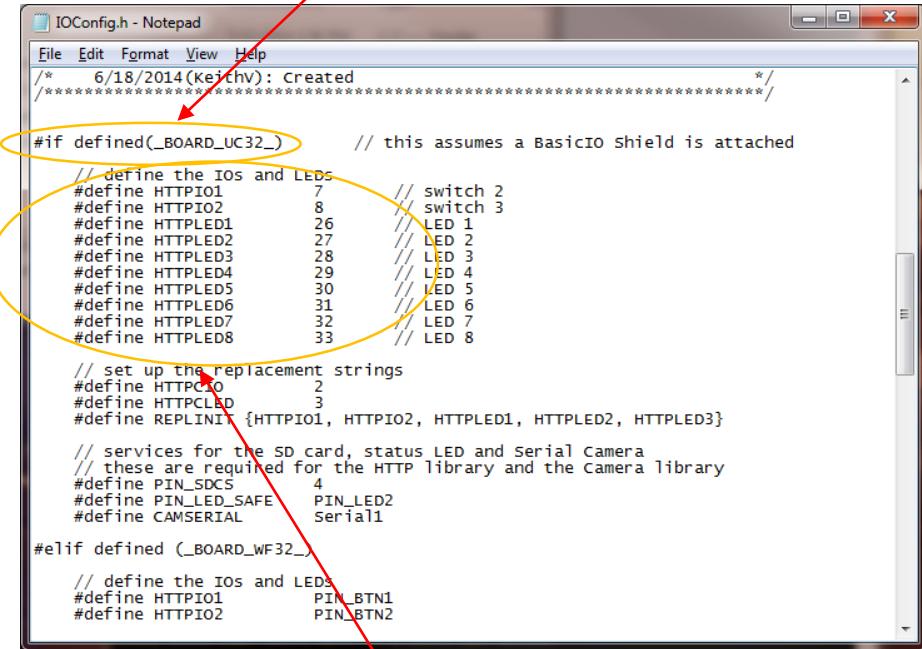


12. Open IOConfig.h with Notepad



LAB Manual For 18020 EWN

13. This file contains the chipKIT™ pin outs for the LEDs, Switches, and Buttons based on the specific board in use. Scroll to the section for the uC32, that is, “_BOARD_UC32_”.



```
/* 6/18/2014 (keithv): created */
#ifndef _IOCONFIG_H_
#define _IOCONFIG_H_

#if defined(_BOARD_UC32_) // this assumes a BasicIO shield is attached

    // define the IOs and LEDs
    #define HTTPPIO1    7      // switch 2
    #define HTTPPIO2    8      // switch 3
    #define HTTPLED1   26      // LED 1
    #define HTTPLED2   27      // LED 2
    #define HTTPLED3   28      // LED 3
    #define HTTPLED4   29      // LED 4
    #define HTTPLED5   30      // LED 5
    #define HTTPLED6   31      // LED 6
    #define HTTPLED7   32      // LED 7
    #define HTTPLED8   33      // LED 8

    // set up the replacement strings
    #define HTTPCIO    2
    #define HTTPLED   3
    #define REPLITINIT {HTTPPIO1, HTTPPIO2, HTTPLED1, HTTPLED2, HTTPLED3}

    // services for the SD card, status LED and Serial Camera
    // these are required for the HTTP library and the Camera library
    #define PIN_SDSCS 4
    #define PIN_LED_SAFE PIN_LED2
    #define CAMSERIAL Serial1

#elif defined (_BOARD_WF32_)

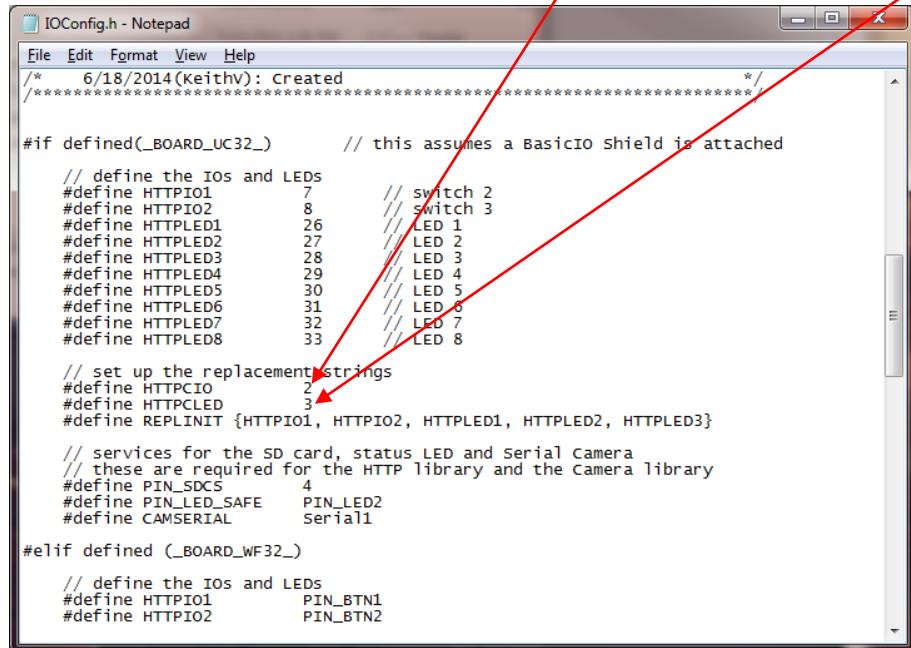
    // define the IOs and LEDs
    #define HTTPPIO1    PIN_BTN1
    #define HTTPPIO2    PIN_BTN2

#endif

#endif
```

Here are the pin defines for the Switches and LEDs.

