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SiWG917 Wi-Fi HTTP Server

Martin Looker (Silicon Labs)

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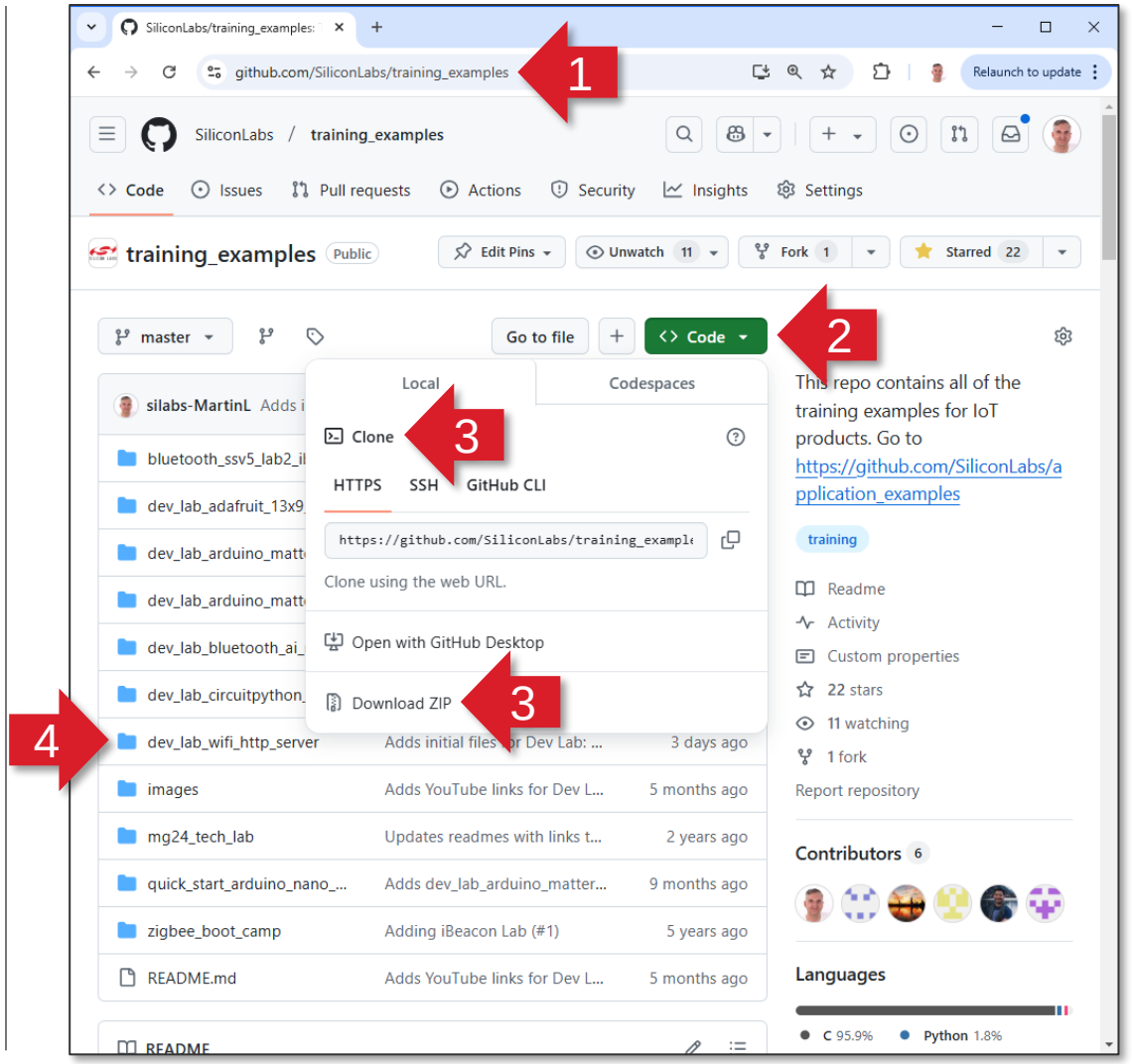
v1.3

In this workshop:

- Connect and setup SiWG917 boards in the Simplicity Studio v5 IDE
- Create, build and run the Wi-Fi HTTP Server example application
- Adapt the Wi-Fi HTTP Server application to display button states in a browser
- How to use software APIs to construct Wi-Fi applications for the SiWG917

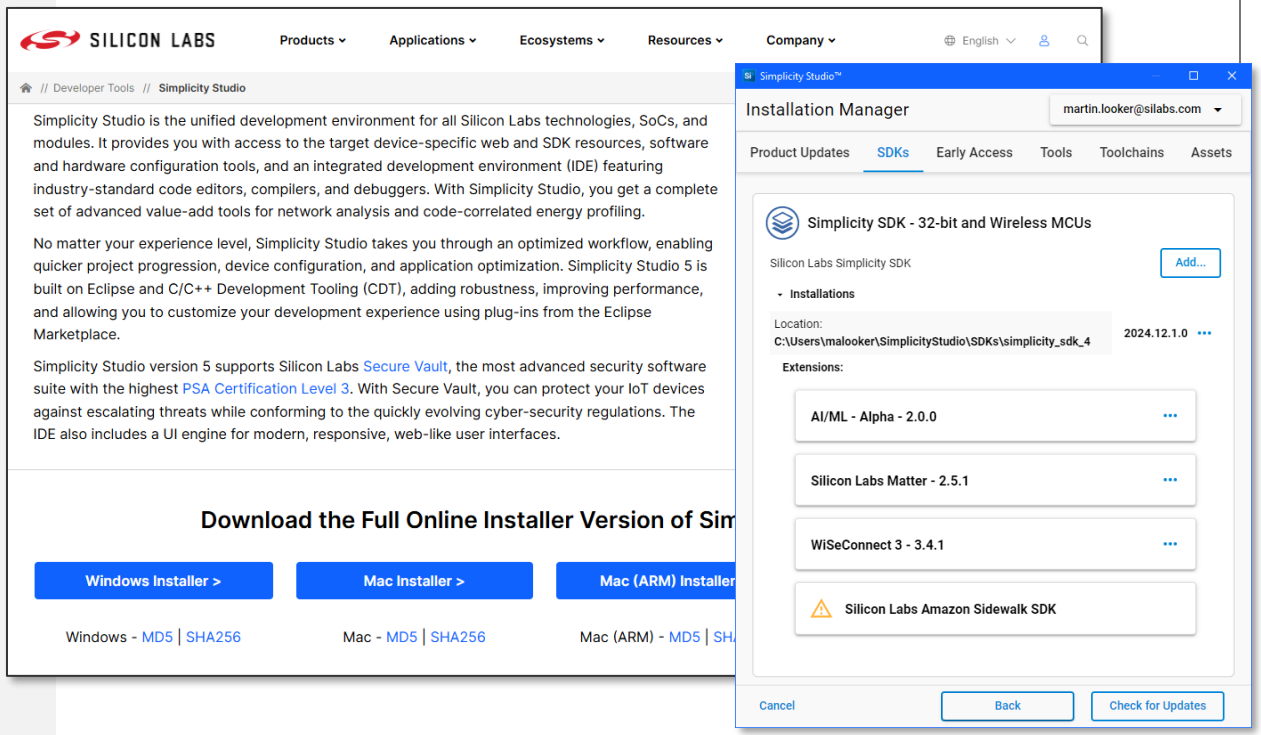
GitHub Silicon Labs Training Examples

- The Silicon Labs Training Examples repository on GitHub contains source files for training workshops and videos
- To download source files for this workshop:
  1. Visit the Silicon Labs Training Examples repository on GitHub https://github.com/SiliconLabs/training_examples
  2. From the Code dropdown
  3. Clone the repository with your favorite Git client
     or
     Click the Download ZIP option (unzip the files on the local PC)
  4. Source files for this workshop are located in the dev_lab_wifi_http_server/source folder
  5. A PDF version of this presentation is in the dev_lab_wifi_http_server/presentation folder

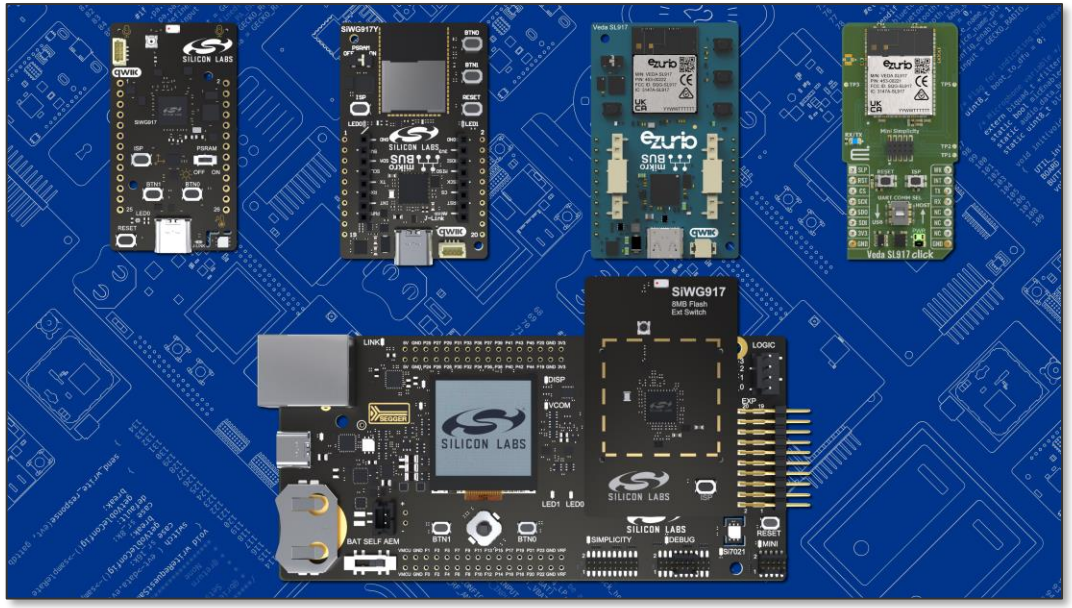


Prerequisites

- Simplicity Studio v5 installed:
  - Download from: https://www.silabs.com/developers/simplicity-studio
  - Ensure the Simplicity SDK is installed including WiSeConnect 3.4.1 or later
- TeraTerm or similar serial terminal application



