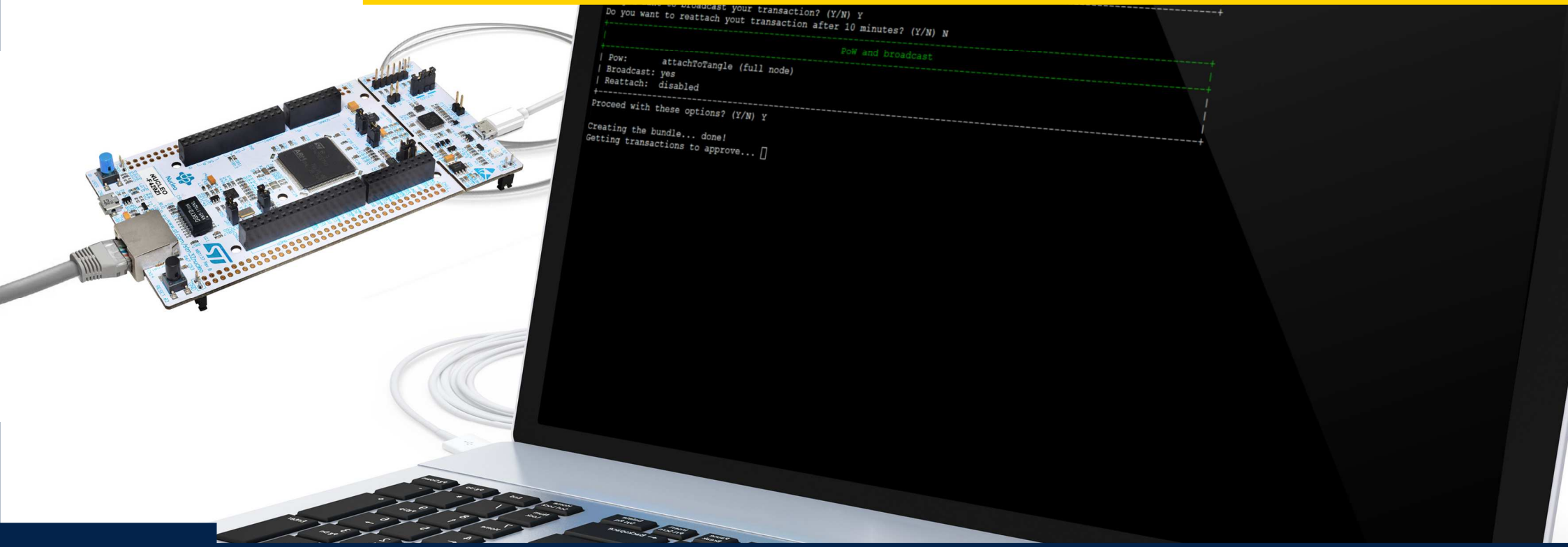
Hands on



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Features applications

- Web server based on raw API:
- **GOAL>** Implement a web server based on the LwIP Socket API with FreeRTOS.
- Use Case: Connect to the STM32 MCU from a web client and to load HTML pages
- The web server application implements the following features:
  - URL parsing
  - CGI (Common Gateway Interface)
  - SSI (Server Side Includes)
  - Dynamic Header generation
  - HTTP Post request

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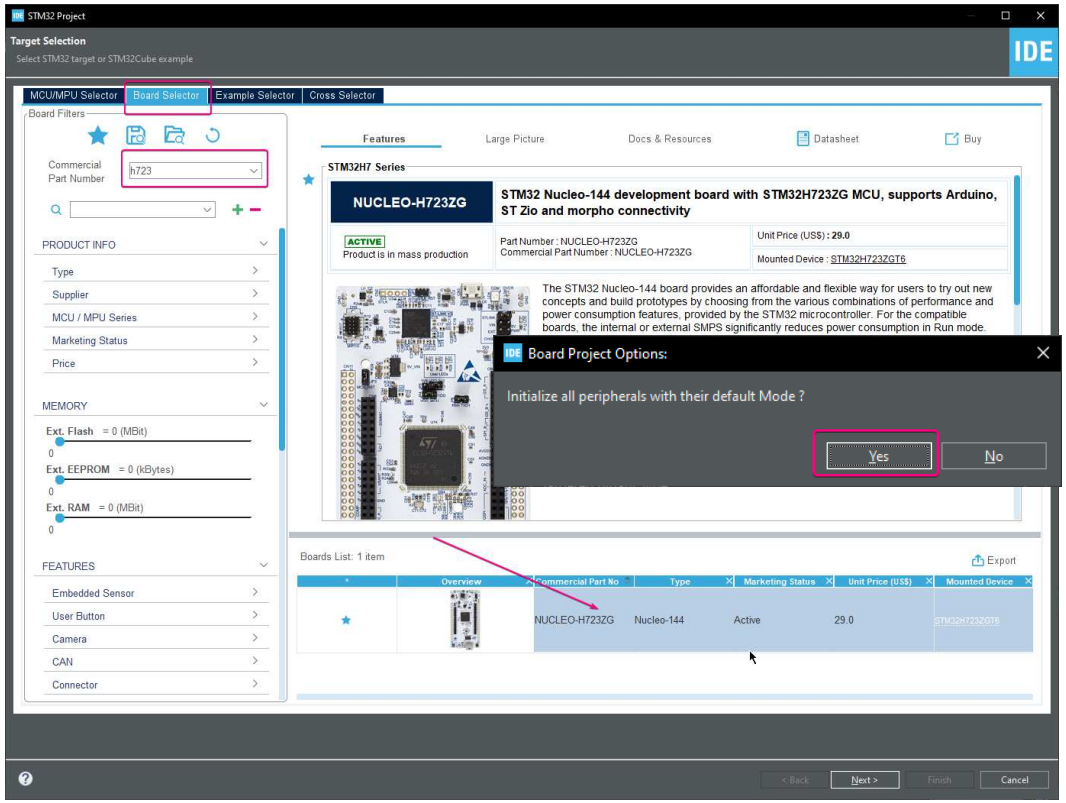
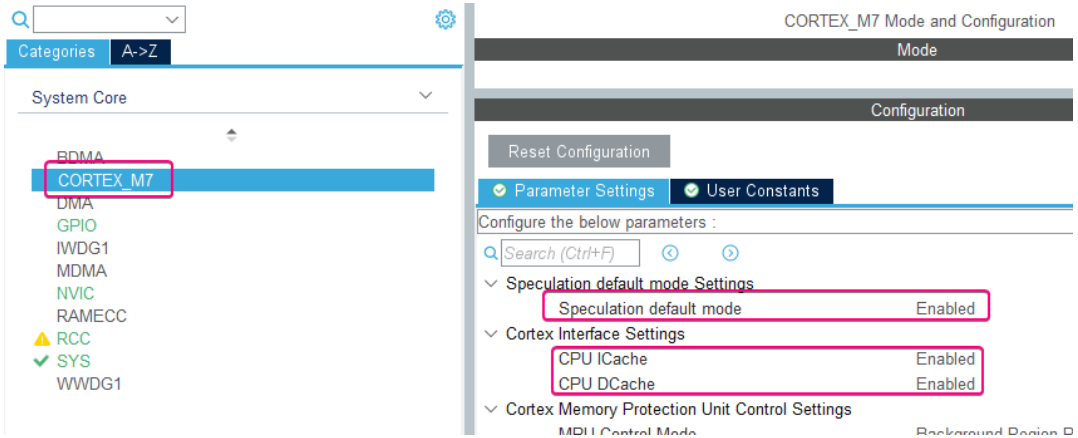
From Scratch

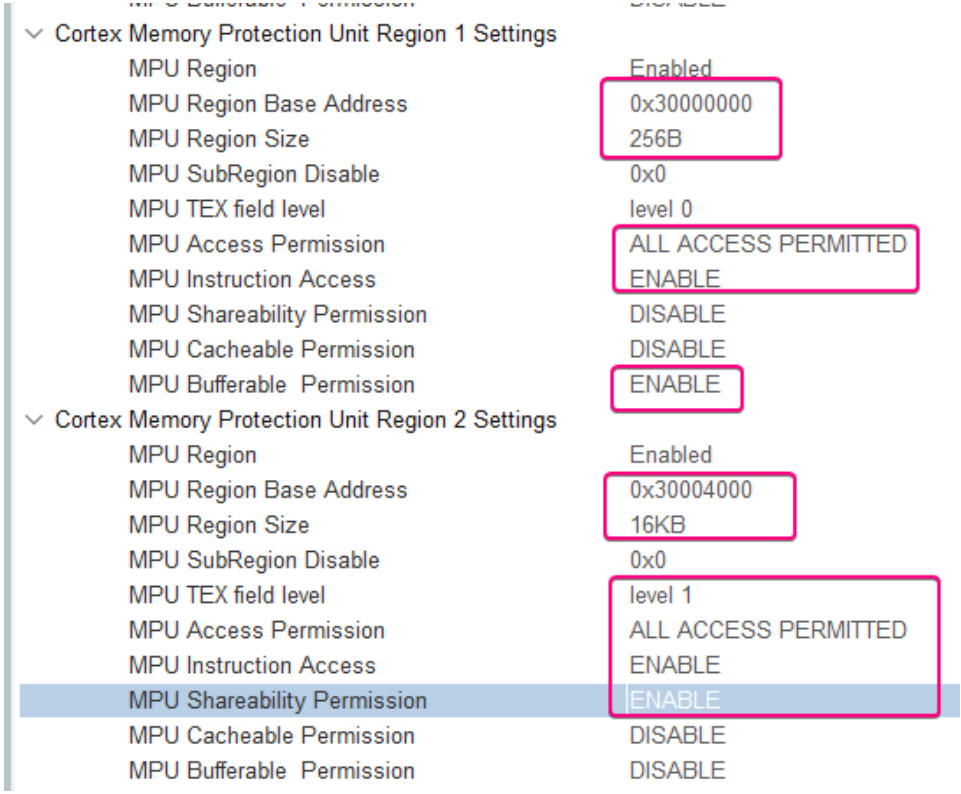
- Create a new Project using STM32CubeIDE
- Select the NUCLEO-H723ZG board
- Give it a name
- Initialize the peripherals