14. We must tell the Compose Functions how many switches we have, and how many LEDs we have.



```
/* 6/18/2014 (keithv): created */
#ifndef _IOCONFIG_H_
#define _IOCONFIG_H_

#if defined(_BOARD_UC32_) // this assumes a BasicIO shield is attached

    // define the IOs and LEDs
    #define HTTPPIO1    7      // switch 2
    #define HTTPPIO2    8      // switch 3
    #define HTTPLED1   26      // LED 1
    #define HTTPLED2   27      // LED 2
    #define HTTPLED3   28      // LED 3
    #define HTTPLED4   29      // LED 4
    #define HTTPLED5   30      // LED 5
    #define HTTPLED6   31      // LED 6
    #define HTTPLED7   32      // LED 7
    #define HTTPLED8   33      // LED 8

    // set up the replacement strings
    #define HTTPCIO    2
    #define HTTPLED   3
    #define REPLITINIT {HTTPPIO1, HTTPPIO2, HTTPLED1, HTTPLED2, HTTPLED3}

    // services for the SD card, status LED and Serial Camera
    // these are required for the HTTP library and the Camera library
    #define PIN_SDSCS 4
    #define PIN_LED_SAFE PIN_LED2
    #define CAMSERIAL Serial1

#elif defined (_BOARD_WF32_)

    // define the IOs and LEDs
    #define HTTPPIO1    PIN_BTN1
    #define HTTPPIO2    PIN_BTN2

#endif

#endif
```

LAB Manual For 18020 EWN

15. The HTMLGetIO Compose Function is written to work off of an ordered list of switches and LEDs, in the same order as the comments in our template IOPage.htm file. We display the switches first and then the LEDs. We currently have 2 switches and 3 LEDs.

The diagram illustrates the connection between two files: `IOConfig.h` and `IOPage.htm`.

IOConfig.h - Notepad

```
/*
 * 6/18/2014 (Keithv): created
 */
#ifndef __IOCONFIG_H
#define __IOCONFIG_H

#if defined(_BOARD_UC32_) // this assumes a BasicIO Shield is attached
    // define the IOs and LEDs
    #define HTTPPIO1    7      // switch 2
    #define HTTPPIO2    8      // switch 3
    #define HTTPLED1   26     // LED 1
    #define HTTPLED2   27     // LED 2
    #define HTTPLED3   28     // LED 3
    #define HTTPLED4   29     // LED 4
    #define HTTPLED5   30     // LED 5
    #define HTTPLED6   31     // LED 6
    #define HTTPLED7   32     // LED 7
    #define HTTPLED8   33     // LED 8

    // set up the replacement strings
    #define HTTPCIO    2
    #define HTTPLED    3
    #define REPLITINIT {HTTPPIO1, HTTPPIO2, HTTPLED1, HTTPLED2, HTTPLED3}

    // services for the SD card, status LED and Serial Camera
    // these are required for the HTTP library and the Camera library
    #define PIN_SDCS    4
    #define PIN_LED_SAFE  PIN_LED2
    #define CAMSERIAL   Serial1

#elif defined (_BOARD_WF32_)

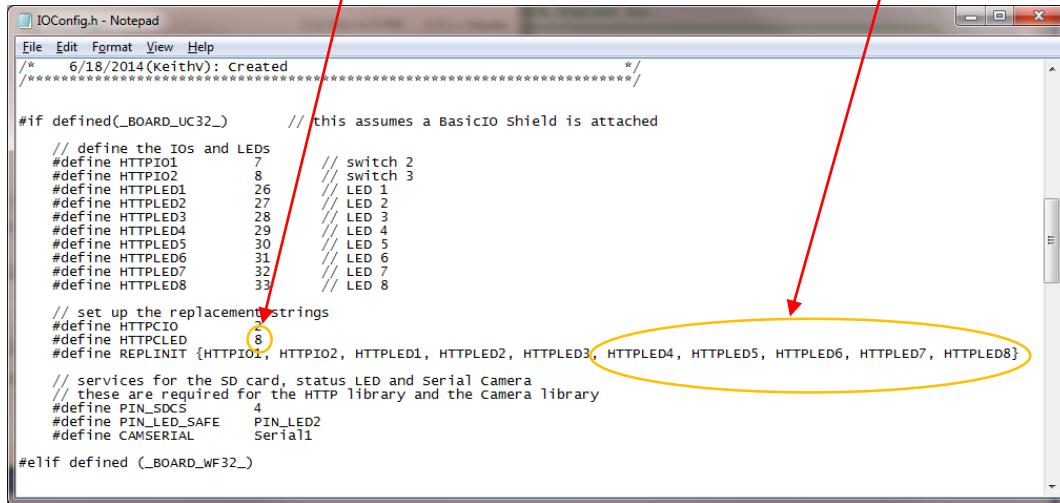
    // define the IOs and LEDs
    #define HTTPPIO1    PIN_BTN1
    #define HTTPPIO2    PIN_BTN2
#endif
#endif
```

IOPage.htm - Notepad

```
<!DOCTYPE html>
<html>
<head>
    <title>IO Page</title>
</head>
<body>
    <div style="width:500px; margin:0px auto 20px;">
        
    </div>
    <div style="margin-left: 40px;>
        Current state of the Button /switch:<br />
    <p>
        Input 1:&nbsp;&nbsp;&nbsp; <!--><br />
        Input 2:&nbsp;&nbsp;&nbsp; <!--><br />
    </p>
    <form method="post" action="IOPage.htm">
        Current State of the LEDs<br />
        Modify and Submit<br />
        <p>
            <input id="LED1" type="checkbox" name="LEDS" value="1" ><!--> /> LED 1<br />
            <input id="LED2" type="checkbox" name="LEDS" value="2" ><!--> /> LED 2<br />
            <input id="LED3" type="checkbox" name="LEDS" value="3" ><!--> /> LED 3<br />
        </p>
        <input id="SubmitLED" type="submit" value="submit" />
    </form>
</div>
</body>
</html>
```