- SiWG917 Wi-Fi kits and boards
  - Silicon Labs Dev Kit
  - Silicon Labs Explorer Kit
  - Ezurio SL917 Veda Explorer Kit
  - Ezurio SL917 Click
  - Silicon Labs Pro Kit
  - More information at https://www.silabs.com/wireless/wi-fi?tab=kits



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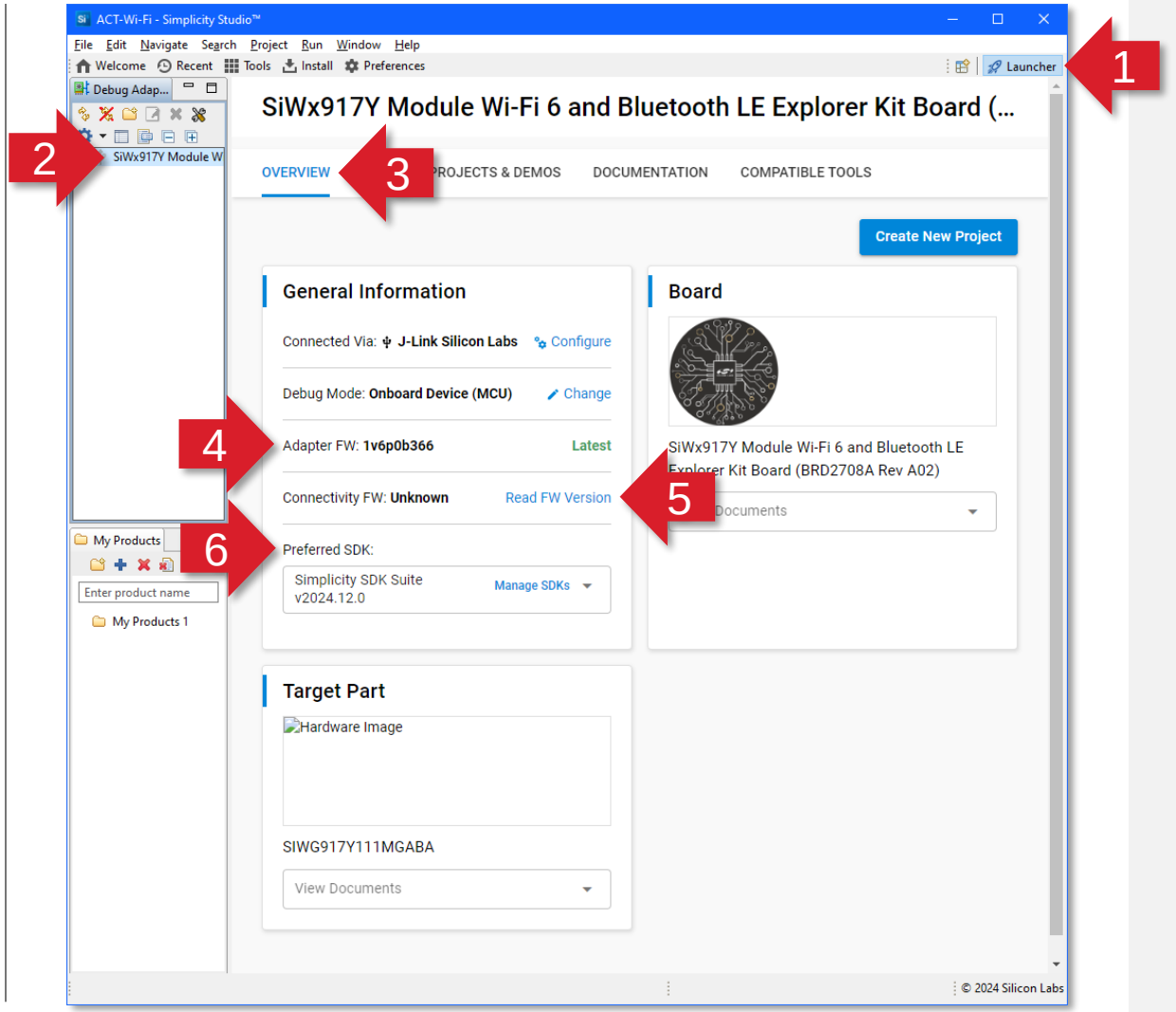
HTTP Server Project

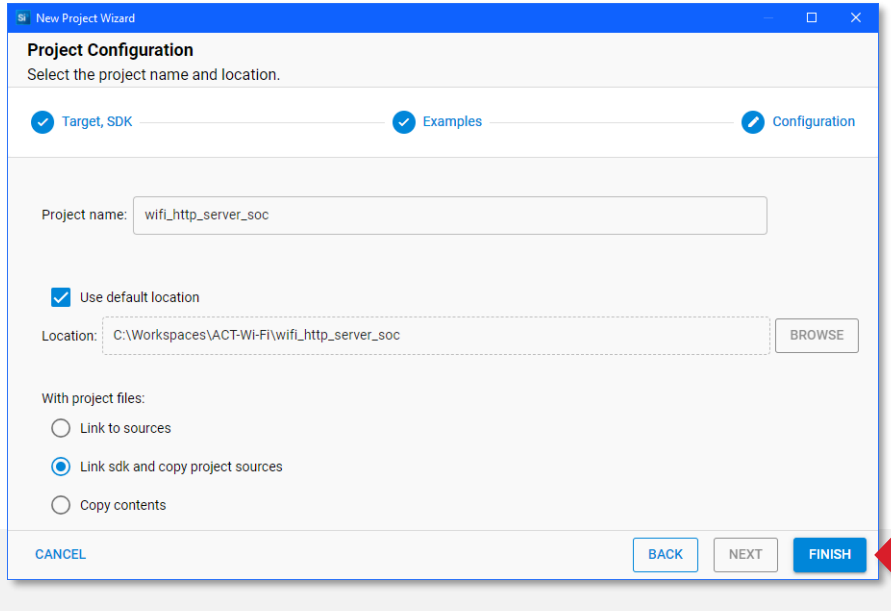
Connect and Update Board

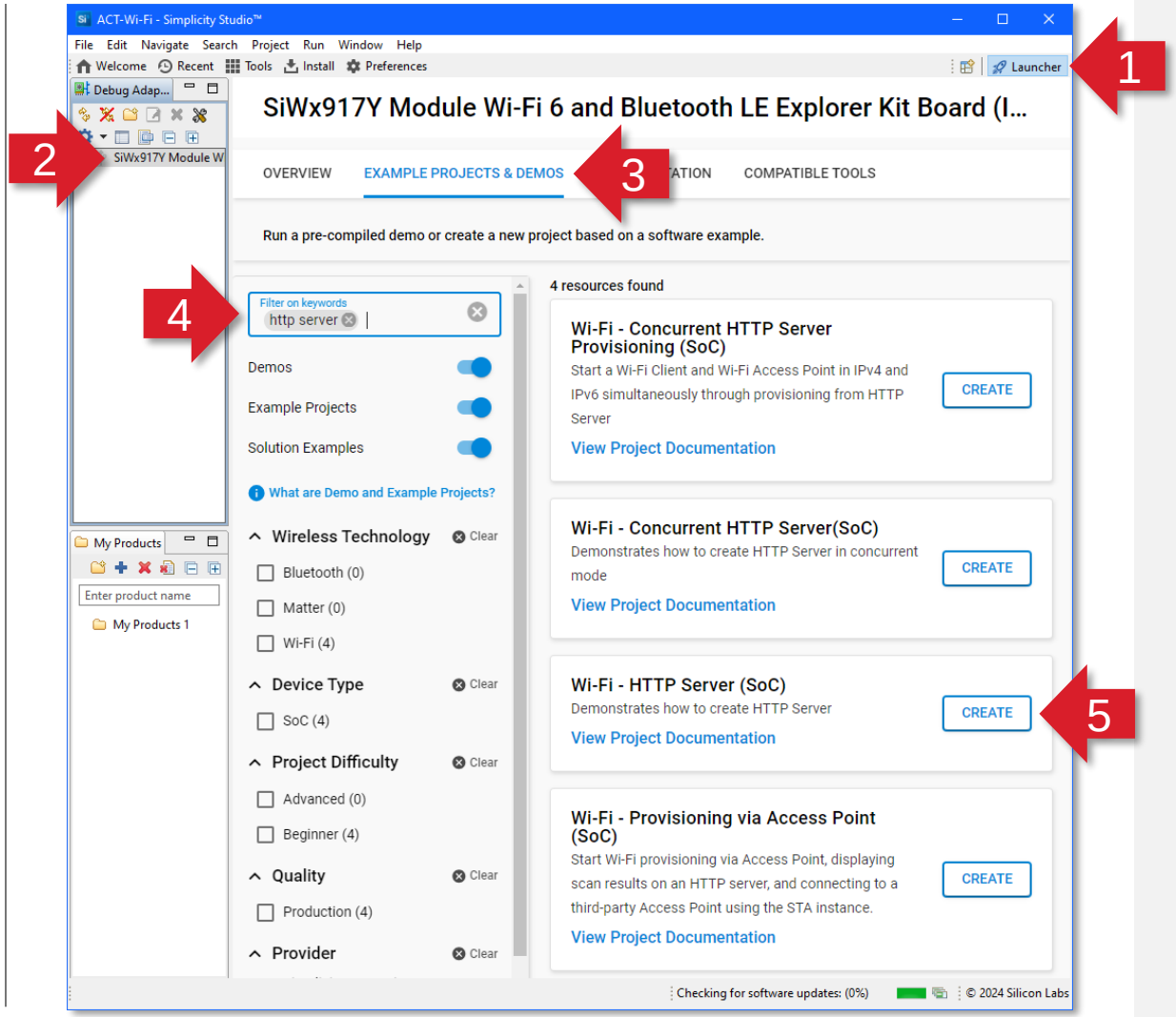
- To connect and update board firmware:
  1. Go to the Launcher perspective
  2. Connect the board using USB and select in the Debug Adapters panel
  3. Make sure the Overview page is selected
  4. In the General Information box, update Adapter FW if the latest is not installed
  5. Read the Connectivity FW version and update if the latest is not installed
  6. Check the Preferred SDK is set to Simplicity SDK Suite