MPU

- Configure the MPU base settings and 2 regions to store the Ethernet descriptors





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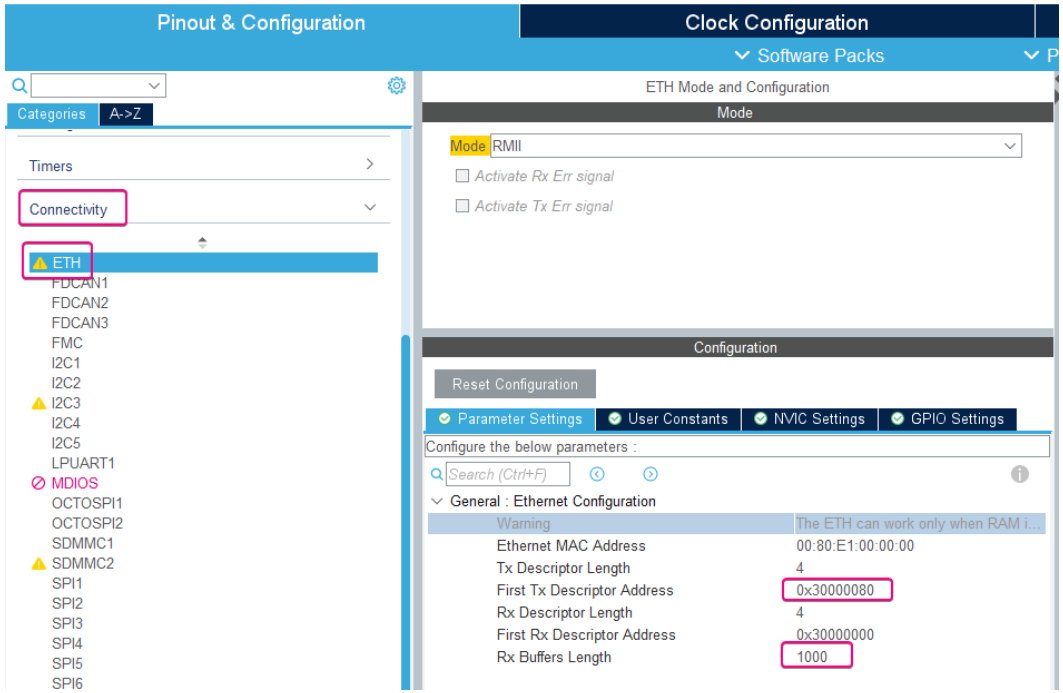
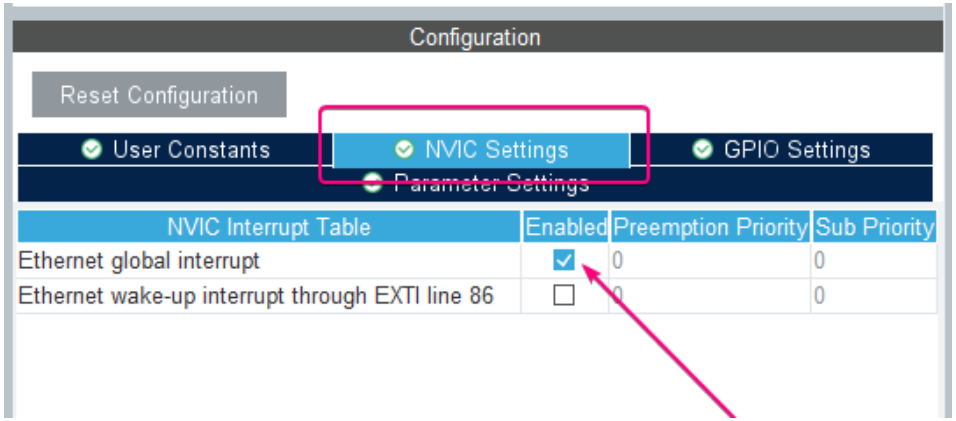
Ethernet

- The First Tx Descriptor Addr:
  - 0x30000080
- The Rx Descriptior Addr:
  - 0x30000000
- Reduce Rx buffers lenght:
  - 1000



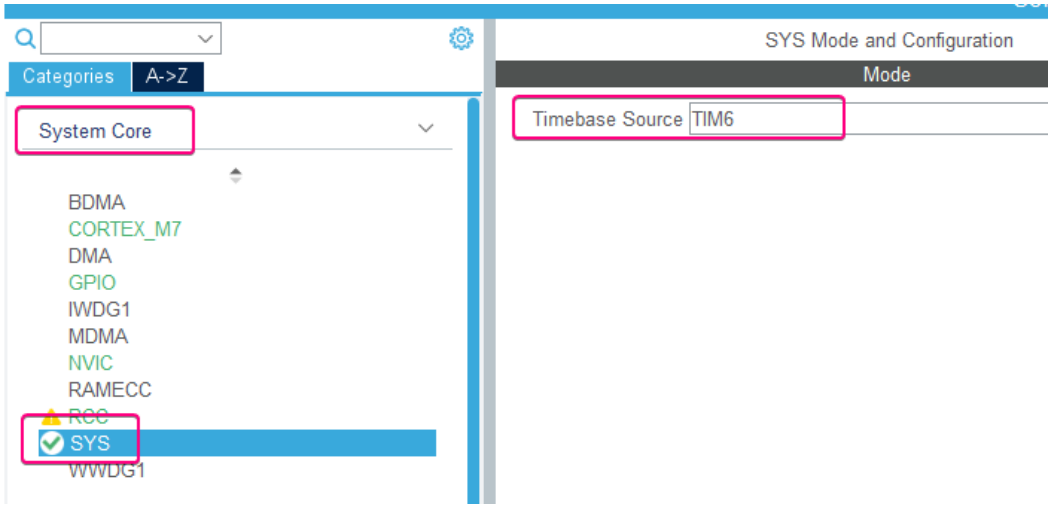
Ethernet

- Since we are using an RTOS, enable the global eth IT in the NVIC



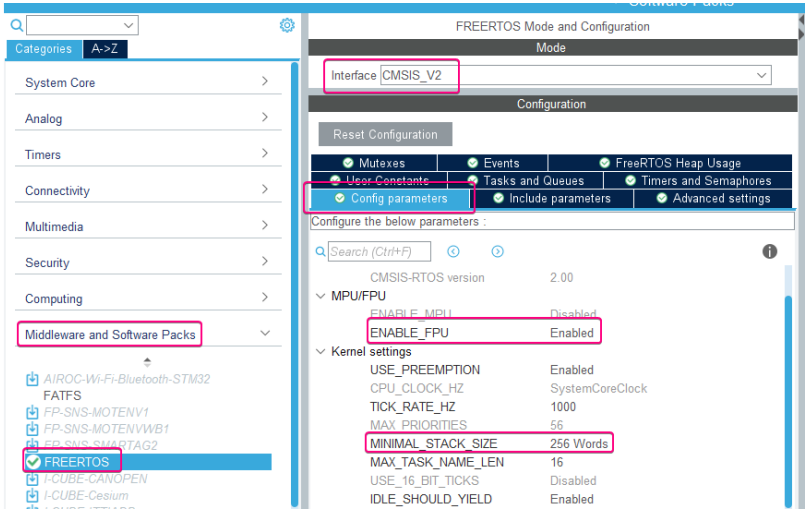
System

- Free up the SYSTICK for the RTOS by changing the HAL timebase
  - We can use TIM6

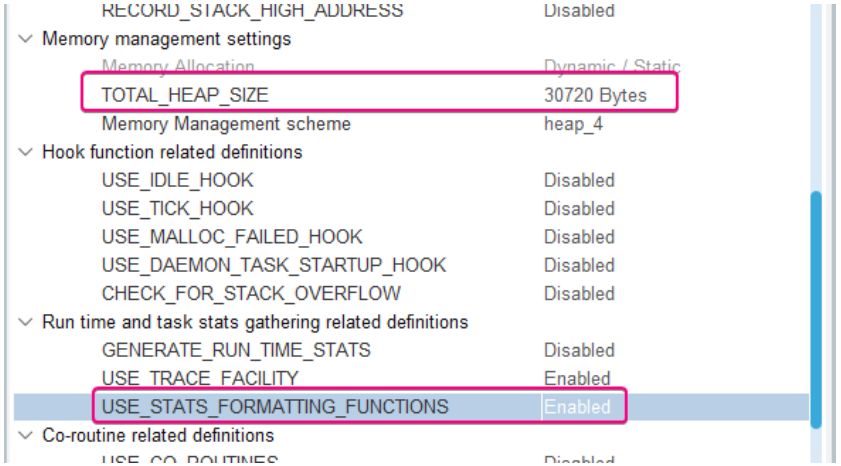


FreeRTOS

- In the middlewares tab, select FreeRTOS and choose CMSIS V2 interface.
- Increase stack size and enable FPU.