LAB Manual For 18020 EWN

16. Modify the defines to indicate 8 LEDs, and add the additional Basic IO Shield LEDs to the ordered list.



```
IOConfig.h - Notepad
File Edit Format View Help
/*
 * 6/18/2014(KeithV): Created
 */
#ifndef _IOCONFIG_H_
#define _IOCONFIG_H_

/* Define the IOs and LEDs */
#define HTTPIO1    7      // switch 2
#define HTTPIO2    8      // switch 3
#define HTTPLED1   26     // LED 1
#define HTTPLED2   27     // LED 2
#define HTTPLED3   28     // LED 3
#define HTTPLED4   29     // LED 4
#define HTTPLED5   30     // LED 5
#define HTTPLED6   31     // LED 6
#define HTTPLED7   32     // LED 7
#define HTTPLED8   33     // LED 8

// Set up the replacement strings
#define HTTPCIO    8
#define HTTPCLED   8
#define REPLINIT {HTTPIO1, HTTPIO2, HTTPLED1, HTTPLED2, HTTPLED3, HTTPLED4, HTTPLED5, HTTPLED6, HTTPLED7, HTTPLED8}

// Services for the SD card, status LED and Serial Camera
// These are required for the HTTP library and the Camera library
#define PIN_SDCS   4
#define PIN_LED1   PIN_LED2
#define CAMSERIAL  Serial1

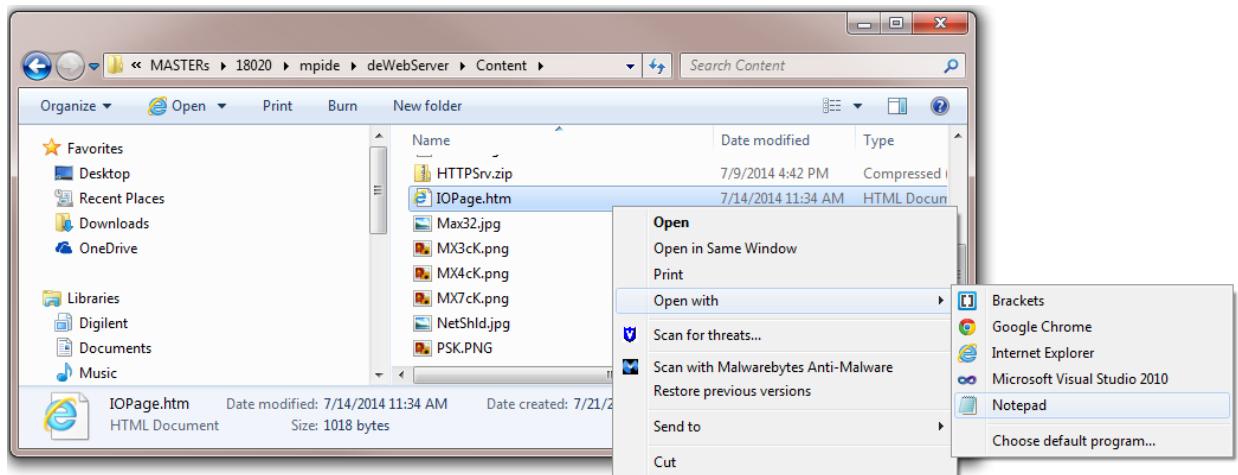
#endif // _IOCONFIG_H_
```

For your convenience, you can cut and paste the following text into the file.

```
#define HTTPCLED    8
#define REPLINIT {HTTPIO1, HTTPIO2, HTTPLED1, HTTPLED2, HTTPLED3, HTTPLED4, HTTPLED5, HTTPLED6, HTTPLED7, HTTPLED8}
```

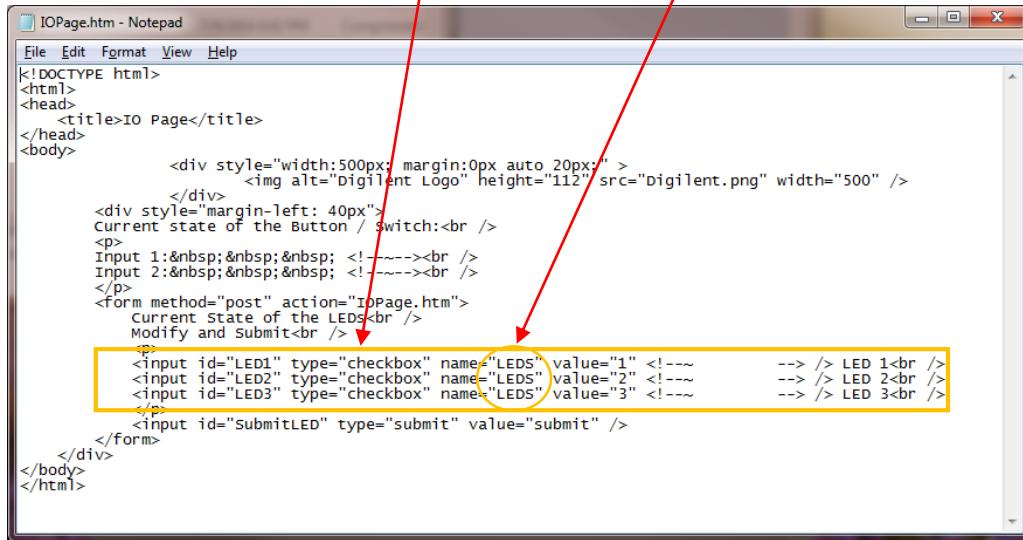
Save IOConfig.h and exit Notepad.