Create Example Application

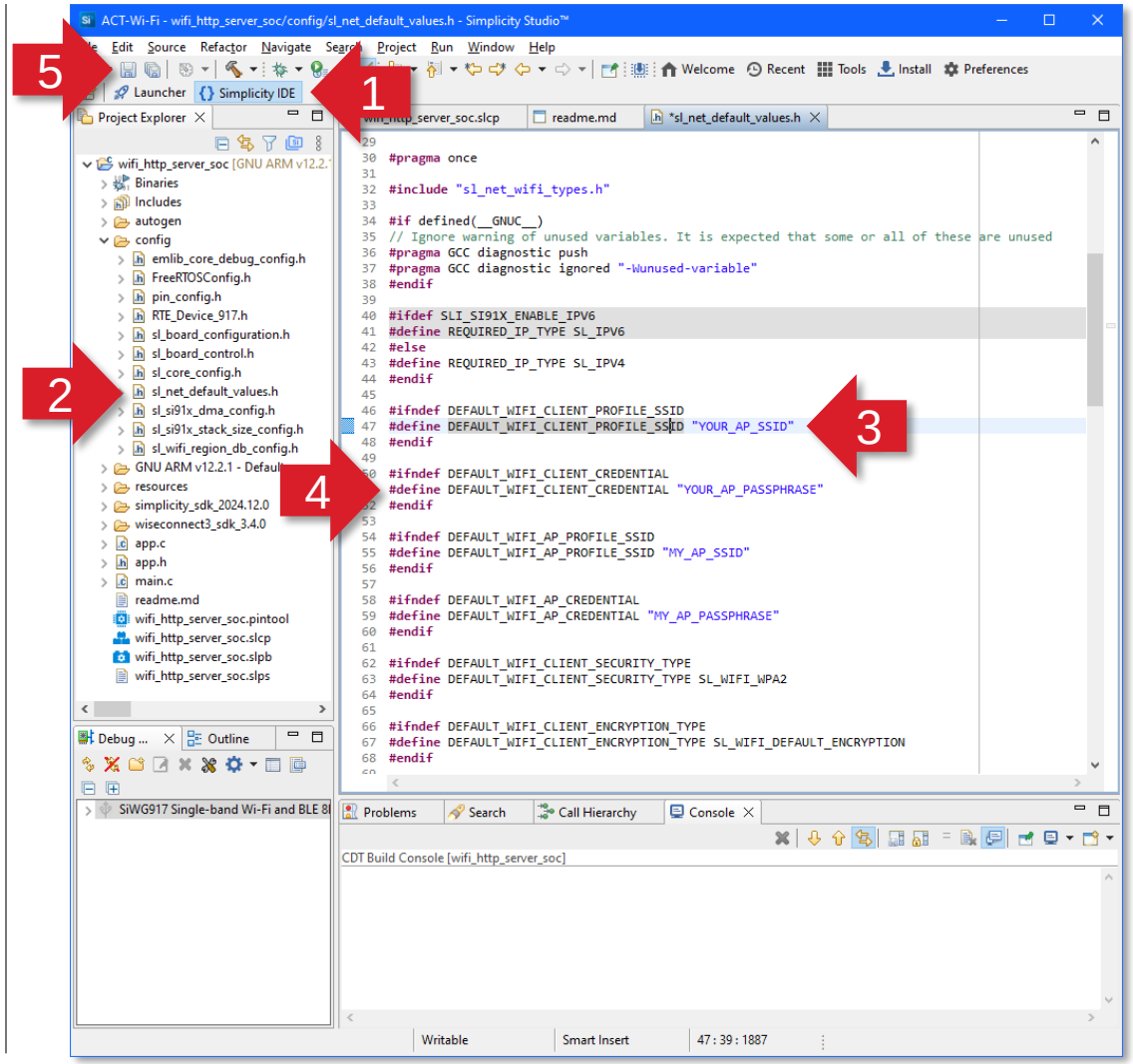
- To create the example application:
  1. Go to the Launcher perspective
  2. Make sure the board is selected in the Debug Adapters panel
  3. Select the Example Projects & Demos page is selected
  4. Enter HTTP Server into the filter editbox
  5. In the Wi-Fi – HTTP Server (SoC) box, click the Create button
  6. In the New Project Wizard window, click the Finish button





Configure Wi-Fi Access Point

- To configure the Wi-Fi access point credentials:
  1. Make sure the Simplicity IDE perspective is selected
  2. In the Project Explorer panel, open the config/sl_net_default_values.h file
  3. Update the DEFAULT_WIFI_CLIENT_PROFILE_SSID define with the SSID of the Wi-Fi network to join
  4. Update the DEFAULT_WIFI_CLIENT_CREDENTIAL define with the password of the Wi-Fi network to join
  5. Save the changes to the file



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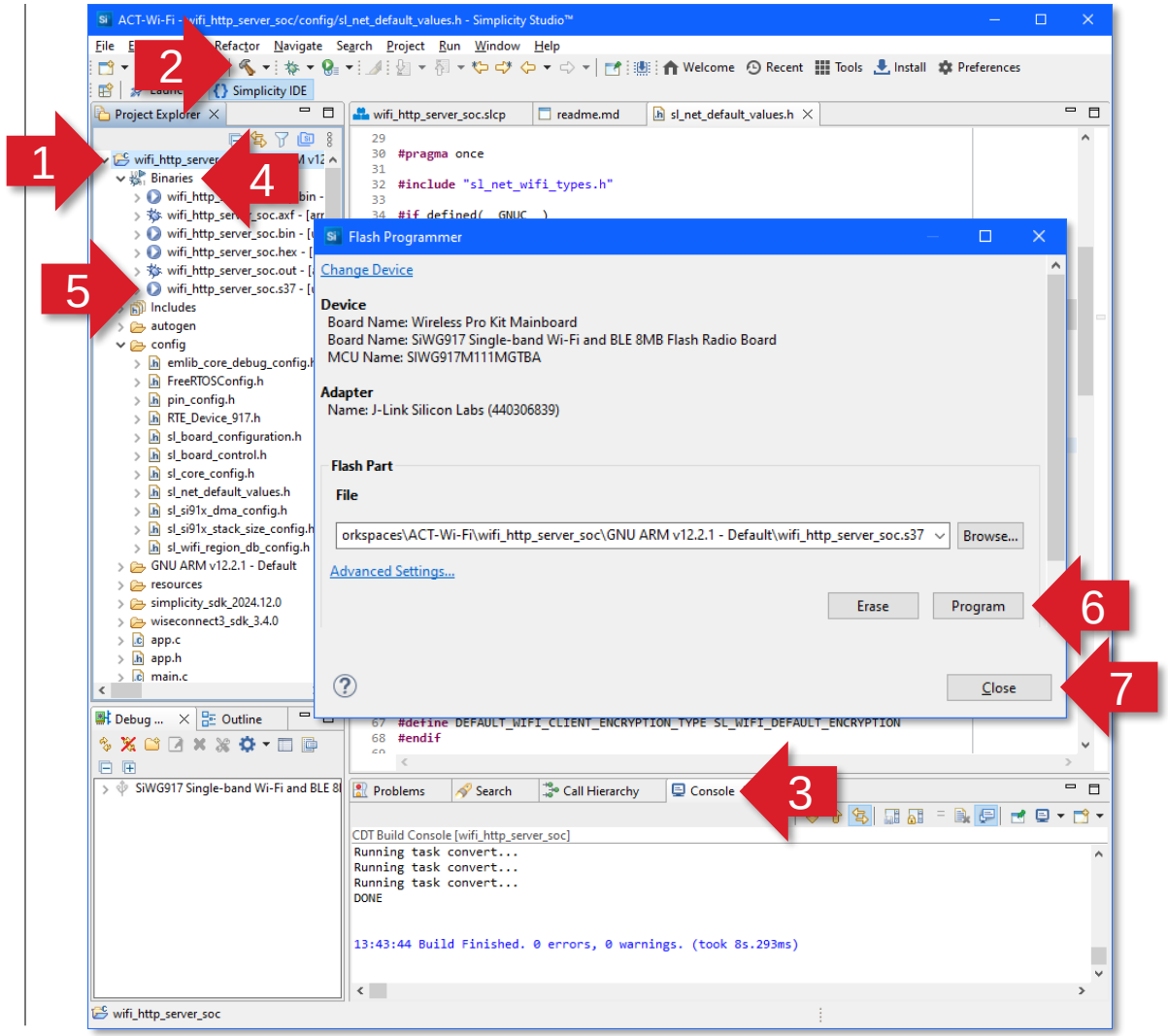
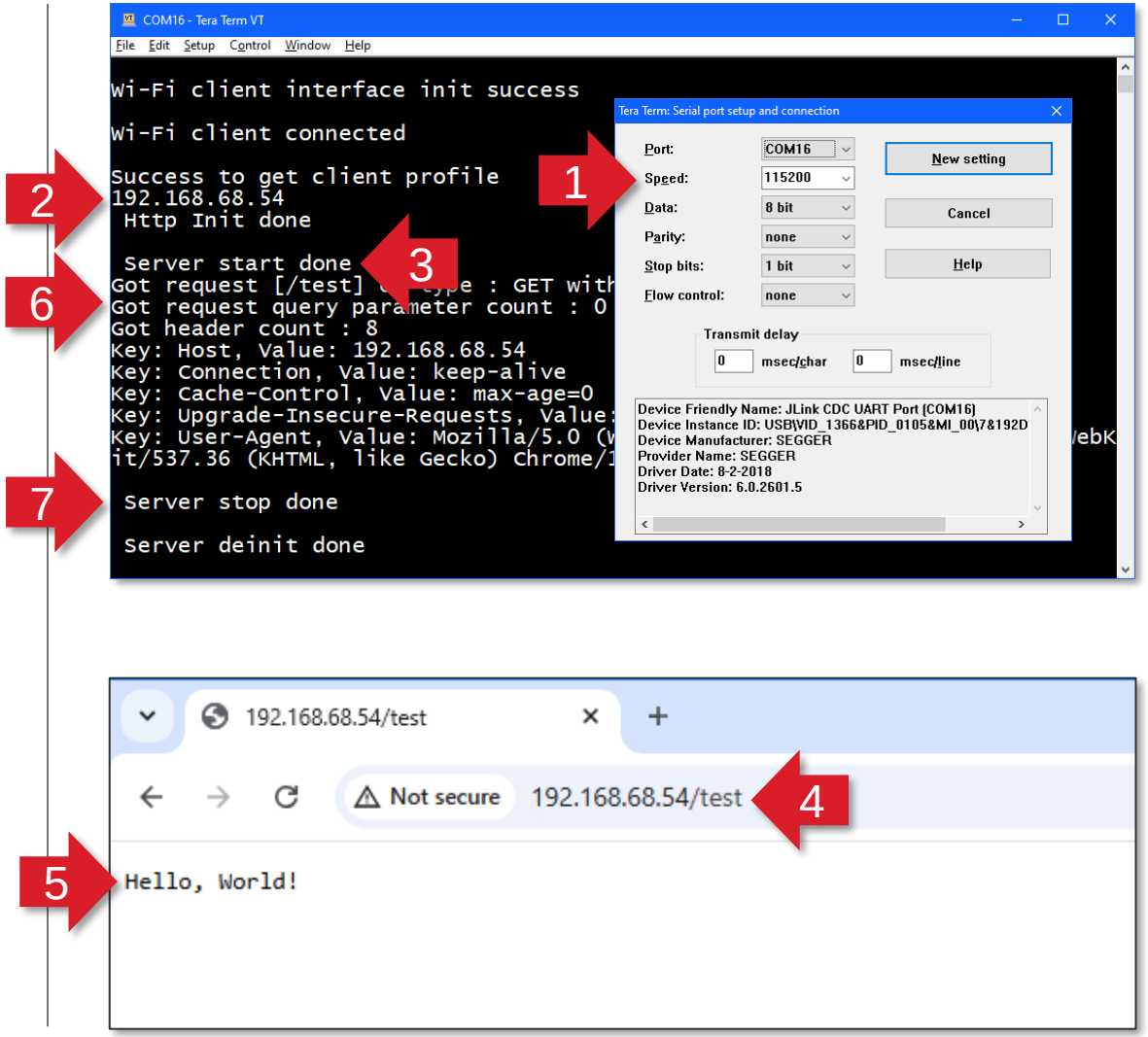
Compile and Flash