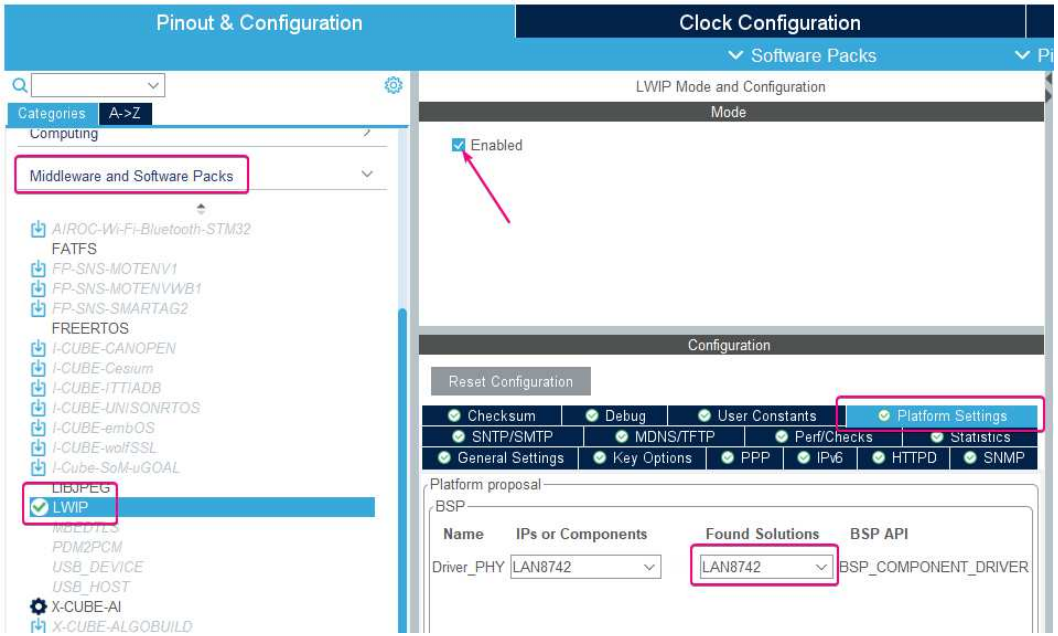


- Also increase the heap size and enable stats formatting functions.

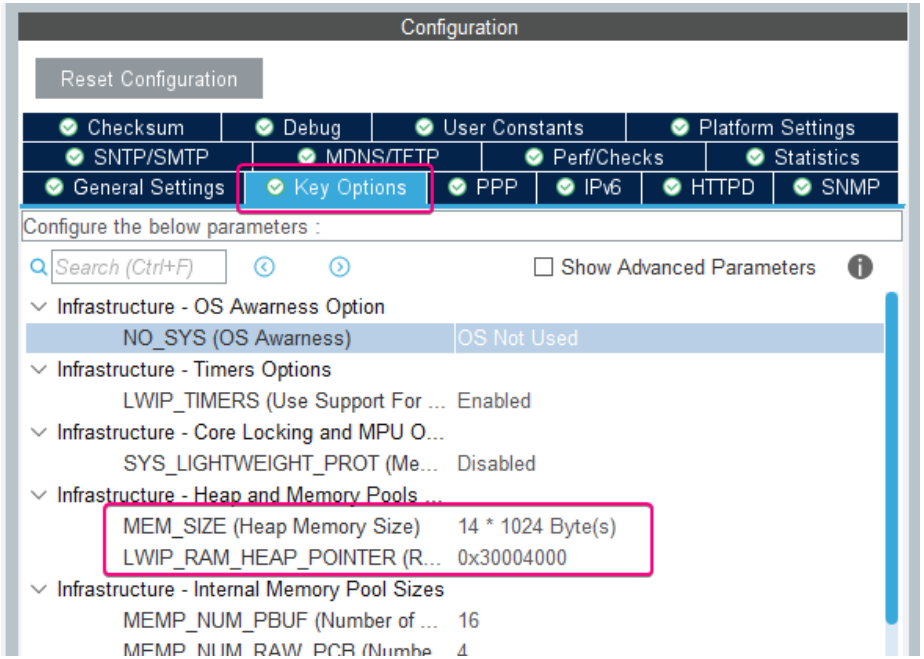


LwIP

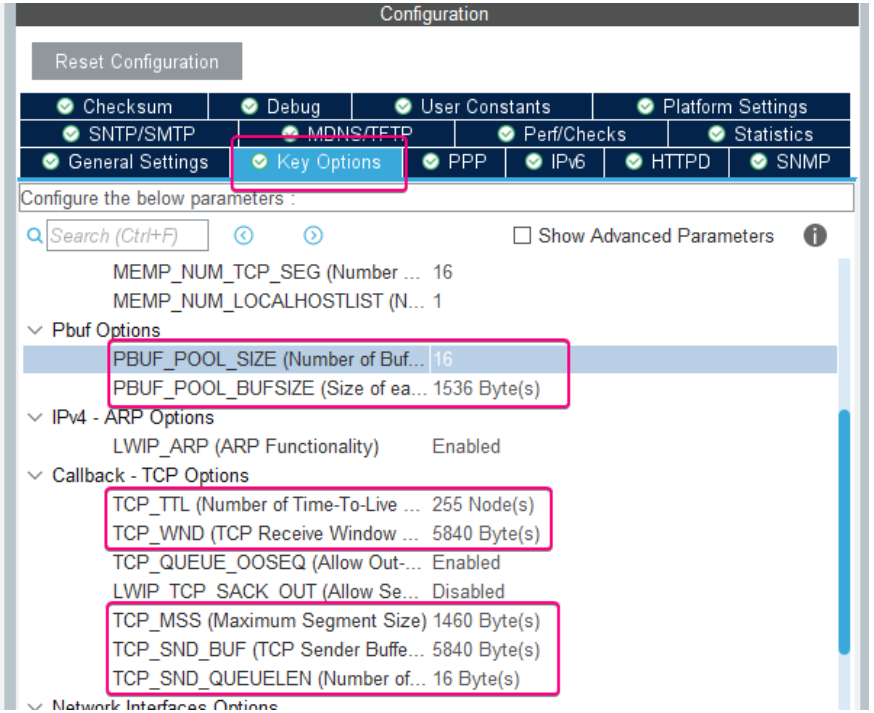
- Enable the LwIP middleware
- In the platform settings enable the phy driver for LAN8742