17. Go down into the “Content” subdirectory and open IOPage.htm with Notepad



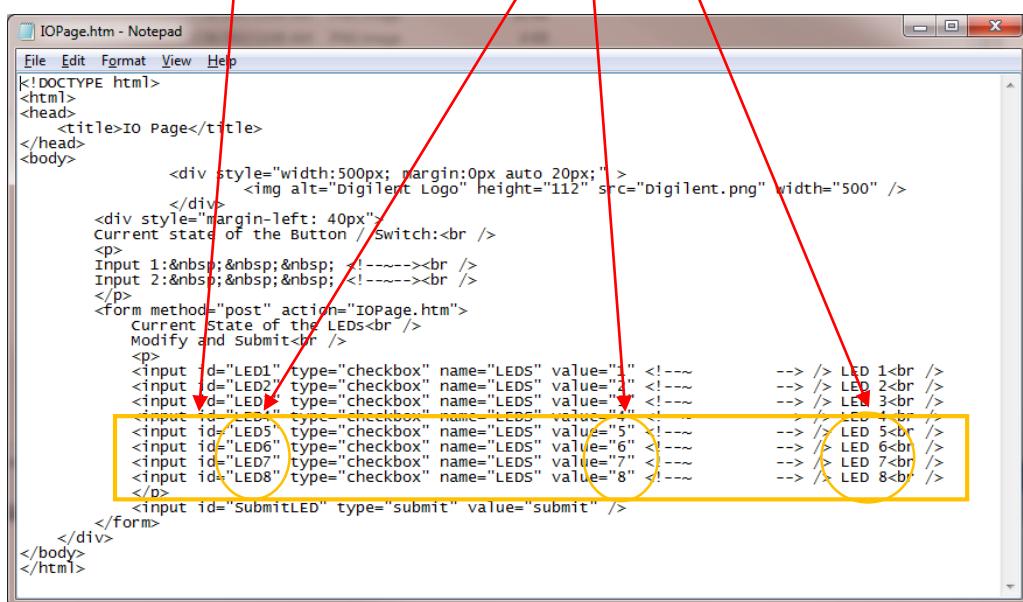
LAB Manual For 18020 EWN

18. In IOPage.htm we currently support 3 LEDs as part of the “LEDS” items.



```
<!DOCTYPE html>
<html>
<head>
    <title>IO Page</title>
</head>
<body>
    <div style="width:500px; margin:0px auto 20px;">
        
    </div>
    <div style="margin-left: 40px">
        Current state of the Button / Switch:<br />
    </p>
    <p>
        Input 1:&nbsp;&nbsp;&nbsp; <!--><br />
        Input 2:&nbsp;&nbsp;&nbsp; <!--><br />
    </p>
    <form method="post" action="IOPage.htm">
        Current state of the LEDs:<br />
        Modify and submit:<br />
        <br>
        <input id="LED1" type="checkbox" name="LEDS" value="1" <!--> /> LED 1<br />
        <input id="LED2" type="checkbox" name="LEDS" value="2" <!--> /> LED 2<br />
        <input id="LED3" type="checkbox" name="LEDS" value="3" <!--> /> LED 3<br />
    </p>
    <input id="SubmittedLED" type="submit" value="submit" />
    </form>
</div>
</body>
</html>
```

19. We need to create 8 entries, and update the id, value, and text.



```
<!DOCTYPE html>
<html>
<head>
    <title>IO Page</title>
</head>
<body>
    <div style="width:500px; margin:0px auto 20px;">
        
    </div>
    <div style="margin-left: 40px">
        Current state of the Button / Switch:<br />
    </p>
    <p>
        Input 1:&nbsp;&nbsp;&nbsp; <!--><br />
        Input 2:&nbsp;&nbsp;&nbsp; <!--><br />
    </p>
    <form method="post" action="IOPage.htm">
        Current state of the LEDs:<br />
        Modify and Submit:<br />
        <br>
        <input id="LED1" type="checkbox" name="LEDS" value="1" <!--> /> LED 1<br />
        <input id="LED2" type="checkbox" name="LEDS" value="2" <!--> /> LED 2<br />
        <input id="LED3" type="checkbox" name="LEDS" value="3" <!--> /> LED 3<br />
        <input id="LED4" type="checkbox" name="LEDS" value="4" <!--> /> LED 4<br />
        <input id="LED5" type="checkbox" name="LEDS" value="5" <!--> /> LED 5<br />
        <input id="LED6" type="checkbox" name="LEDS" value="6" <!--> /> LED 6<br />
        <input id="LED7" type="checkbox" name="LEDS" value="7" <!--> /> LED 7<br />
        <input id="LED8" type="checkbox" name="LEDS" value="8" <!--> /> LED 8<br />
    </p>
    <input id="SubmittedLED" type="submit" value="submit" />
    </form>
</div>
</body>
</html>
```

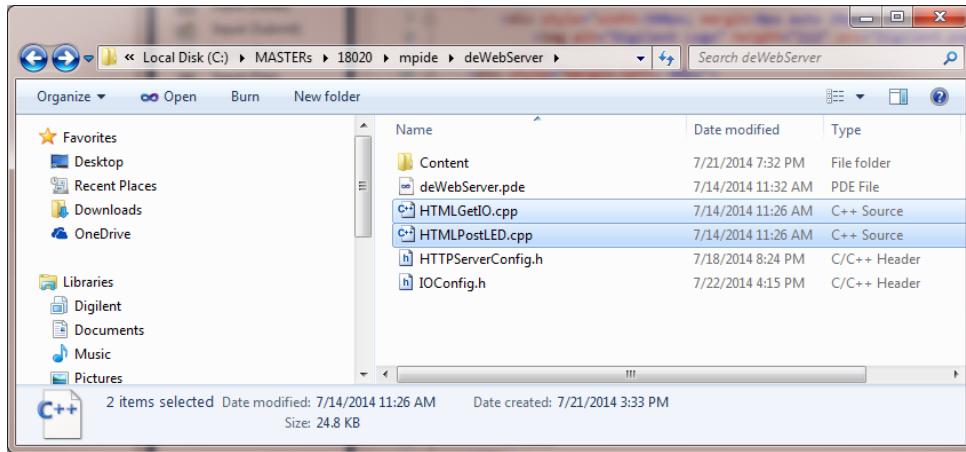
To help out, you can copy and paste the following lines

```
<input id="LED4" type="checkbox" name="LEDS" value="4" <!--> /> LED 4<br />
<input id="LED5" type="checkbox" name="LEDS" value="5" <!--> /> LED 5<br />
<input id="LED6" type="checkbox" name="LEDS" value="6" <!--> /> LED 6<br />
<input id="LED7" type="checkbox" name="LEDS" value="7" <!--> /> LED 7<br />
<input id="LED8" type="checkbox" name="LEDS" value="8" <!--> /> LED 8<br />
```

Save IOPage.htm and exit Notepad.

LAB Manual For 18020 EWN

20. In your sketch directory HTMLGetIO.cpp implements the ComposeHTMLGetIO() callback function that renders the IOPage.htm from the template IOPage.htm. HTMLPostLED.cpp implements the ComposeHTMLPostLED() callback function that processes the POST IOPage.htm resource. These functions were written to be generic enough to handle the Switches and LEDs as enumerated in the REPLIT ordered list in IOConfig.h without changing the code.



21. However, for your understanding of the code, you can see there are some strings defined that are exactly the same number of characters in length as the replacement comment strings in IOPage.htm; this allows for direct replacement without change the file size.

```
static const char szReplacestr[] = "<!--";  
static const char szchecked[] = "checked=\"checked\"";  
static const char szunchecked[] = "";  
static const char szON[] = "ON";  
static const char szOFF[] = "OFF";
```