- To compile the software:
  1. In the Project Explorer panel, select the top-level project
  2. Click the Build (hammer) button on the toolbar
  3. Compilation progress is shown in the Console panel
- To flash the software:
  4. In the Project Explorer panel, open the Binaries folder
  5. Locate the .s37 file, right click and select Flash to device…
  6. In the Flash Programmer window, click the Program button
  7. When complete, click the Close button



Operation

- To operate the HTTP Server:
  1. Connect a serial terminal to the board using: 115200 baud, 8 data bits, no parity, 1 stop bit, no flow control
  2. Reset the board, when the device joins the network its IP address will be output to the terminal
  3. Server start done will be output when the HTTP server is running
  4. In a web browser enter the IP address followed by /test
  5. Hello, World! Will be displayed in the browser window
  6. Data on the HTTP request is displayed in the serial terminal
  7. After serving the request, the HTTP server is stopped and deinitialised
  8. If the browser is refreshed, connection refused will be returned as the server is no longer running (not shown)



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HTTP Server Review

Application Startup

- The application code is structured around FreeRTOS with the application parts of the code in app.c:
- The app_init() function is called at startup from main.c
- The app_init() function creates a new thread that runs in the application_start() function

```
335 void app_init(const void *unused)
336 {
337   UNUSED_PARAMETER(unused);
338   osThreadNew((osThreadFunc_t)application_start, NULL, &thread_attributes);
339 }
340
341 static void application_start(void *argument)
342 {
```

Wi-Fi Startup

- The application_start() function handles the setup and joining of the Wi-Fi network:
- The sl_net_init() function initializes the network interface
  - The interface is initialized as a client device
  - The Wi-Fi configuration passed in using a sl_wifi_device_configuration_t structure
  - Note, despite the variable name this configures the Wi-Fi *not* the HTTP Server
- The sl_net_up() function brings up the network interface, for a client:
  - Uses the default profile which includes the SSID and password set in the sl_net_default_values.h file
  - Scans and connects to the network specified in the profile
- The sl_net_get_profile() function reads back the profile when it has joined the network
  - The IP address is extracted from this profile and output to the serial port

```
341 static void application_start(void *argument)
342 {
343   UNUSED_PARAMETER(argument);
344   sl_status_t status                    = 0;
345   sl_http_server_config_t server_config = { 0 };
346
347   status = sl_net_init(SL_NET_WIFI_CLIENT_INTERFACE, &http_server_configuration, NULL, NULL);
348   if (status != SL_STATUS_OK) {
349     printf("\r\nFailed to start Wi-Fi Client interface: 0x%lx\r\n", status);
350     return;
351   }
352   printf("\r\nWi-Fi client interface init success\r\n");
353
354   status = sl_net_up(SL_NET_WIFI_CLIENT_INTERFACE, SL_NET_DEFAULT_WIFI_CLIENT_PROFILE_ID);
355   if (status != SL_STATUS_OK) {
356     printf("\r\nFailed to bring Wi-Fi client interface up: 0x%lX\r\n", status);
357     return;
358   }
359   printf("\r\nWi-Fi client connected\r\n");
360
361   status = sl_net_get_profile(SL_NET_WIFI_CLIENT_INTERFACE, SL_NET_DEFAULT_WIFI_CLIENT_PROFILE_
362   if (status != SL_STATUS_OK) {
363     printf("Failed to get client profile: 0x%lx\r\n", status);
364     return;
365   }
366   printf("\r\nSuccess to get client profile\r\n");
367
368   ip_address.type = SL_IPV4;
369   memcpy(&ip_address.ip.v4.bytes, &profile.ip.ip.v4.ip_address.bytes, sizeof(sl_ipv4_address_t)
370   print_sl_ip_address(&ip_address);
```

HTTP Server Startup

- Near the start of app.c, an array of sl_http_server_handler_t structures are initialized:
  - Each element pairs a URI with a function to be called when the URI is requested
  - The /test URI causes the buffered_request_handler() function to be called
- The application_start() function also starts the HTTP Server:
  - A sl_http_server_config_t structure is initialized with settings for the HTTP Server, including the request handlers
  - The sl_http_server_init() function initializes the server using the configuration structure
  - The sl_http_server_start() function begins running the server
  - The thread is kept in a loop while the is_server_running variable is true

```
101 static sl_http_server_handler_t request_handlers[4] =
102     { { .uri = "/test",      .handler = buffered_request_handler },
103       { .uri = "/data",      .handler = large_data_handler },
104       { .uri = "/cert1.pem", .handler = large_response_handler },
105       { .uri = "/cert2.pem", .handler = chunked_large_response_handler } };
```

```
372   server_config.port            = HTTP_SERVER_PORT;
373   server_config.default_handler  = NULL;
374   server_config.handlers_list    = request_handlers;
375   server_config.handlers_count   = 4;
376   server_config.client_idle_time = 1;
377
378   status = sl_http_server_init(&server_handle, &server_config);
379   if (status != SL_STATUS_OK) {
380     printf("\r\nHTTP server init failed:%lx\r\n", status);
381     return;
382   }
383   printf("\r\n Http Init done\r\n");
384
385   status = sl_http_server_start(&server_handle);
386   if (status != SL_STATUS_OK) {
387     printf("\r\n Server start fail:%lx\r\n", status);
388     return;
389   }
390   printf("\r\n Server start done\r\n");
391
392   is_server_running = true;
393   while (is_server_running) {
394     osDelay(100);
395   }
```

HTTP Request Handler (1)

- The buffered_request_handler() function is called when the /test URI is requested:
- Local variables are initialized including:
  - http_response for the response data
  - header for the response header
- The next part of the function outputs data in the HTTP request to the serial port

```
238 sl_status_t buffered_request_handler(sl_http_server_t *handle, sl_http_server_request_t *req)
239 {
240   sl_http_recv_req_data_t recvData        = { 0 };
241   sl_http_server_response_t http_response = { 0 };
242   sl_http_header_t request_headers[5]     = { 0 };
243   sl_http_header_t header                 = { .key = "Server", .value = "SI917-HTTPServer" };
244
245   printf("Got request [%s] of type : %s with data length : %lu\n",
246          req->uri.path,
247          request_type[req->type],
248          req->request_data_length);
249   if (req->request_data_length > 0) {
250     recvData.request       = req;
251     recvData.buffer        = (uint8_t *)response;
252     recvData.buffer_length = 1024;
253
254     sl_http_server_read_request_data(handle, &recvData);
255     response[recvData.received_data_length] = 0;
256     printf("Got request data as : %s\n", response);
257   }
258
259   printf("Got request query parameter count : %u\n", req->uri.query_parameter_count);
260   if (req->uri.query_parameter_count > 0) {
261     for (int i = 0; i < req->uri.query_parameter_count; i++) {
262       printf("query: %s, value: %s\n", req->uri.query_parameters[i].query, req->uri.query_param
263     }
264   }
265
266   printf("Got header count : %u\n", req->request_header_count);
267   sl_http_server_get_request_headers(handle, req, request_headers, 5);
268
269   int length = (req->request_header_count > 5) ? 5 : req->request_header_count;
270   for (int i = 0; i < length; i++) {
271     printf("Key: %s, Value: %s\n", request_headers[i].key, request_headers[i].value);
272   }
```

HTTP Request Handler (2)

- The final part of the buffered_request_handler() function constructs and sends the response:
- The response code is set to OK
- The content type is set to plain text
- The headers are added
- The response data is set to “Hello, World!” and data lengths set appropriately
- The sl_http_server_send_response() function is then used to transmit the HTTP response
- Finally, the is_server_running variable is set to false
  - This allows the loop in the application_start() function to end

```
274   // Set the response code to 200 (OK)
275   http_response.response_code = SL_HTTP_RESPONSE_OK;
276
277   // Set the content type to plain text
278   http_response.content_type = SL_HTTP_CONTENT_TYPE_TEXT_PLAIN;
279   http_response.headers      = &header;
280   http_response.header_count = 1;
281
282   // Set the response data to "Hello, World!"
283   char *response_data               = "Hello, World!";
284   http_response.data                = (uint8_t *)response_data;
285   http_response.current_data_length  = strlen(response_data);
286   http_response.expected_data_length = http_response.current_data_length;
287   sl_http_server_send_response(handle, &http_response);
288   is_server_running = false;
289   return SL_STATUS_OK;
290 }
```