- Increase the heap size and change it's address

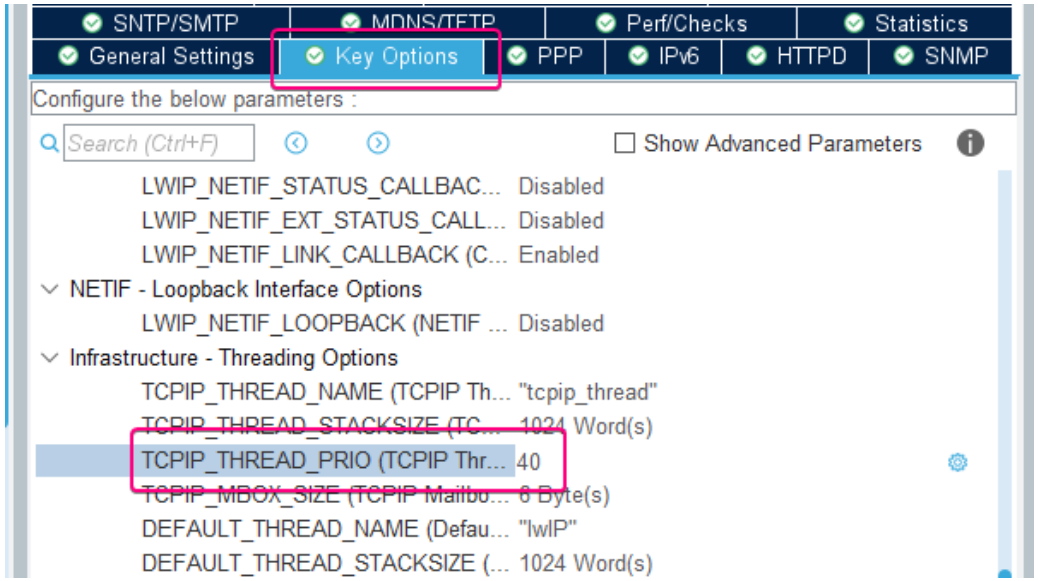


- Increase a few Pbuf and TCP parameters

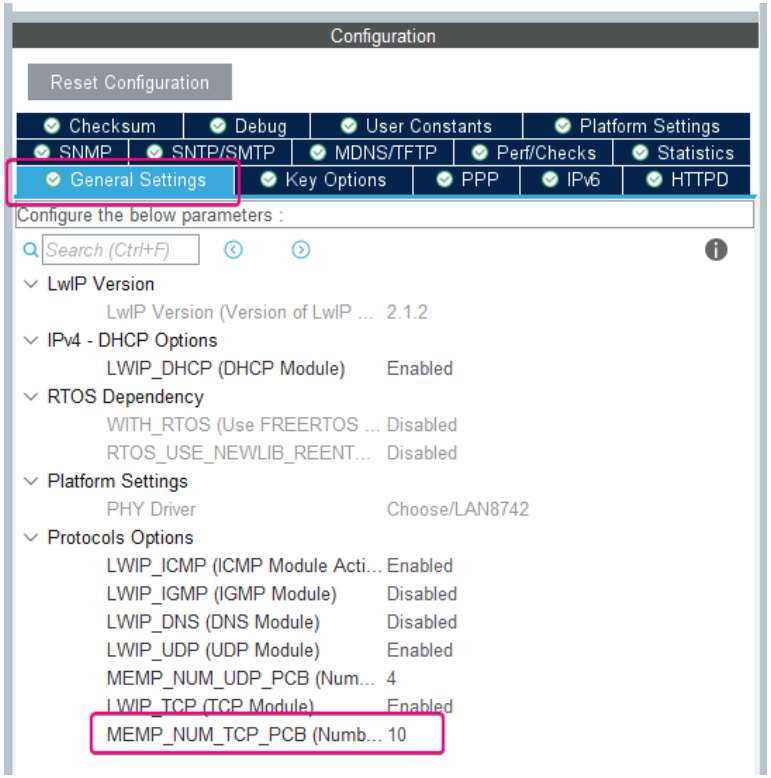


LwIP

- Change the TCPIP thread priority to 40



- Also increase the number of TCP PCBs



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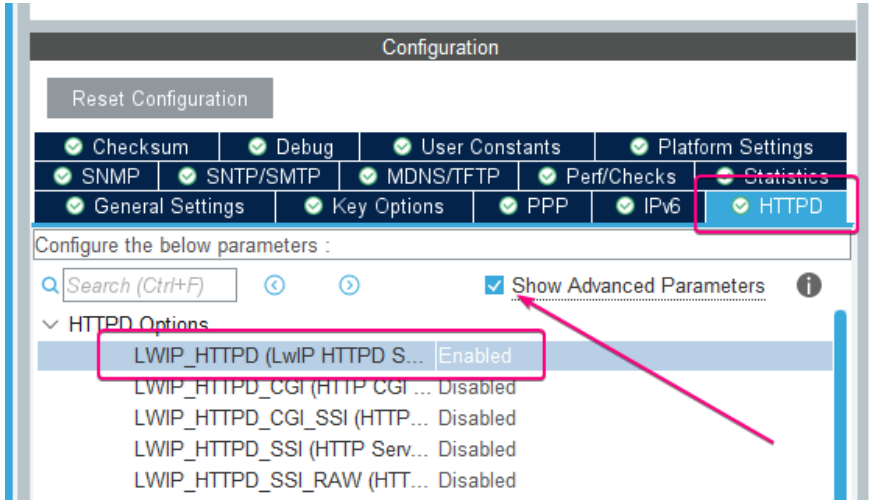
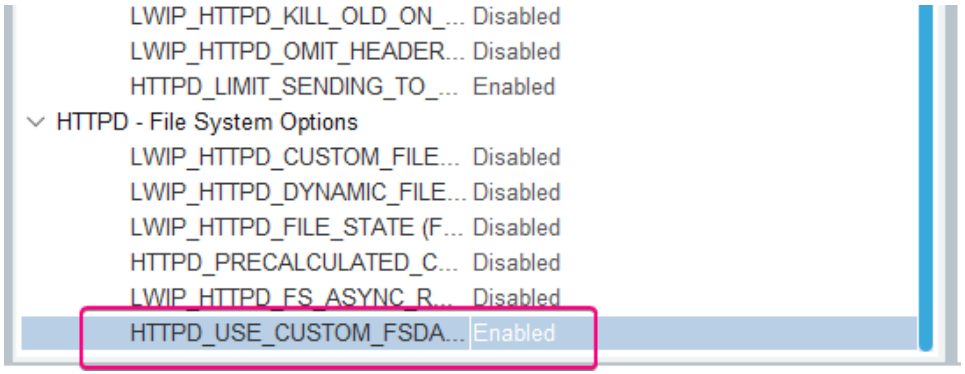
LwIP

- In the HTTPD, enable it and show the advanced parameters

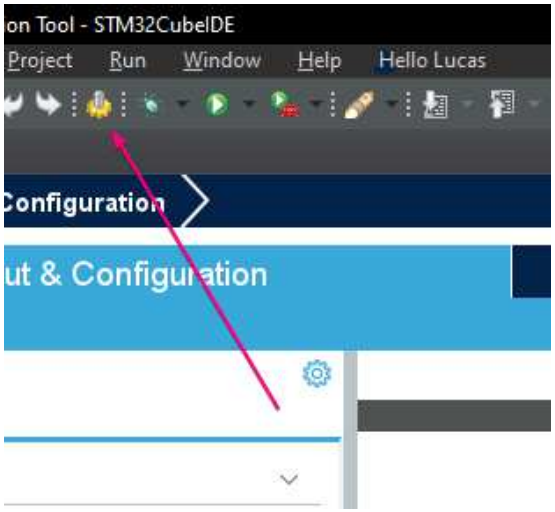


- Scroll all the way down and enable the custom data setting



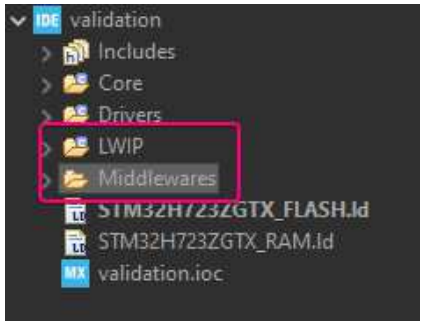
Check Point - Configuration wrap up

- Generate the code
- Don’t build it yet ☺

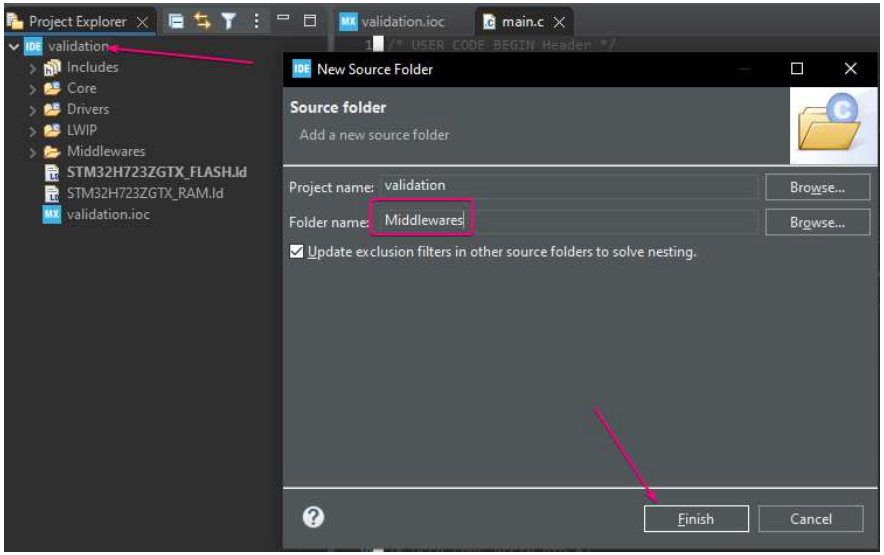


STM32CubeIDE 1.15.0 bug found

- There's currently a bug in STM32CubeIDE 1.15.0 where the Middleware folder may not be a source folder



- To fix this, left click the Project and create a new source folder called Middlewares



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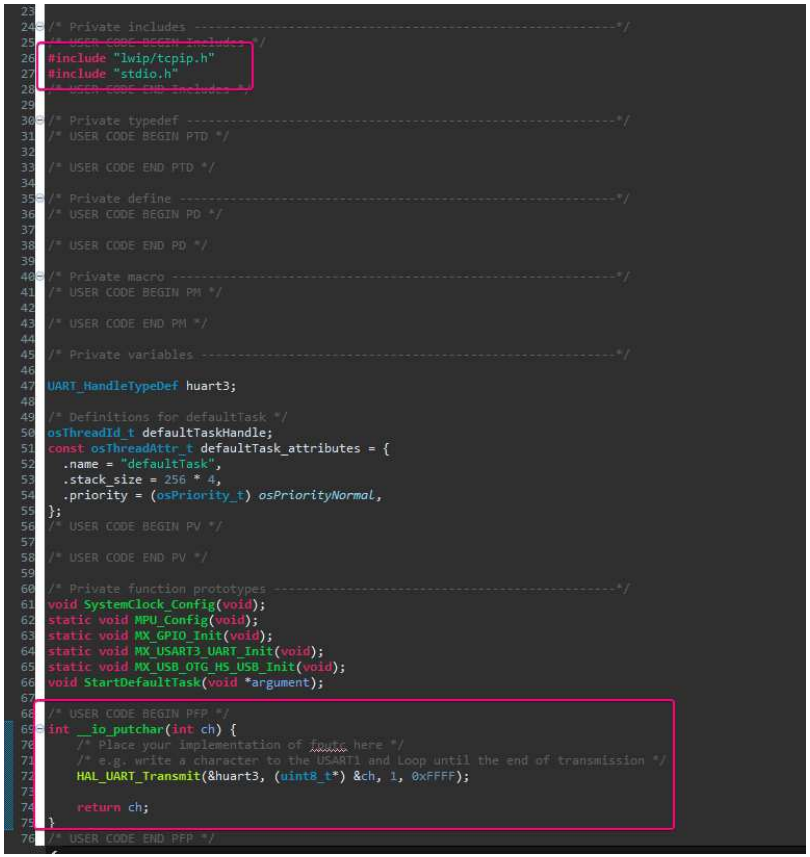
main.c – USER CODE BEGIN and PFP

- Add 2 includes and the putchar implementation

```
/* USER CODE BEGIN Includes */
#include "lwip/tcpip.h"
#include "stdio.h"
/* USER CODE END Includes */
```

```
/* USER CODE BEGIN PFP */
int __io_putchar(int ch) {
        HAL_UART_Transmit(&huart3, (uint8_t*) &ch, 1, 0xFFFF);
        return ch;
}
/* USER CODE END PFP */
```

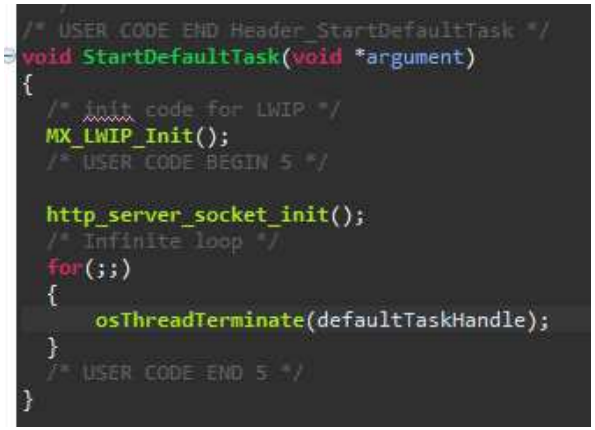


main.c – USER CODE BEGIN 2 and 5

- In the USER CODE 2 section, add a few application start prints


```
/* USER CODE BEGIN 2 */
 printf("LwIP_HTTP_Server_Socket_RTOS\n");
 printf("NUCLEO-H723ZG board\n");
 printf("State: Ethernet Initialization ...\n");
 /* USER CODE END 2 */
```

- Use the default task to start the http server, then kill the thread.




```
/* USER CODE BEGIN 5 */

 http_server_socket_init();
 /* Infinite loop */
 for(;;)
 {
      osThreadTerminate(defaultTaskHandle);
 }
 /* USER CODE END 5 */
```