The code just loops through the full number of items in the “REPLIT” ordered list, looking for the replacement comment string. When one is found the next chipKIT™ IO pin in the ordered list is read to get the current state (this works for Buttons, Switches, and LEDs) and determines if it is ON or OFF and then replaces the comment string with the appropriate HTML replacement string.

```
if(iReplace < cReplacementsStrings)  
{  
    if((pchLast = strstr(pchLast, szReplacestr)) == NULL)  
    {  
        // oh this is not good, something is wrong with the template file  
        Serial.print("Unable to find template replacement on index ");  
        Serial.print(iReplace, DEC);  
        Serial.print(" in template file ");  
        Serial.println(szPage);  
        pClientInfo->htmlState = JMFFILENOTFOUND;  
    }  
    else  
    {  
        bool ison = digitalRead(rgReplacePins[iReplace]);  
        if(iReplace < HTTPC10)  
        {  
            if(ison)  
            {  
                memcpy(pchLast, szON, sizeof(szON)-1);  
            }  
            else  
            {  
                memcpy(pchLast, szOFF, sizeof(szOFF)-1);  
            }  
        }  
        else if((iReplace - HTTPC10) < HTTPCLED)  
        {  
            if(ison)  
            {  
                memcpy(pchLast, szchecked, sizeof(szchecked)-1);  
            }  
            else  
            {  
                memcpy(pchLast, szunchecked, sizeof(szunchecked)-1);  
            }  
        }  
        // do the next replacement string.  
        iReplace++;  
    }  
}
```

LAB Manual For 18020 EWN

22. In `HTMLPostLED.cpp`, the input buffer is read until the content length in the HTTP Header is found.
This length is saved away in the scratch buffer (`rgbOut`) for later use.

```
case CONTLEN:  
    // if we hit the end of the header then there was no content length  
    // and we don't know how to handle that, so exit with an error  
    // File not found is probably the wrong error, but it does get out out  
    // Fortunately all major browsers put in the content lenght, so this  
    // will almost never fail.  
    if(strlen((char *) pclientInfo->rgbIn) == 0)    // cbRead may be longer than just the line, so do a strlen  
    {  
        return(JumpToComposeHTMLPage(pclientInfo, ComposeHTTP404Error));  
    }  
    // found the content lengths  
    else if(memcmp((byte *) szContentLength, pclientInfo->rgbIn, sizeof(szContentLength)-1) == 0)  
    {  
        *((uint32_t *) pclientInfo->rgbout) = atoi((char *) &pclientInfo->rgbIn[sizeof(szContentLength)-1]);  
        pclientInfo->htmlState = ENDHDR;  
    }  
    retCMD = GCMD::GETLINE;  
    break;
```

23. The rest of the HTTP Header is skipped until the empty line at the end of the HTTP Header is found.

```
case ENDHDR:  
    // the header is ended with a double \r\n\r\n, so I will get  
    // a zero length line. Just keep reading lines until we get to the blank line  
    if(strlen((char *) pclientInfo->rgbIn) == 0)    // cbRead may be longer than just the line, so do a strlen()  
    {  
        uint32_t i = 0;  
        // go to beyond the \0  
        for(i = 0; i < pclientInfo->cbRead && pclientInfo->rgbIn[i] == '\0'; i++);  
        // move the buffer to the front  
        pclientInfo->cbRead -= i;  
        if(pclientInfo->cbRead > 0)  
        {  
            memcpy(pclientInfo->rgbIn, &pclientInfo->rgbIn[i], pclientInfo->cbRead);  
        }  
        pclientInfo->htmlState = DATA;  
    }  
    else  
    {  
        retCMD = GCMD::GETLINE;  
    }  
    break;
```

24. We continue to read until the full body of the HTTP message (as specified by our Content Length in the scratch buffer) is in the input buffer (`rgbIn`).

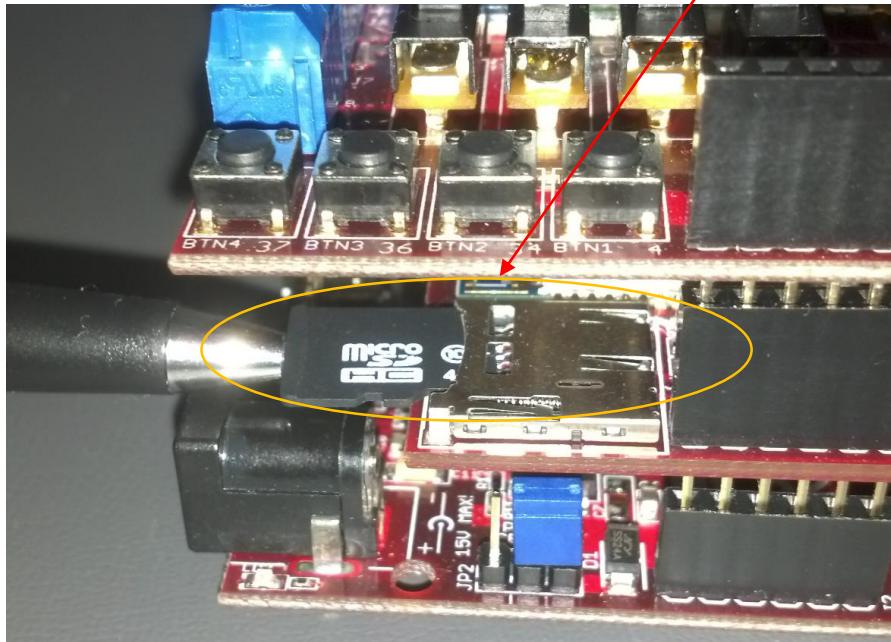
```
case DATA:  
    // we know the body will be small, so just keep reading until we have the full  
    // body of the HTTP message read into our input buffer.  
    // remember we put the lenght in our output buffer using that as temp storage  
    if(pclientInfo->cbRead < *((uint32_t *) pclientInfo->rgbout))  
    {  
        pclientInfo->rgbIn[*(uint32_t *) pclientInfo->rgbout] = '\0';  
        retCMD = GCMD::READ;  
    }  
    else  
    {  
        pclientInfo->htmlState = PARSE;  
    }  
    break;
```

LAB Manual For 18020 EWN

25. We look for the “LEDS=<nbr>” in the HTTP Body, adjust the value character to a zero based integer and index into the ordered list of chipKIT™ Pins and change the state of the LED.