HTTP Server Shutdown

- When the while loop exits in the application_start() function:
  - The sl_http_server_stop() function is called to stop the server
  - The sl_http_server_deinit() is called to deinitialize the server

```
392   is_server_running = true;
393   while (is_server_running) {
394     osDelay(100);
395   }
396
397   status = sl_http_server_stop(&server_handle);
398   if (status != SL_STATUS_OK) {
399     printf("\r\n Server stop fail:%lx\r\n", status);
400     return;
401   }
402   printf("\r\n Server stop done\r\n");
403
404   status = sl_http_server_deinit(&server_handle);
405   if (status != SL_STATUS_OK) {
406     printf("\r\n Server deinit fail:%lx\r\n", status);
407     return;
408   }
409   printf("\r\n Server deinit done\r\n");
410 }
```

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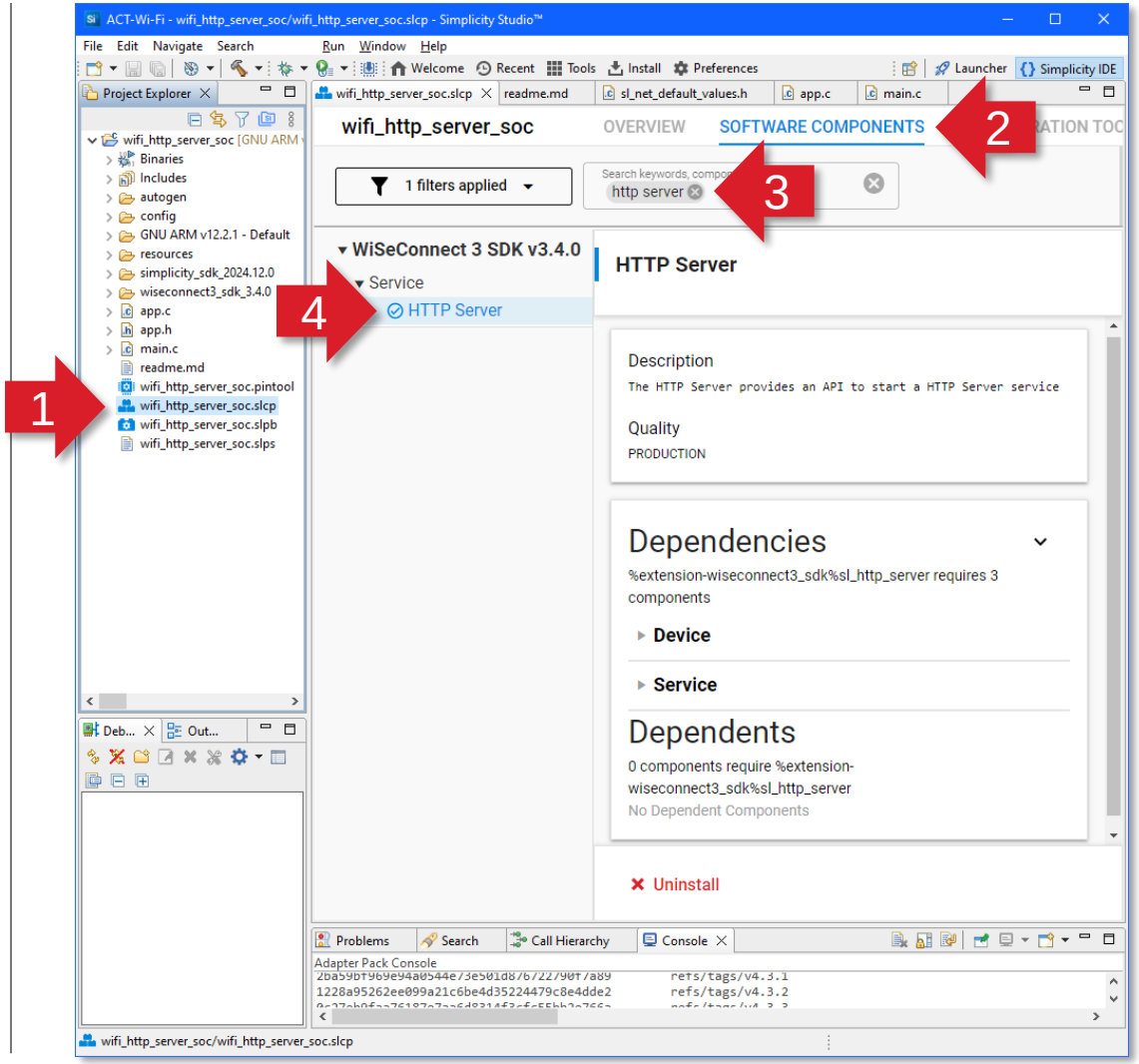
HTTP Server Project Enhancements

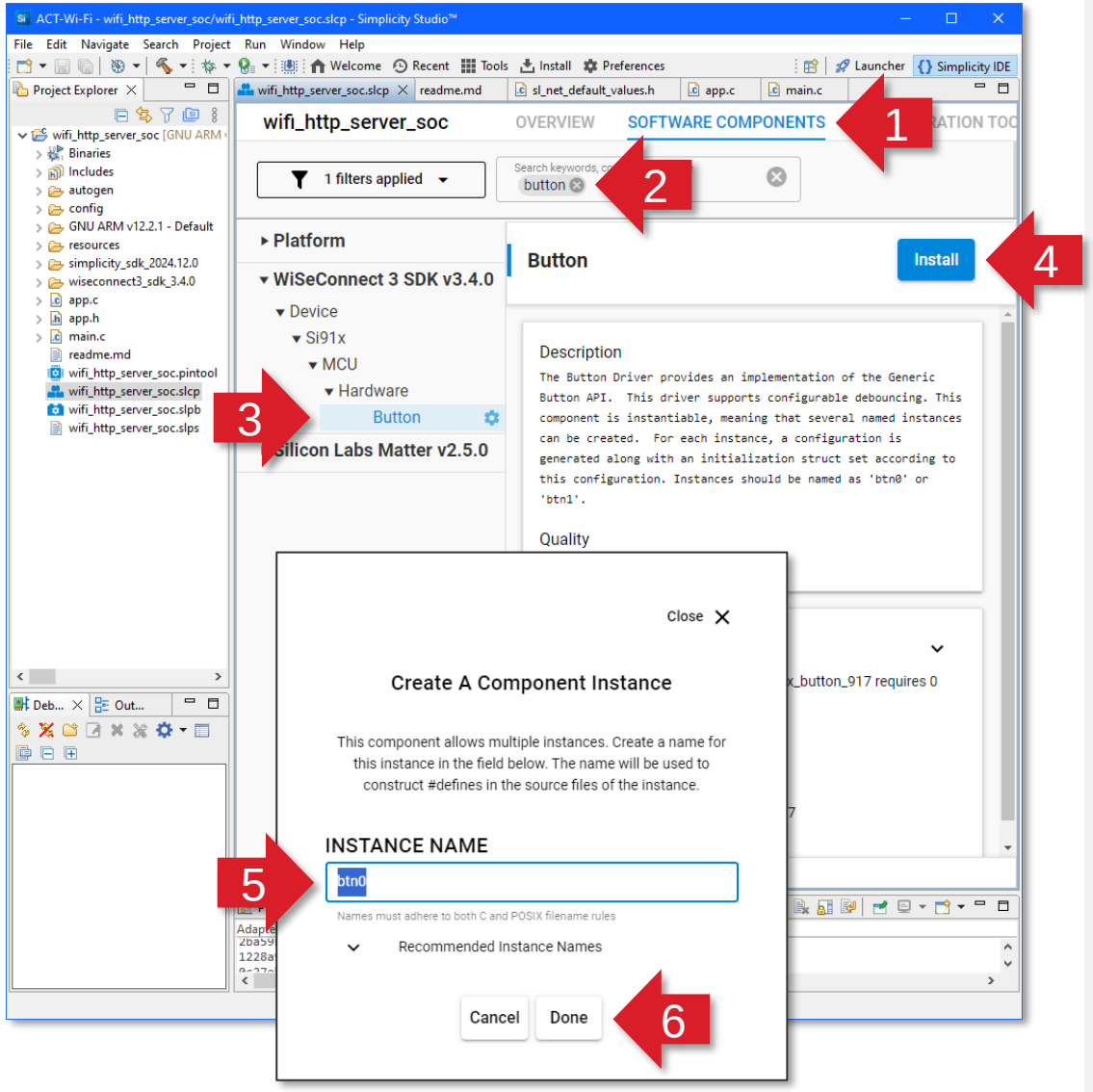
HTTP Server Software Component

- Software Components are a convenient way to add functionality to a project
- The HTTP Server Software Component is pre-installed in the example project
  - This provides the structures and functions used to operate the HTTP Server
- To view it:
  1. Open the .slcp file in the main project
  2. Go to the Software Components page
  3. Search for HTTP Server
  4. This component is already installed in the example project, as indicated by the tickbox
- The .slcp file also provides other options to manage the project and access relevant tools