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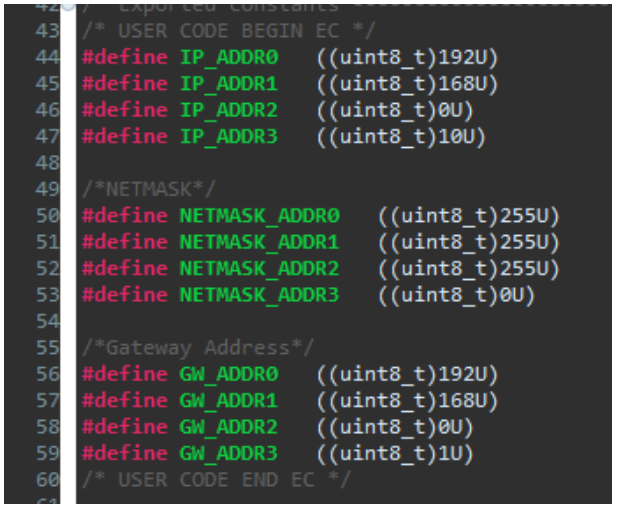
main.h – USER CODE BEGIN EC

- In the exported constants section, add the static IP gateway and netmask adresses.

```
/* USER CODE BEGIN EC */
#define IP_ADDR0   ((uint8_t)192U)
#define IP_ADDR1   ((uint8_t)168U)
#define IP_ADDR2   ((uint8_t)0U)
#define IP_ADDR3   ((uint8_t)10U)

/*NETMASK*/
#define NETMASK_ADDR0   ((uint8_t)255U)
#define NETMASK_ADDR1   ((uint8_t)255U)
#define NETMASK_ADDR2   ((uint8_t)255U)
#define NETMASK_ADDR3   ((uint8_t)0U)

/*Gateway Address*/
#define GW_ADDR0   ((uint8_t)192U)
#define GW_ADDR1   ((uint8_t)168U)
#define GW_ADDR2   ((uint8_t)0U)
#define GW_ADDR3   ((uint8_t)1U)
/* USER CODE END EC */
```



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lwip.h – USER CODE BEGIN 0

- On lwip.h add the dhcp states, thread and the 2 application threads

```
/* USER CODE BEGIN 0 */
 /* DHCP process states */
  #define DHCP_OFF                  (uint8_t) 0
  #define DHCP_START                (uint8_t) 1
  #define DHCP_WAIT_ADDRESS         (uint8_t) 2
  #define DHCP_ADDRESS_ASSIGNED     (uint8_t) 3
  #define DHCP_TIMEOUT              (uint8_t) 4
  #define DHCP_LINK_DOWN            (uint8_t) 5
  /* Exported functions ------------------------------------------------------- */
  #if LWIP_DHCP
  void DHCP_Thread(void *argument);
  #endif
  void http_server_socket_init(void);
  void DynWebPage(int conn);
/* USER CODE END 0 */
```

```
/* USER CODE BEGIN 0 */
 /* DHCP process states */
  #define DHCP_OFF                  (uint8_t) 0
  #define DHCP_START                (uint8_t) 1
  #define DHCP_WAIT_ADDRESS         (uint8_t) 2
  #define DHCP_ADDRESS_ASSIGNED     (uint8_t) 3
  #define DHCP_TIMEOUT              (uint8_t) 4
  #define DHCP_LINK_DOWN            (uint8_t) 5
  /* Exported functions ------------------------------------------------------- */
  #if LWIP_DHCP
  void DHCP_Thread(void *argument);
  #endif
  void http_server_socket_init(void);
  void DynWebPage(int conn);
/* USER CODE END 0 */
```

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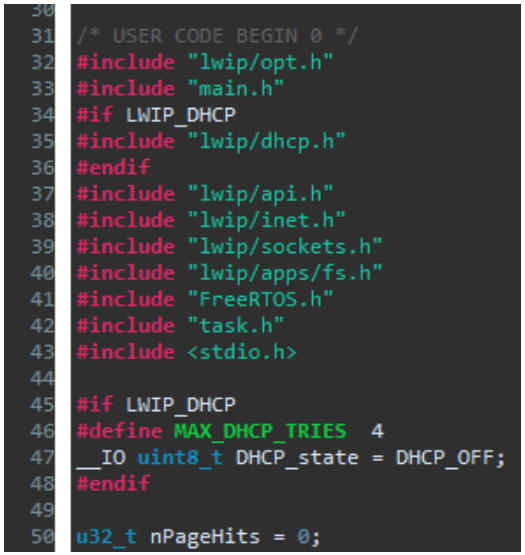
lwip.c – USER CODE BEGIN 0

- Add the necessary includes, the dhcp variables and a page hits Variable.

```
/* USER CODE BEGIN 0 */
#include "lwip/opt.h"
#include "main.h"
#if LWIP_DHCP
#include "lwip/dhcp.h"
#endif
#include "lwip/api.h"
#include "lwip/inet.h"
#include "lwip/sockets.h"
#include "lwip/apps/fs.h"
#include "FreeRTOS.h"
#include "task.h"
#include <stdio.h>

#if LWIP_DHCP
#define MAX_DHCP_TRIES  4
__IO uint8_t DHCP_state = DHCP_OFF;
#endif

u32_t nPageHits = 0;
```



lwip.c – USER CODE BEGIN 0

- Add the page header const
  - From provided material
- Add the server prototype
- Add the priority define

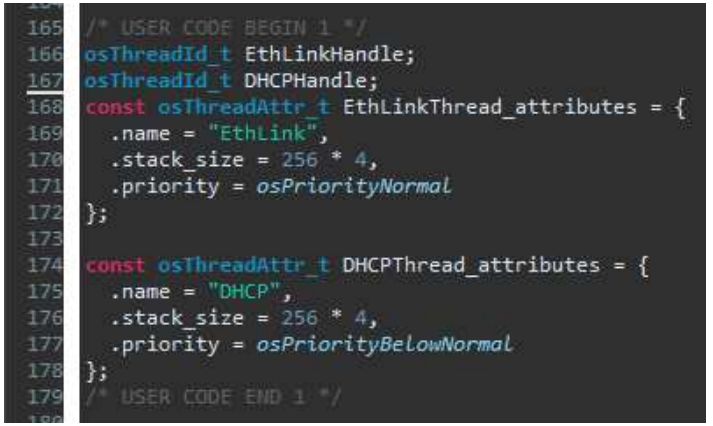
```
#define WEBSERVER_THREAD_PRIO    ( osPriorityAboveNormal )

void http_server_serve(int conn);
```

```
0x73,0x74,0x79,0x6c,0x65,0x3d,0x22,0x66,0x6f,0x6e,0x74,0x2d,0x77,0x65,0x69,0x67,
0x68,0x74,0x3a,0x20,0x62,0x6f,0x6c,0x64,0x3b,0x22,0x3e,0x3c,0x2f,0x73,0x70,0x61,
0x6e,0x3e,0x3c,0x73,0x6d,0x61,0x6c,0x6c,0x3e,0x3c,0x73,0x70,0x61,0x6e,0x20,0x73,
0x74,0x79,0x6c,0x65,0x3d,0x22,0x66,0x6f,0x6e,0x74,0x2d,0x66,0x61,0x6d,0x69,0x6c,
0x79,0x3a,0x20,0x56,0x65,0x72,0x64,0x61,0x6e,0x61,0x3b,0x22,0x3e,0x4e,0x75,0x6d,
0x62,0x65,0x72,0x20,0x6f,0x66,0x20,0x70,0x61,0x67,0x65,0x20,0x68,0x69,0x74,0x73,
0x3a,0x26,0x6e,0x62,0x73,0x70,0x3b,0x0d,0x0a,0x0d,0x0a,0x3c,0x2f,0x73,0x70,0x61,
0x6e,0x3e,0x3c,0x2f,0x73,0x6d,0x61,0x6c,0x6c,0x3e,0x0d,0x0a,0x3c,0x2f,0x62,0x6f,
0x64,0x79,0x3e,0x3c,0x2f,0x68,0x74,0x6d,0x6c,0x3e, 0
};
#define WEBSERVER_THREAD_PRIO    ( osPriorityAboveNormal )

void http_server_serve(int conn);
/* USER CODE END 0 */
```

lwip.c – USER CODE BEGIN 1

- In the USER CODE 1 section create 2 thread handles and their attributes

```
/* USER CODE BEGIN 1 */
osThreadId_t EthLinkHandle;
osThreadId_t DHCPHandle;
const osThreadAttr_t EthLinkThread_attributes = {
  .name = "EthLink",
  .stack_size = 256 * 4,
  .priority = osPriorityNormal
};

const osThreadAttr_t DHCPThread_attributes = {
  .name = "DHCP",
  .stack_size = 256 * 4,
  .priority = osPriorityBelowNormal
};
/* USER CODE END 1 */
```