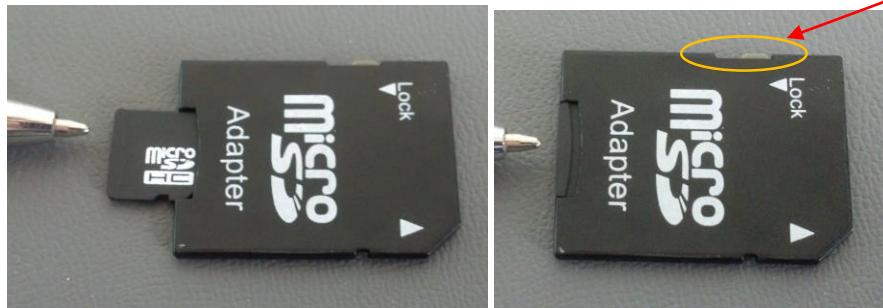
```
case PARSE:  
{  
    int ledstate[HTTPCLED];  
    pPattern = (char *) pclientinfo->rgbIn;  
    // init all LEDS to LOW  
    memset(ledstate, LOW, sizeof(ledstate));  
    // read in the LED states  
    while((pPattern = strstr(pPattern, szLEDS)) != NULL)  
    {  
        int i;  
        pPattern += sizeof(szLEDS) - 1;  
        i = (int) (*pPattern - '1');  
        if(0 <= i && i < HTTPCLED)  
        {  
            ledstate[i] = HIGH;  
        }  
    }  
    // set the LED state  
    for(int i=0; i < HTTPCLED; i++)  
    {  
        digitalWrite(rgReplacePins[HTTPCIO + i], ledstate[i]);  
    }  
}
```

26. Now we must put our modified IOPage.htm on the µSD card. Remove the µSD card by pushing in on the card until it clicks out.



LAB Manual For 18020 EWN

27. Insert the µSD card fully into the Micro SD Adapter. Also make sure your adapter is unlocked.



28. Insert the Micro SD Adapter fully into the SD slot on your computer.

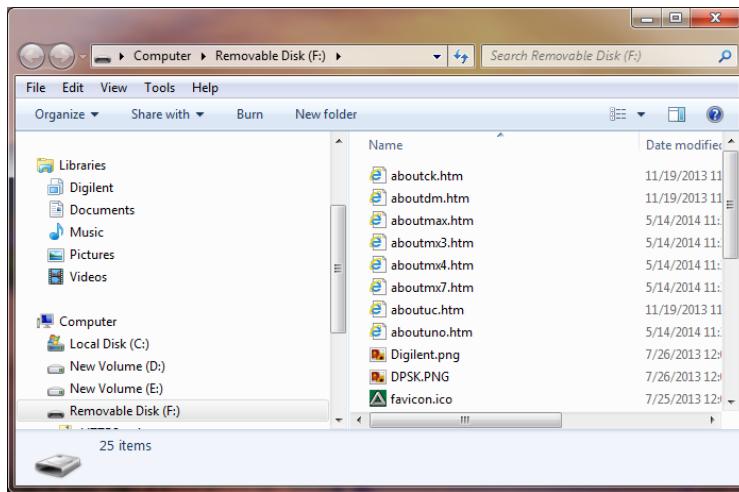


29. Windows should notify you of the Removable Disk, Open the folder and view the files.

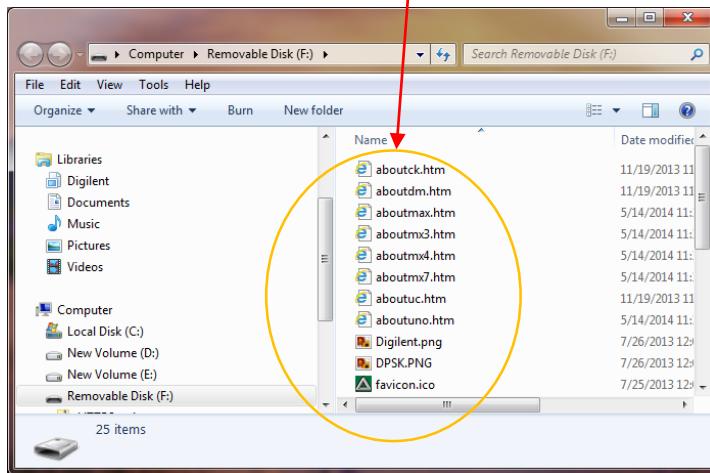


LAB Manual For 18020 EWN

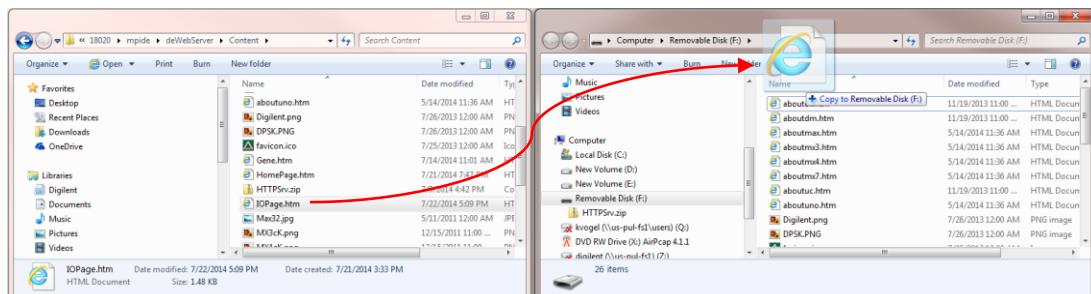
30. If windows does not AutoPlay to the above dialog, open the directory manually from Windows Explorer