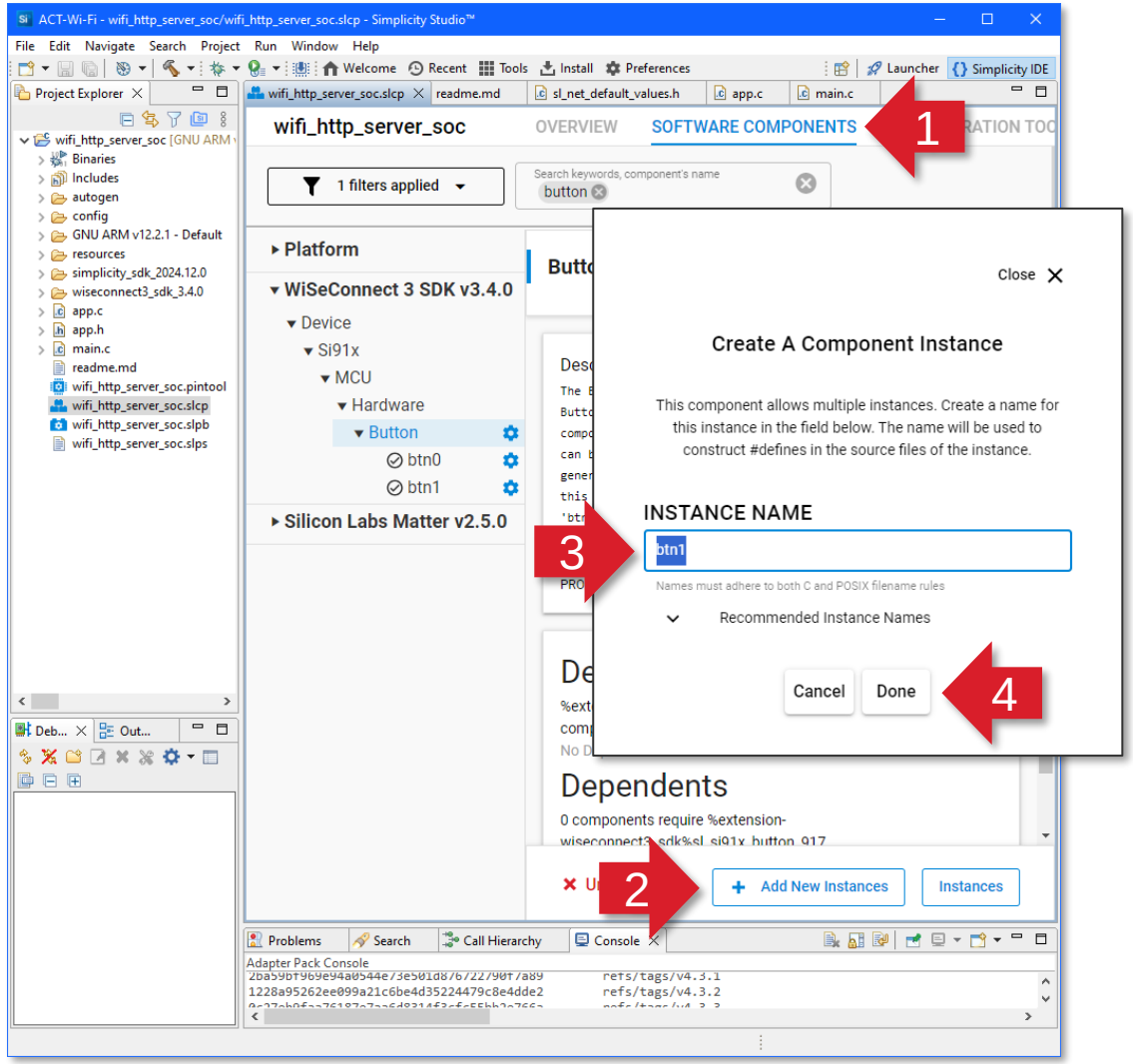
Button 0 Software Component

- We will add Software Components for the buttons we want to monitor:
  1. Make sure you are on the Software Components page
  2. Search for Button
  3. In the tree on the left, unfold: WiSeConnect 3 SDK > Device > Si91x > MCU > Hardware > Button
  4. Click the Install button
  5. In the Create a Component Instance window check the instance name is set to btn0
  6. Click the Done button
- This adds the button APIs to the project and also code to use it with Button 0 on the board with the correct pin configuration



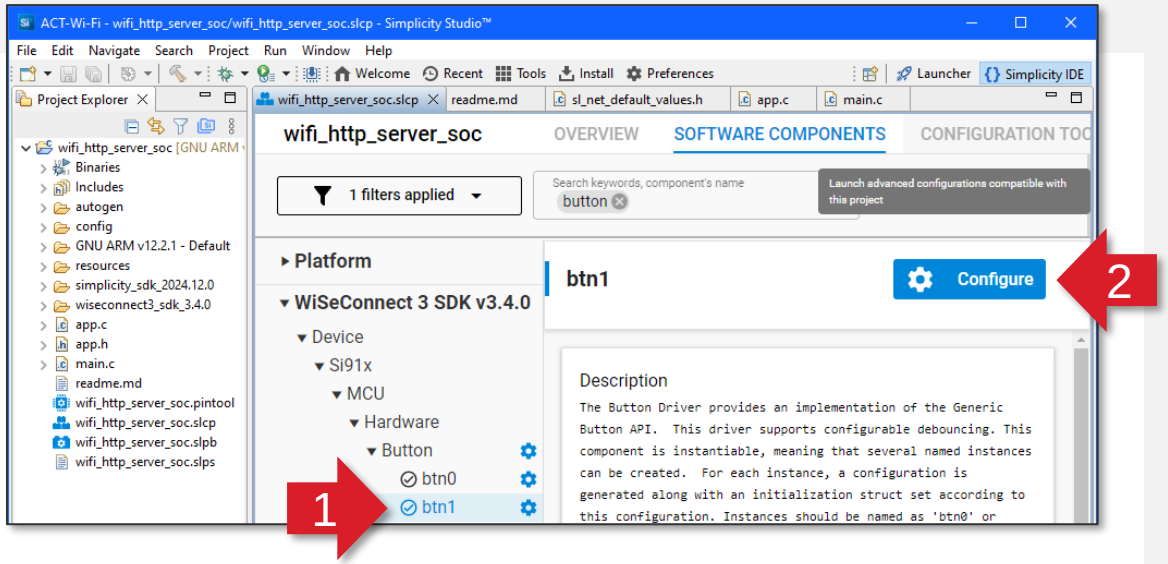
Button 1 Software Component

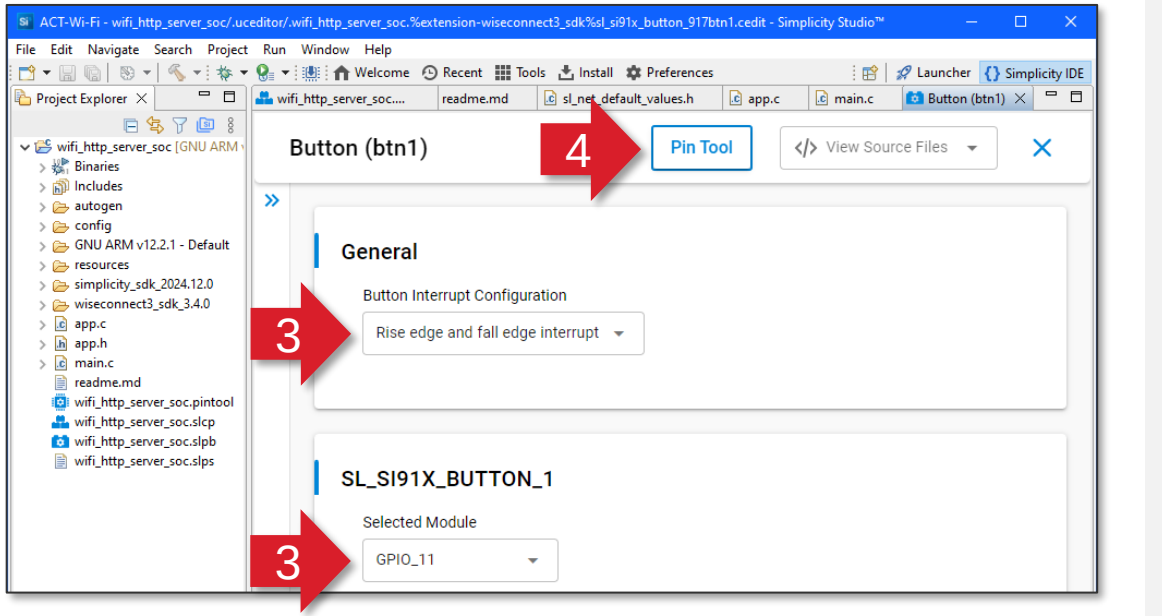
- To add the instance for Button 1:
  1. Make sure you are on the Software Components page
  2. Click the Add New Instances button
  3. In the Create a Component Instance window check the instance name is set to btn1
  4. Click the Done button

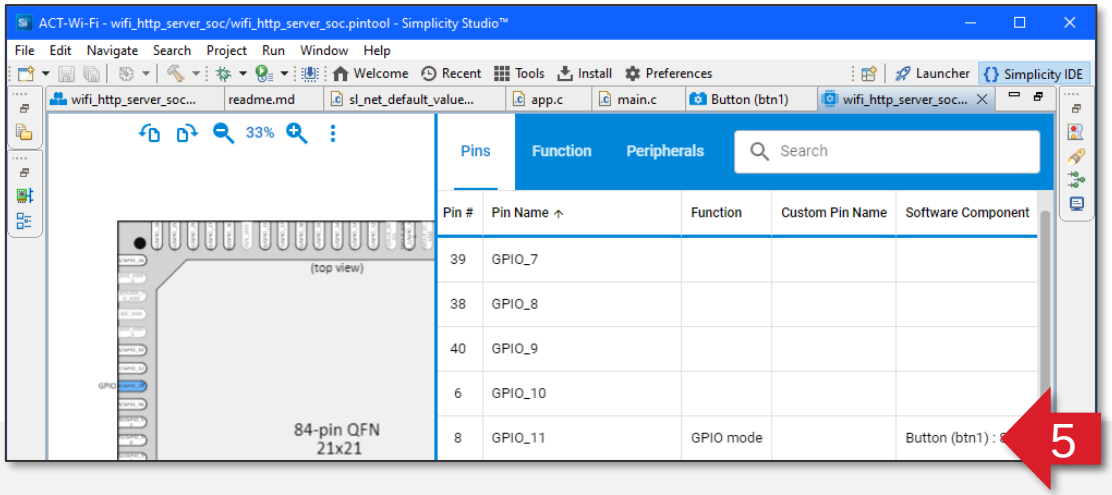


Button Configuration

- We used recommended instance names which are pre-mapped onto the GPIO for the buttons on the board
- We can view this configuration:
  1. Click one of the instances under Button in the treeview
  2. Click the Configure button
  3. The Interrupt Configuration and assigned GPIO pin can be viewed and edited in this window
  4. Click the Pin Tool button
  5. This tool shows the low-level assignment of pins to peripherals including the GPIO assignment for the Button instance