lwip.c – USER CODE 2

- Add the main application code, starting by the DCHP process thread

```
/* USER CODE BEGIN 2 */
#if LWIP_DHCP
void DHCP_Thread(void *argument)
{
  struct netif *netif = (struct netif *) argument;
  ip_addr_t ipaddr;
  ip_addr_t netmask;
  ip_addr_t gw;
  struct dhcp *dhcp;
  uint8_t iptxt[20];
  for (;;)
  {
    switch (DHCP_state)
    {
    case DHCP_START:
     {
       printf("State: Looking for DHCP server ...\n");
       HAL_GPIO_WritePin(LED_GREEN_GPIO_Port, LED_GREEN_Pin, GPIO_PIN_RESET);
       HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port, LED_YELLOW_Pin, GPIO_PIN_RESET);
       ip_addr_set_zero_ip4(&netif->ip_addr);
       ip_addr_set_zero_ip4(&netif->netmask);
       ip_addr_set_zero_ip4(&netif->gw);
       dhcp_start(netif);
       DHCP_state = DHCP_WAIT_ADDRESS;
     }
     break;
```

```
/* USER CODE BEGIN 2 */
#if LWIP_DHCP
/**
  * @brief  DHCP Process
  * @param  argument: network interface
  * @retval None
  */
void DHCP_Thread(void *argument)
{
  struct netif *netif = (struct netif *) argument;
  ip_addr_t ipaddr;
  ip_addr_t netmask;
  ip_addr_t gw;
  struct dhcp *dhcp;
  uint8_t iptxt[20];

  for (;;)
  {
    switch (DHCP_state)
    {
    case DHCP_START:
      {
        printf("State: Looking for DHCP server ...\n");
        HAL_GPIO_WritePin(LED_GREEN_GPIO_Port, LED_GREEN_Pin, GPIO_PIN_RESET);
        HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port, LED_YELLOW_Pin, GPIO_PIN_RESET);
        ip_addr_set_zero_ip4(&netif->ip_addr);
        ip_addr_set_zero_ip4(&netif->netmask);
        ip_addr_set_zero_ip4(&netif->gw);
        dhcp_start(netif);
        DHCP_state = DHCP_WAIT_ADDRESS;
      }
      break;
    case DHCP_WAIT_ADDRESS:
      {
        if (dhcp_supplied_address(netif))
        {
          DHCP_state = DHCP_ADDRESS_ASSIGNED;
          sprintf((char *)iptxt, "%s", ip4addr_ntoa(netif_ip4_addr(netif)));
          printf("IP address assigned by a DHCP server: %s\n", iptxt);
          HAL_GPIO_WritePin(LED_GREEN_GPIO_Port, LED_GREEN_Pin, GPIO_PIN_SET);
          HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port, LED_YELLOW_Pin, GPIO_PIN_RESET);
        }
        else
        {
          dhcp = (struct dhcp *)netif_get_client_data(netif, LWIP_NETIF_CLIENT_DATA_INDEX_DHCP);
```

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lwip.c – USER CODE BEGIN 2

- Cont.

```
case DHCP_WAIT_ADDRESS:
    {
     if (dhcp_supplied_address(netif))
     {
      DHCP_state = DHCP_ADDRESS_ASSIGNED;
      sprintf((char *)iptxt, "%s", ip4addr_ntoa(netif_ip4_addr(netif)));
      printf("IP address assigned by a DHCP server: %s\n", iptxt);
      HAL_GPIO_WritePin(LED_GREEN_GPIO_Port, LED_GREEN_Pin, GPIO_PIN_SET);
      HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port, LED_YELLOW_Pin, GPIO_PIN_RESET);
     }
     else
     {
      dhcp = (struct dhcp *)netif_get_client_data(netif, LWIP_NETIF_CLIENT_DATA_INDEX_DHCP);
```

```
/* USER CODE BEGIN 2 */
#if LWIP_DHCP
/**
  * @brief  DHCP Process
  * @param  argument: network interface
  * @retval None
  */
void DHCP_Thread(void *argument)
{
  struct netif *netif = (struct netif *) argument;
  ip_addr_t ipaddr;
  ip_addr_t netmask;
  ip_addr_t gw;
  struct dhcp *dhcp;
  uint8_t iptxt[20];

  for (;;)
  {
    switch (DHCP_state)
    {
    case DHCP_START:
      {
        printf("State: Looking for DHCP server ...\n");
        HAL_GPIO_WritePin(LED_GREEN_GPIO_Port, LED_GREEN_Pin, GPIO_PIN_RESET);
        HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port, LED_YELLOW_Pin, GPIO_PIN_RESET);
        ip_addr_set_zero_ip4(&netif->ip_addr);
        ip_addr_set_zero_ip4(&netif->netmask);
        ip_addr_set_zero_ip4(&netif->gw);
        dhcp_start(netif);
        DHCP_state = DHCP_WAIT_ADDRESS;
      }
      break;
    case DHCP_WAIT_ADDRESS:
      {
        if (dhcp_supplied_address(netif))
        {
          DHCP_state = DHCP_ADDRESS_ASSIGNED;
          sprintf((char *)iptxt, "%s", ip4addr_ntoa(netif_ip4_addr(netif)));
          printf("IP address assigned by a DHCP server: %s\n", iptxt);
          HAL_GPIO_WritePin(LED_GREEN_GPIO_Port, LED_GREEN_Pin, GPIO_PIN_SET);
          HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port, LED_YELLOW_Pin, GPIO_PIN_RESET);
        }
        else
        {
          dhcp = (struct dhcp *)netif_get_client_data(netif, LWIP_NETIF_CLIENT_DATA_INDEX_DHCP);
```

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lwip.c – USER CODE 2

- Cont.

```
/* DHCP timeout */
        if (dhcp->tries > MAX_DHCP_TRIES)
        {
          DHCP_state = DHCP_TIMEOUT;
          /* Static address used */
          IP_ADDR4(&ipaddr, IP_ADDR0 ,IP_ADDR1 , IP_ADDR2 , IP_ADDR3 );
          IP_ADDR4(&netmask, NETMASK_ADDR0, NETMASK_ADDR1, NETMASK_ADDR2,
NETMASK_ADDR3);
          IP_ADDR4(&gw, GW_ADDR0, GW_ADDR1, GW_ADDR2, GW_ADDR3);
          netif_set_addr(netif, ip_2_ip4(&ipaddr), ip_2_ip4(&netmask), ip_2_ip4(&gw));
          sprintf((char *)iptxt, "%s", ip4addr_ntoa(netif_ip4_addr(netif)));
          printf("DHCP Timeout !! \n");
          printf("Static IP address: %s\n", iptxt);
          HAL_GPIO_WritePin(LED_GREEN_GPIO_Port, LED_GREEN_Pin, GPIO_PIN_SET);
          HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port, LED_YELLOW_Pin, GPIO_PIN_RESET);
        }
       }
     }
     break;
  case DHCP_LINK_DOWN:
    {
      DHCP_state = DHCP_OFF;
      HAL_GPIO_WritePin(LED_GREEN_GPIO_Port, LED_GREEN_Pin, GPIO_PIN_RESET);
      HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port, LED_YELLOW_Pin, GPIO_PIN_SET);
    }
    break;
    default: break;
    }
    /* wait 500 ms */
    osDelay(500);
  }
}
#endif  /* LWIP_DHCP */
```

```
237          /* DHCP timeout */
238          if (dhcp->tries > MAX_DHCP_TRIES)
239          {
240            DHCP_state = DHCP_TIMEOUT;
241
242            /* Static address used */
243            IP_ADDR4(&ipaddr, IP_ADDR0 ,IP_ADDR1 , IP_ADDR2 , IP_ADDR3 );
244            IP_ADDR4(&netmask, NETMASK_ADDR0, NETMASK_ADDR1, NETMASK_ADDR2, NETMASK_ADDR3);
245            IP_ADDR4(&gw, GW_ADDR0, GW_ADDR1, GW_ADDR2, GW_ADDR3);
246            netif_set_addr(netif, ip_2_ip4(&ipaddr), ip_2_ip4(&netmask), ip_2_ip4(&gw));
247            sprintf((char *)iptxt, "%s", ip4addr_ntoa(netif_ip4_addr(netif)));
248            printf("DHCP Timeout !! \n");
249            printf("Static IP address: %s\n", iptxt);
250            HAL_GPIO_WritePin(LED_GREEN_GPIO_Port, LED_GREEN_Pin, GPIO_PIN_SET);
251            HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port, LED_YELLOW_Pin, GPIO_PIN_RESET);
252          }
253        }
254      }
255      break;
256    case DHCP_LINK_DOWN:
257      {
258        DHCP_state = DHCP_OFF;
259        HAL_GPIO_WritePin(LED_GREEN_GPIO_Port, LED_GREEN_Pin, GPIO_PIN_RESET);
260        HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port, LED_YELLOW_Pin, GPIO_PIN_SET);
261      }
262      break;
263      default: break;
264      }
265
266      /* wait 500 ms */
267      osDelay(500);
268    }
269  }
270  #endif  /* LWIP_DHCP */
```

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lwip.c – USER CODE 2

- Next is the server function, where the assets will be accessed and served

```
void http_server_serve(int conn)
{
  int buflen = 1500;
  int ret;
  struct fs_file file;
  unsigned char recv_buffer[1500];

  /* Read in the request */
    ret = read(conn, recv_buffer, buflen);
    if(ret < 0) return;

    /* Check if request to get ST.gif */
    if (strncmp((char *)recv_buffer,"GET /STM32H7xx_files/ST.gif",27)==0)
    {
      fs_open(&file, "/STM32H7xx_files/ST.gif");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    /* Check if request to get stm32.jpeg */
    else if (strncmp((char *)recv_buffer,"GET /STM32H7xx_files/stm32.jpg",30)==0)
    {
      fs_open(&file, "/STM32H7xx_files/stm32.jpg");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
```

```
void http_server_serve(int conn)
{
  int buflen = 1500;
  int ret;
  struct fs_file file;
  unsigned char recv_buffer[1500];

  /* Read in the request */
    ret = read(conn, recv_buffer, buflen);
    if(ret < 0) return;

    /* Check if request to get ST.gif */
    if (strncmp((char *)recv_buffer,"GET /STM32H7xx_files/ST.gif",27)==0)
    {
      fs_open(&file, "/STM32H7xx_files/ST.gif");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    /* Check if request to get stm32.jpeg */
    else if (strncmp((char *)recv_buffer,"GET /STM32H7xx_files/stm32.jpg",30)==0)
    {
      fs_open(&file, "/STM32H7xx_files/stm32.jpg");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    /* Check if request to get ST logo.jpeg */
    else if (strncmp((char *)recv_buffer,"GET /STM32H7xx_files/logo.jpg", 29) == 0)
    {
      fs_open(&file, "/STM32H7xx_files/logo.jpg");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    else if(strncmp((char *)recv_buffer, "GET /STM32H7xxTASKS.html", 24) == 0)
    {
      /* Load dynamic page */
      DynWebPage(conn);
    }
    else if((strncmp((char *)recv_buffer, "GET /STM32H7xx.html", 19) == 0)||(strncmp((char *)recv_buffer, "GET / ", 6) == 0))
    {
      /* Load STM32H7xxpage */
      fs_open(&file, "/STM32H7xx.html");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    else
    {
      /* Load 404 page */
      fs_open(&file, "/404.html");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    /* Close connection socket */
    close(conn);
  }
```