31. You should see the HTML files on the μSD card.

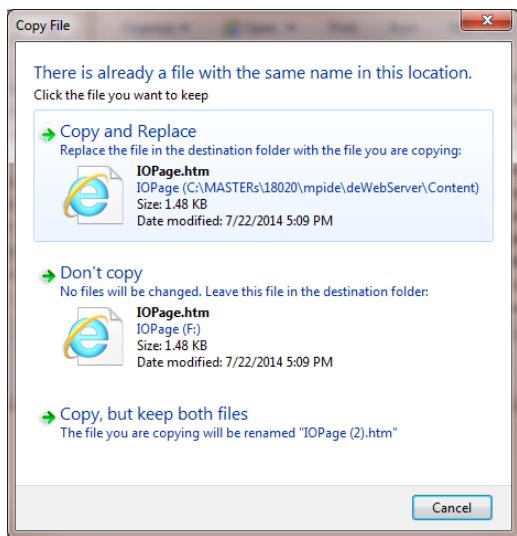


32. Now drag and drop IOPage.htm from your “Content” directory to the root of the μSD card.

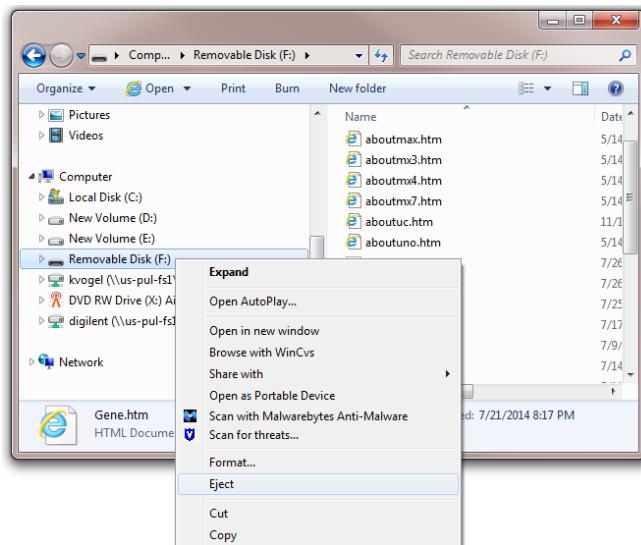


LAB Manual For 18020 EWN

33. Remember that IOPage.htm already existed on the µSD card, so you will need to replace the file.

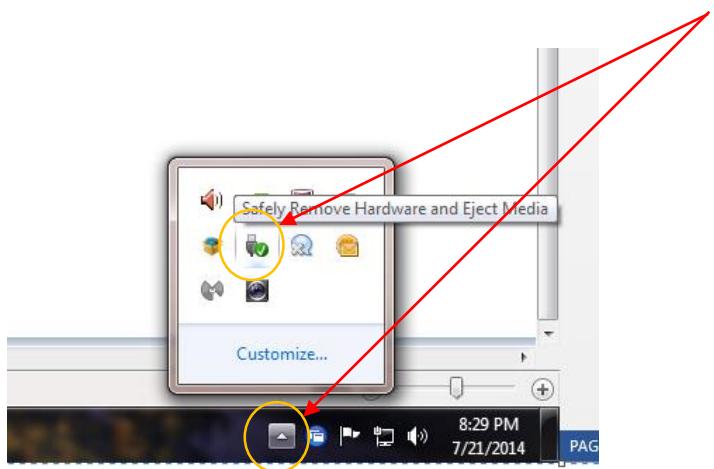


34. Remember to Eject the Removable µSD card to ensure all data was written to the card.

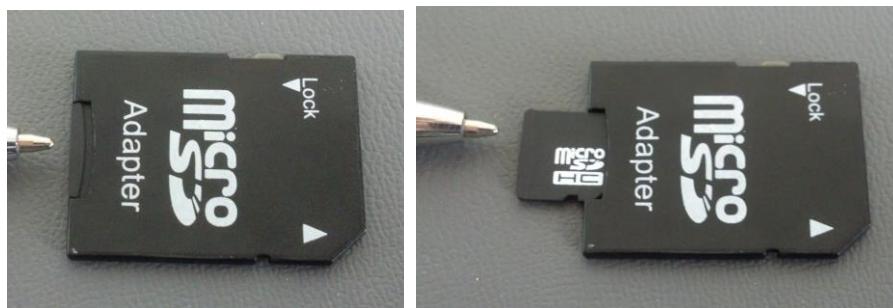


LAB Manual For 18020 EWN

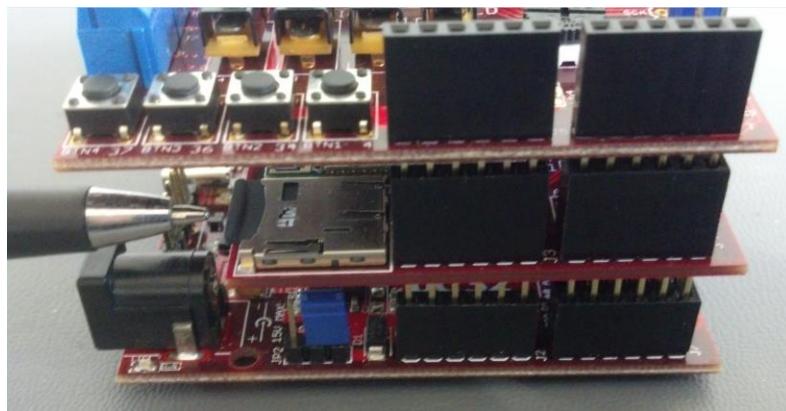
35. If you don't have an Eject menu item, then eject the hardware safely with the hardware manager.



36. Remove the Micro SD Adapter from the computer and remove the µSD card from the Micro SD Adapter.



37. Fully reinserted the µSD card into the chipKIT™ uC32 µSD reader.



LAB Manual For 18020 EWN

38. Since we modified code we will need to recompile and upload the sketch to the uC32. Remember to wait until it is done uploading.

The screenshot shows the MPIDE IDE interface with the title bar "deWebServer | Mpide 0023-windows-20140605-test". The menu bar includes File, Edit, Sketch, Tools, and Help. Below the menu is a toolbar with several icons, one of which is highlighted with a yellow circle and a red arrow pointing to it. The central area displays the "deWebServer" sketch code. At the bottom of the code editor, a message "Done uploading." is displayed, also highlighted with a yellow circle and a red arrow. The status bar at the bottom right shows "chipKIT uC32 on COM46".