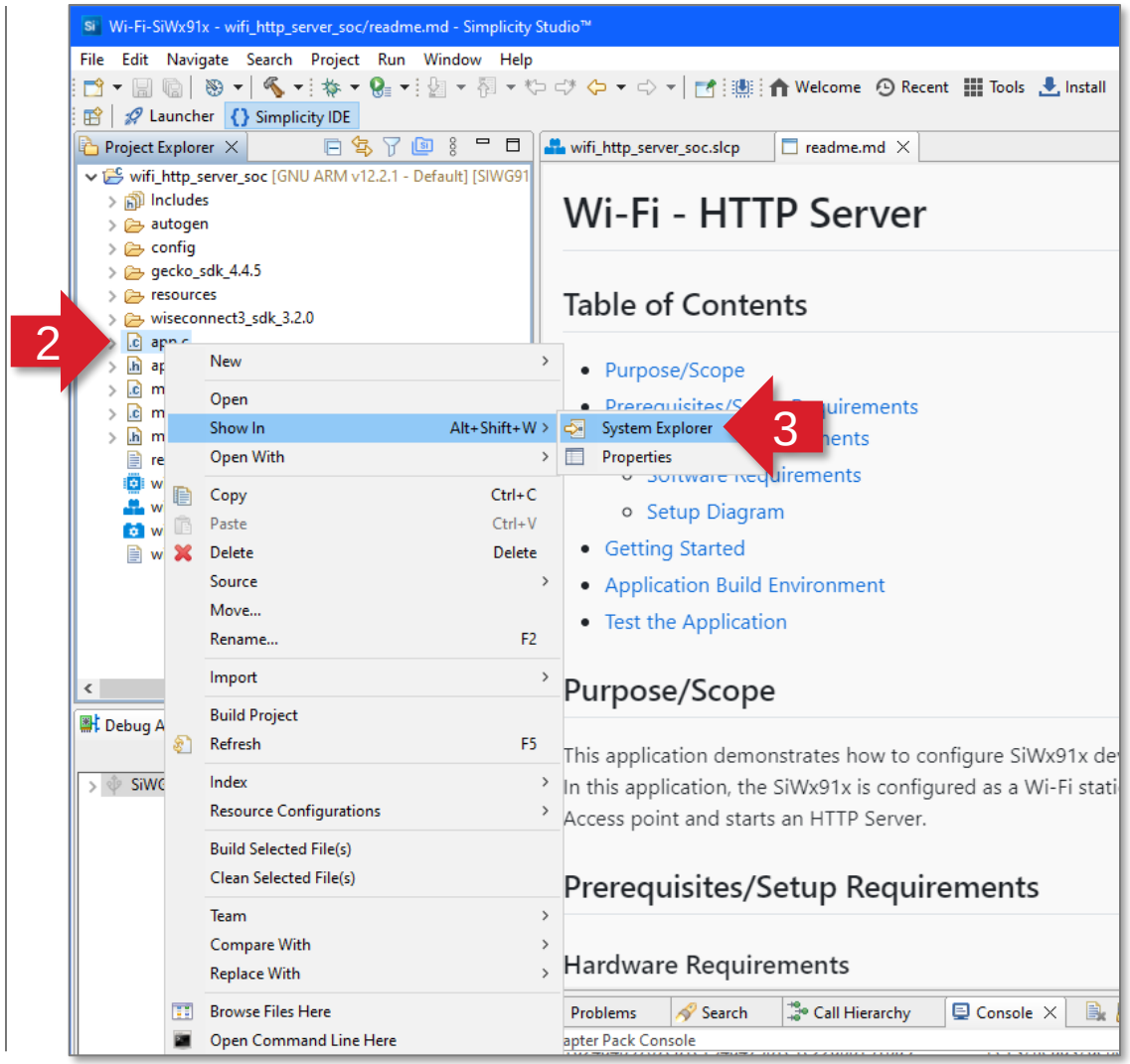






Update app.c

- To update app.c in the project folder:
  1. Locate the app.c file downloaded from GitHub (located in the dev_lab_wifi_http_server/source folder) and copy to the clipboard
  2. In Simplicity Studio, locate the app.c file in the Project Explorer panel
  3. Right-click and select Show in > System Explorer
  4. Paste the app.c file from the clipboard into the opened folder (replacing the existing file)



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HTTP Server Enhancements Review

app.c – Includes, Defines and Global Variables

- New includes, defines and global variables are added to app.c:
- Includes to access the button APIs
- An APP_VERSION define
- A HTML_RESPONSE define containing a formatting string for the HTML response:
  1. The meta tag contains browser instructions to request a refresh every 5 seconds
  2. Tokens are in place to include the seconds the application has been running and states of button 0 and button 1
- A HTML_RESPONSE define with a maximum size for the HTML response buffer
- Global variables for:
  - Number of seconds the application has been running
  - States for buttons
  - A buffer in which to build the HTML response

```
43 #include "sl_si91x_button.h"
44 #include "sl_si91x_button_pin_config.h"
45 #include "sl_si91x_button_instances.h"
```

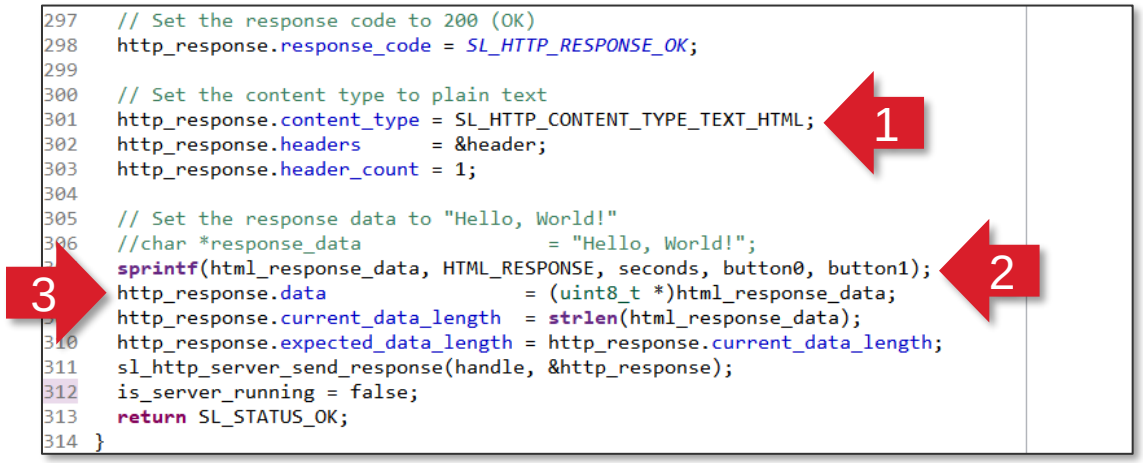
```
47 /*******************************************************
48  *                      Macros
49  ******************************************************/
50 #define APP_VERSION "v0.0.6"
```

```
52 #define HTML_RESPONSE "<!DOCTYPE html>\r\n" \
53   "<html>\r\n" \
54   "  <head>\r\n" \
55   "    <title>SiWG917 HTTP Server</title>\r\n" \
56   "    <meta http-equiv=\"refresh\" content=\"5\">" \
57   "  </head>\r\n" \
58   "  <body>\r\n" \
59   "    <p>SiWG917 HTTP Server " APP_VERSION "</p>\r\n" \
60   "    <pre>seconds = %ld</pre>\r\n" \
61   "    <pre>button0 = %d</pre>\r\n" \
62   "    <pre>button1 = %d</pre>\r\n" \
63   "  </body>\r\n" \
64   "</html>"
65 #define HTML_RESPONSE_SIZE 768
```

```
132 uint32_t seconds = 0;
133 int8_t   button0 = BUTTON_STATE_INVALID;
134 int8_t   button1 = BUTTON_STATE_INVALID;
135 char html_response_data[HTML_RESPONSE_SIZE] = "";
```

app.c – buffered_request_handler()

- Changes are made to the response generated in the buffered_request_handler() function:
  1. The content_type is changed to TEXT_HTML
  2. The current seconds, button0 and button1 states are formatted into the html_response_data buffer
  3. The html_response_data buffer is added to the response, along with an updated length



app.c – application_start()

- Changes are made to the application_start() function which runs the application's thread:
  1. A debug message, with the version number is output to the serial port
  2. The while loop is allowed to run forever
  3. In the while loop, the delay is increased to 1 second (from 100ms)
  4. The seconds, button0 and button1 variables are updated
     - For the buttons, the pins are read directly

```
367  static void application_start(void *argument)
368  {
369    UNUSED_PARAMETER(argument);
370    sl_status_t status                    = 0;
371    sl_http_server_config_t server_config = { 0 };
372
373    printf("\r\nSiWG917 HTTP Server %s\r\n", APP_VERSION);
```

1

```
    is_server_running = true;
    while (1) {
      osDelay(1000);
      seconds++;
      button0 = sl_si91x_button_pin_state(SL_BUTTON_BTN0_PIN);
      button1 = sl_si91x_button_pin_state(SL_BUTTON_BTN1_PIN);
    }
```