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lwip.c – USER CODE BEGIN 2

- Cont.

```
/* Check if request to get ST logo.jpeg */
  else if (strncmp((char *)recv_buffer,"GET /STM32H7xx_files/logo.jpg", 29) == 0)
  {
    fs_open(&file, "/STM32H7xx_files/logo.jpg");
    write(conn, (const unsigned char*)(file.data), (size_t)file.len);
    fs_close(&file);
  }
  else if(strncmp((char *)recv_buffer, "GET /STM32H7xxTASKS.html", 24) == 0)
  {
    /* Load dynamic page */
    DynWebPage(conn);
  }
  else if((strncmp((char *)recv_buffer, "GET /STM32H7xx.html", 19) == 0)||(strncmp((char
*)recv_buffer, "GET / ", 6) == 0))
  {
    /* Load STM32H7xxpage */
    fs_open(&file, "/STM32H7xx.html");
    write(conn, (const unsigned char*)(file.data), (size_t)file.len);
    fs_close(&file);
  }
  else
  {
    /* Load 404 page */
    fs_open(&file, "/404.html");
    write(conn, (const unsigned char*)(file.data), (size_t)file.len);
    fs_close(&file);
  }
  /* Close connection socket */
  close(conn);
 }
```

```
void http_server_serve(int conn)
{
  int buflen = 1500;
  int ret;
  struct fs_file file;
  unsigned char recv_buffer[1500];

  /* Read in the request */
    ret = read(conn, recv_buffer, buflen);
    if(ret < 0) return;

    /* Check if request to get ST.gif */
    if (strncmp((char *)recv_buffer,"GET /STM32H7xx_files/ST.gif",27)==0)
    {
      fs_open(&file, "/STM32H7xx_files/ST.gif");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    /* Check if request to get stm32.jpeg */
    else if (strncmp((char *)recv_buffer,"GET /STM32H7xx_files/stm32.jpg",30)==0)
    {
      fs_open(&file, "/STM32H7xx_files/stm32.jpg");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    /* Check if request to get ST logo.jpeg */
    else if (strncmp((char *)recv_buffer,"GET /STM32H7xx_files/logo.jpg", 29) == 0)
    {
      fs_open(&file, "/STM32H7xx_files/logo.jpg");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    else if(strncmp((char *)recv_buffer, "GET /STM32H7xxTASKS.html", 24) == 0)
    {
      /* Load dynamic page */
      DynWebPage(conn);
    }
    else if((strncmp((char *)recv_buffer, "GET /STM32H7xx.html", 19) == 0)||(strncmp((char *)recv_buffer, "GET / ", 6) == 0))
    {
      /* Load STM32H7xxpage */
      fs_open(&file, "/STM32H7xx.html");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    else
    {
      /* Load 404 page */
      fs_open(&file, "/404.html");
      write(conn, (const unsigned char*)(file.data), (size_t)file.len);
      fs_close(&file);
    }
    /* Close connection socket */
    close(conn);
  }
```

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lwip.c – USER CODE 2

- The server socket thread will handle the TCP connection, binding to port 80 and listening to port 5

```
static void http_server_socket_thread(void *arg)
{
  int sock, newconn, size;
  struct sockaddr_in address, remotehost;

 /* create a TCP socket */
  if ((sock = socket(AF_INET, SOCK_STREAM, 0)) < 0)
  {
    return;
  }
  /* bind to port 80 at any interface */
  address.sin_family = AF_INET;
  address.sin_port = htons(80);
  address.sin_addr.s_addr = INADDR_ANY;
  if (bind(sock, (struct sockaddr *)&address, sizeof (address)) < 0)
  {
    return;
  }
  /* listen for incoming connections (TCP listen backlog = 5) */
  listen(sock, 5);
  size = sizeof(remotehost);
  while (1)
  {
    newconn = accept(sock, (struct sockaddr *)&remotehost, (socklen_t *)&size);
    http_server_serve(newconn);
  }
}
```

```
323 static void http_server_socket_thread(void *arg)
324 {
325   int sock, newconn, size;
326   struct sockaddr_in address, remotehost;
327
328
329  /* create a TCP socket */
330   if ((sock = socket(AF_INET, SOCK_STREAM, 0)) < 0)
331   {
332     return;
333   }
334
335   /* bind to port 80 at any interface */
336   address.sin_family = AF_INET;
337   address.sin_port = htons(80);
338   address.sin_addr.s_addr = INADDR_ANY;
339
340   if (bind(sock, (struct sockaddr *)&address, sizeof (address)) < 0)
341   {
342     return;
343   }
344
345   /* listen for incoming connections (TCP listen backlog = 5) */
346   listen(sock, 5);
347
348   size = sizeof(remotehost);
349
350   while (1)
351   {
352     newconn = accept(sock, (struct sockaddr *)&remotehost, (socklen_t *)&size);
353     http_server_serve(newconn);
354   }
355 }
```

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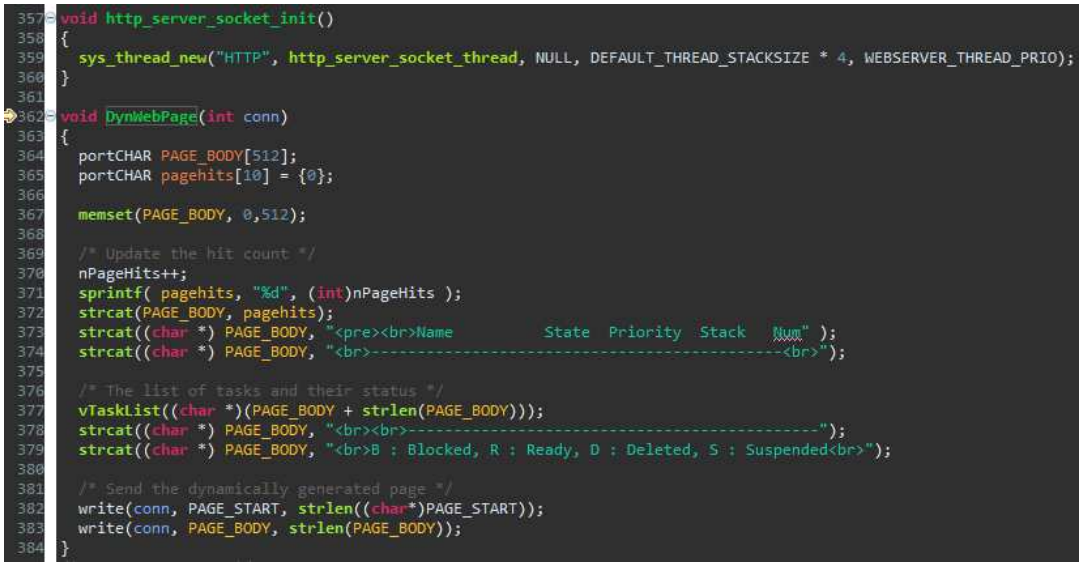
lwip.c – USER CODE 2

```
void http_server_socket_init()
{
  sys_thread_new("HTTP", http_server_socket_thread, NULL,
DEFAULT_THREAD_STACKSIZE * 4, WEBSERVER_THREAD_PRIO);
}

void DynWebPage(int conn)
{
  portCHAR PAGE_BODY[512];
  portCHAR pagehits[10] = {0};

  memset(PAGE_BODY, 0,512);

  /* Update the hit count */
  nPageHits++;
  sprintf( pagehits, "%d", (int)nPageHits );
  strcat(PAGE_BODY, pagehits);
  strcat((char *) PAGE_BODY, "<pre><br>Name        State  Priority  Stack   Num" );
  strcat((char *) PAGE_BODY, "<br>-------------------------------------------<br>");

  /* The list of tasks and their status */
  vTaskList((char *)(PAGE_BODY + strlen(PAGE_BODY)));
  strcat((char *) PAGE_BODY, "<br><br>-------------------------------------------");
  strcat((char *) PAGE_BODY, "<br>B : Blocked, R : Ready, D : Deleted, S :
Suspended<br>");

  /* Send the dynamically generated page */
  write(conn, PAGE_START, strlen((char*)PAGE_START));
  write(conn, PAGE_BODY, strlen(PAGE_BODY));
}
/* USER CODE END 2 */
```

- The final functions are responsible for the HTTP thread init and the dynamic webpage



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lwip.c – USER CODE BEGIN H7_OS

- Initizalise the DHCP thread in the LWIP_Init function

```
#if LWIP_DHCP
  /* Start DHCPClient */
  DHCPHandle = osThreadNew(DHCP_Thread, &gnetif, &DHCPThread_attributes);
#endif
/* USER CODE END H7_OS_THREAD_NEW_CMSIS_RTOS_V2 */
```

```
409   /* Set the link callback function, this function is called on change of link status*/
410   netif_set_link_callback(&gnetif, ethernet_link_status_updated);
411
412   /* Create the Ethernet link handler thread */
413 /* USER CODE BEGIN H7_OS_THREAD_NEW_CMSIS_RTOS_V2 */
414   memset(&attributes, 0x0, sizeof(osThreadAttr_t));
415   attributes.name = "EthLink";
416   attributes.stack_size = INTERFACE_THREAD_STACK_SIZE;
417   attributes.priority = osPriorityBelowNormal;
418   osThreadNew(ethernet_link_thread, &gnetif, &attributes);
419 #if LWIP_DHCP
420   /* Start DHCPClient */
421   DHCPHandle = osThreadNew(DHCP_Thread, &gnetif, &DHCPThread_attributes);
422 #endif
423 /* USER CODE END H7_OS_THREAD_NEW_CMSIS_RTOS_V2 */
424
425   /* Start DHCP negotiation for a network interface (IPv4) */
426   dhcp_start(&gnetif);
427
428 /* USER CODE BEGIN 3 */
429
430 /* USER CODE END 3 */
431 }
```