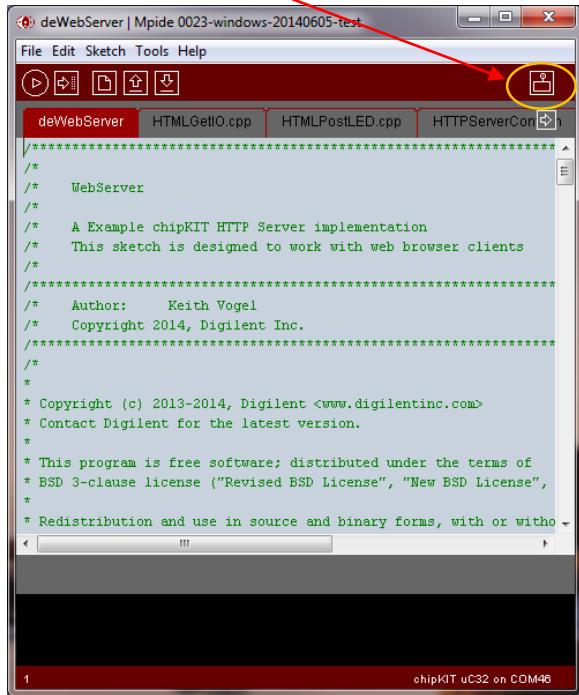
```
deWebServer | Mpide 0023-windows-20140605-test
File Edit Sketch Tools Help
[Upload] [Save] [Open] [New] [Close]
deWebServer HTMLGetIO.cpp HTMLPostLED.cpp HTTPServerConfig.h IOConfig.h
***** WebServer *****
/*
 * A Example chipKIT HTTP Server implementation
 * This sketch is designed to work with web browser clients
 */
/*
 * Author: Keith Vogel
 * Copyright 2014, Digilent Inc.
 */
/*
 * Copyright (c) 2013-2014, Digilent <www.digilentinc.com>
 * Contact Digilent for the latest version.
 *
 * This program is free software; distributed under the terms of
 * BSD 3-clause license ("Revised BSD License", "New BSD License", or "Modified BSD License")
 *
 * Redistribution and use in source and binary forms, with or without modification,
 * are permitted provided that the following conditions are met:
 */
Done uploading.

Binary sketch size: 122652 bytes (of a 520192 byte maximum)

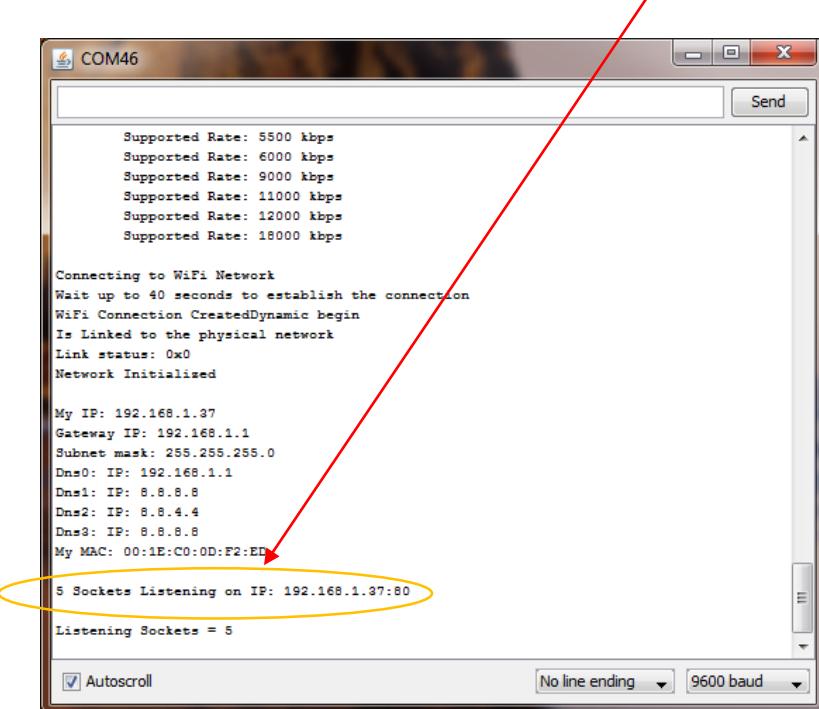
1 chipKIT uC32 on COM46
```

LAB Manual For 18020 EWN

39. Restart the Serial Monitor.

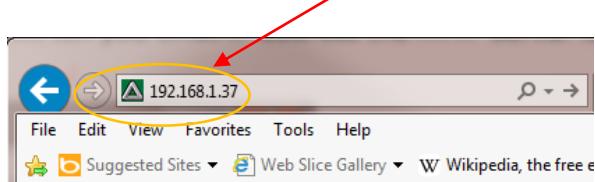


40. You should see the HTTP Server start as before, wait for the IP address so you know what to type into the browser address line; it should be the same address as before but does not have to be.



LAB Manual For 18020 EWN

41. Start Internet Explorer and type in the IP Address in the Address line and enter.



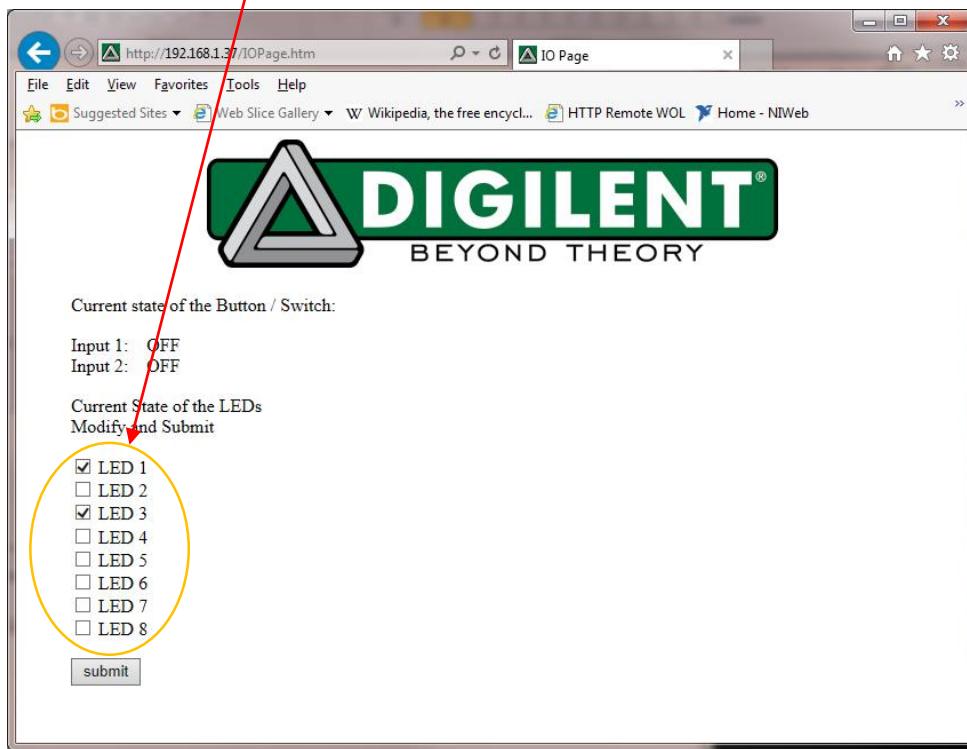
42. Internet Explorer should load the HomePage.htm as before.



Click on the “Posting a Form” link to get to your updated IOPage.htm.

LAB Manual For 18020 EWN

43. Now you should see 8 LED entries instead of 3.



Change the state of the LEDs and hit submit. See how the uC32 LEDs respond.

44. You have modified a dynamic HTML page.

END LAB 3