2 3 4

HTTP Server Enhancements Operation

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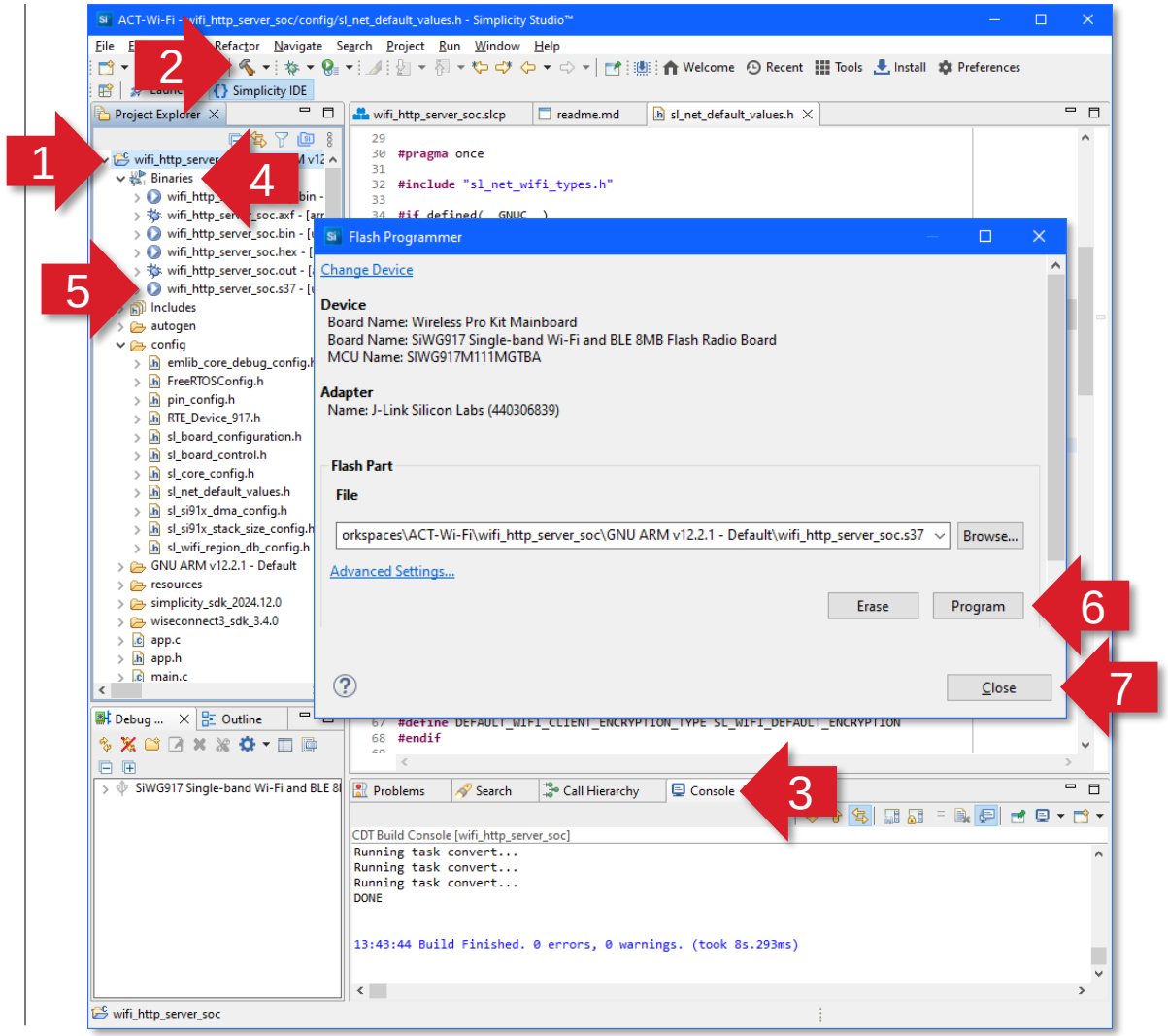
  7. When complete, click the Close button



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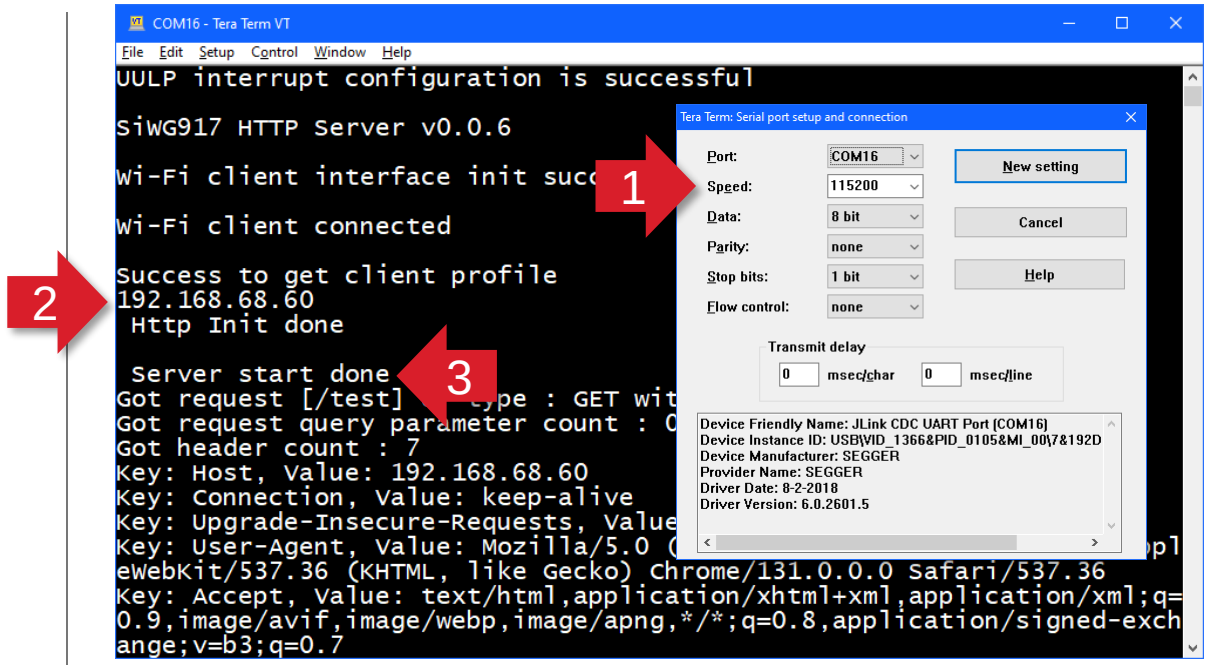
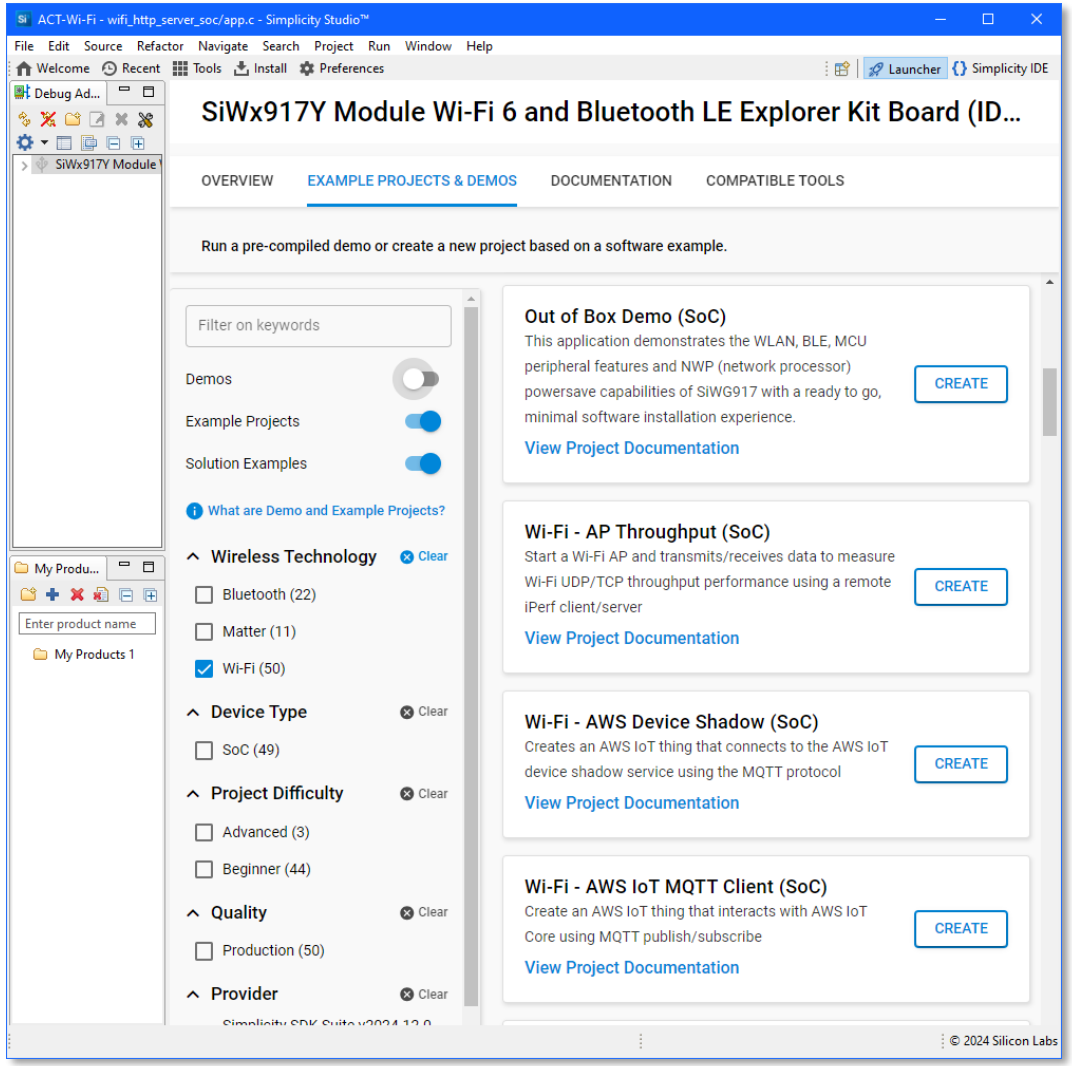
- To operate the HTTP Server:
  1. Connect a serial terminal to the board using: 115200 baud, 8 data bits, no parity, 1 stop bit, no flow control
  2. Reset the board, when the device joins the network its IP address will be output to the terminal
  3. Server start done will be output when the HTTP server is running
  4. In a web browser enter the IP address followed by /test
  5. The HTML will be displayed in the browser window, including the seconds, button0 and button 1 values
  6. The browser will automatically refresh every 5 seconds (not shown)



Next Steps

Next Steps

- There are lots more Wi-Fi examples available in Simplicity Studio
  - Choose the one closest to your final application as your starting point
  - The Out of Box Demo (SoC) provides a good overview showing how to join a Wi-Fi network by providing the SSID and password over Bluetooth, pinging and MQTT data transfer
  - There are many Matter over Wi-Fi examples
- For more fully-featured examples check the Silicon Labs Wi-Fi Examples repository on GitHub: https://github.com/SiliconLabs/wifi_applications
- Documentation on the Wi-Fi APIs is available from the Documentation page in the Launcher and also online: https://docs.silabs.com/wiseconnect/latest/wiseconnect-developing-with-wiseconnect-sdk
- Subscribe to the Silicon Labs YouTube channel, where we will be adding Wi-Fi tutorials in the future: https://www.youtube.com/@ViralSilabs/videos



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Thank You