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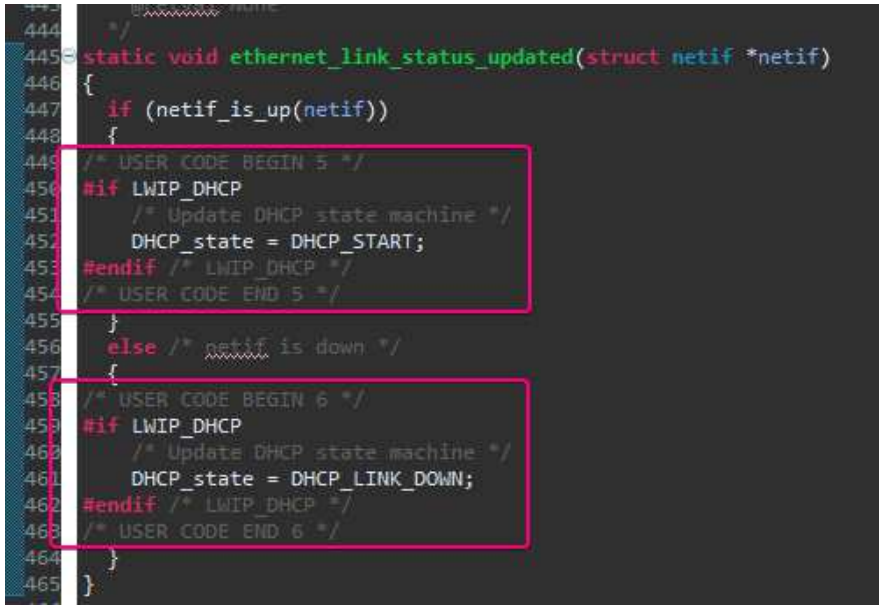
lwip.c – USER CODE BEGIN 5

- Lastly, add the final DHCP state machine code on the link update function

```
/* USER CODE BEGIN 5 */
#if LWIP_DHCP
   /* Update DHCP state machine */
   DHCP_state = DHCP_START;
#endif /* LWIP_DHCP */
/* USER CODE END 5 */
  }
  else /* netif is down */
  {
/* USER CODE BEGIN 6 */
#if LWIP_DHCP
   /* Update DHCP state machine */
   DHCP_state = DHCP_LINK_DOWN;
#endif /* LWIP_DHCP */
/* USER CODE END 6 */
```



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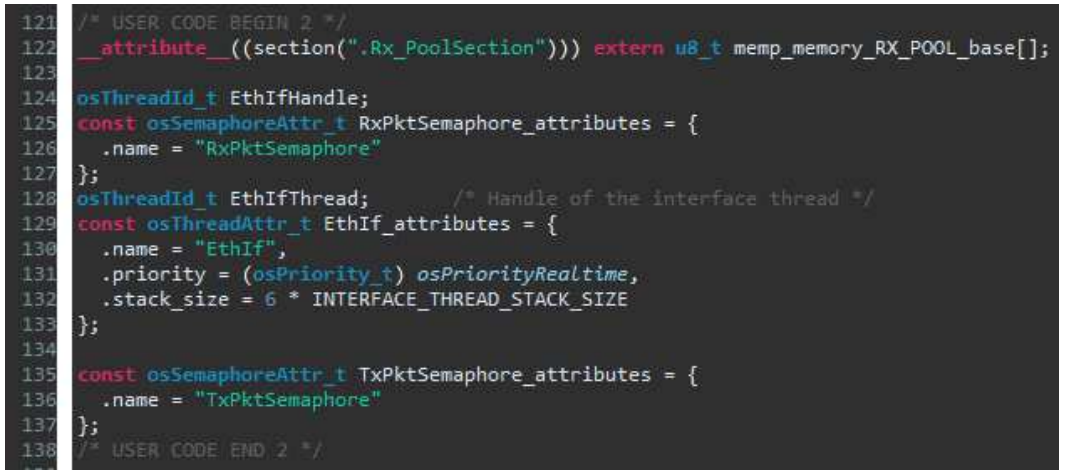
ethernetif.c – USER CODE BEGIN 2

- Add semaphores for the packets and allocating the Rx section

```
/* USER CODE BEGIN 2 */
__attribute__((section(".Rx_PoolSection"))) extern u8_t
memp_memory_RX_POOL_base[];

osThreadId_t EthIfHandle;
const osSemaphoreAttr_t RxPktSemaphore_attributes = {
  .name = "RxPktSemaphore"
};
osThreadId_t EthIfThread;      /* Handle of the interface thread */
const osThreadAttr_t EthIf_attributes = {
  .name = "EthIf",
  .priority = (osPriority_t) osPriorityRealtime,
  .stack_size = 6 * INTERFACE_THREAD_STACK_SIZE
};

const osSemaphoreAttr_t TxPktSemaphore_attributes = {
  .name = "TxPktSemaphore"
};
/* USER CODE END 2 */
```



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LINKER SCRIPT

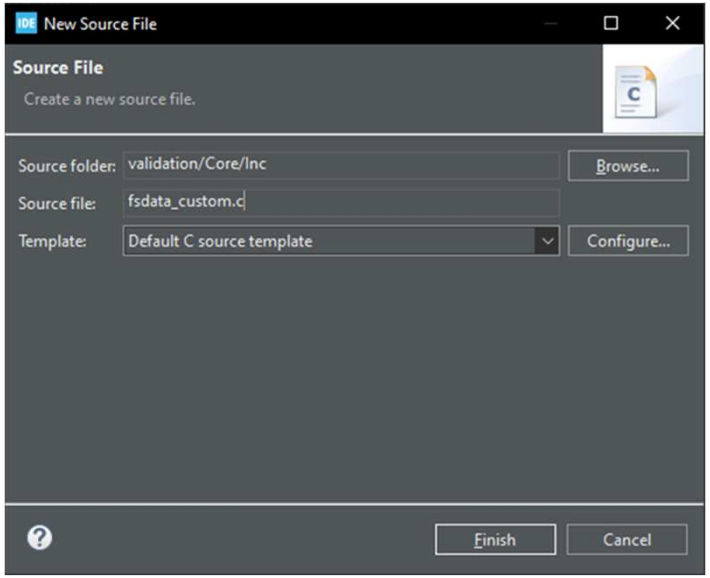
- In the linker file add the descriptor sections on the RAM_D2 memory

```
.lwip_sec (NOLOAD) : {
  . = ABSOLUTE(0x30000000);
  *(.RxDecripSection)

  . = ABSOLUTE(0x30000080);
  *(.TxDecripSection)

  . = ABSOLUTE(0x30000100);
  *(.Rx_PoolSection)
} >RAM_D2 AT> FLASH
```

```
169       .lwip_sec (NOLOAD) : {
170     . = ABSOLUTE(0x30000000);
171     *(.RxDecripSection)
172
173     . = ABSOLUTE(0x30000080);
174     *(.TxDecripSection)
175
176     . = ABSOLUTE(0x30000100);
177     *(.Rx_PoolSection)
178   } >RAM_D2 AT> FLASH
```

fsdata_custom.c

- A file named fsdata_custom.c must be created inside the inc folder



- Copy the provided data from the txt file to this. These will be our webpages.

```
4233 const struct fsdata_file file__STM32H7xx_files_ST_gif[] = { {
4234 file_NULL,
4235 data__STM32H7xx_files_ST_gif,
4236 data__STM32H7xx_files_ST_gif + 24,
4237 sizeof(data__STM32H7xx_files_ST_gif) - 24,
4238 FS_FILE_FLAGS_HEADER_INCLUDED | FS_FILE_FLAGS_HEADER_PERSISTENT,
4239 }};
4240
4241 const struct fsdata_file file__STM32H7xx_files_logo_jpg[] = { {
4242 file__STM32H7xx_files_ST_gif,
4243 data__STM32H7xx_files_logo_jpg,
4244 data__STM32H7xx_files_logo_jpg + 28,
4245 sizeof(data__STM32H7xx_files_logo_jpg) - 28,
4246 FS_FILE_FLAGS_HEADER_INCLUDED | FS_FILE_FLAGS_HEADER_PERSISTENT,
4247 }};
4248
4249 const struct fsdata_file file__STM32H7xx_files_stm32_jpg[] = { {
4250 file__STM32H7xx_files_logo_jpg,
4251 data__STM32H7xx_files_stm32_jpg,
4252 data__STM32H7xx_files_stm32_jpg + 28,
4253 sizeof(data__STM32H7xx_files_stm32_jpg) - 28,
4254 FS_FILE_FLAGS_HEADER_INCLUDED | FS_FILE_FLAGS_HEADER_PERSISTENT,
4255 }};
4256
4257 const struct fsdata_file file__404_html[] = { {
4258 file__STM32H7xx_files_stm32_jpg,
4259 data__404_html,
4260 data__404_html + 12,
4261 sizeof(data__404_html) - 12,
4262 FS_FILE_FLAGS_HEADER_INCLUDED | FS_FILE_FLAGS_HEADER_PERSISTENT,
4263 }};
4264
4265 const struct fsdata_file file__STM32H7xx_html[] = { {
4266 file__404_html,
4267 data__STM32H7xx_html,
4268 data__STM32H7xx_html + 16,
4269 sizeof(data__STM32H7xx_html) - 16,
4270 FS_FILE_FLAGS_HEADER_INCLUDED | FS_FILE_FLAGS_HEADER_PERSISTENT,
4271 }};
```

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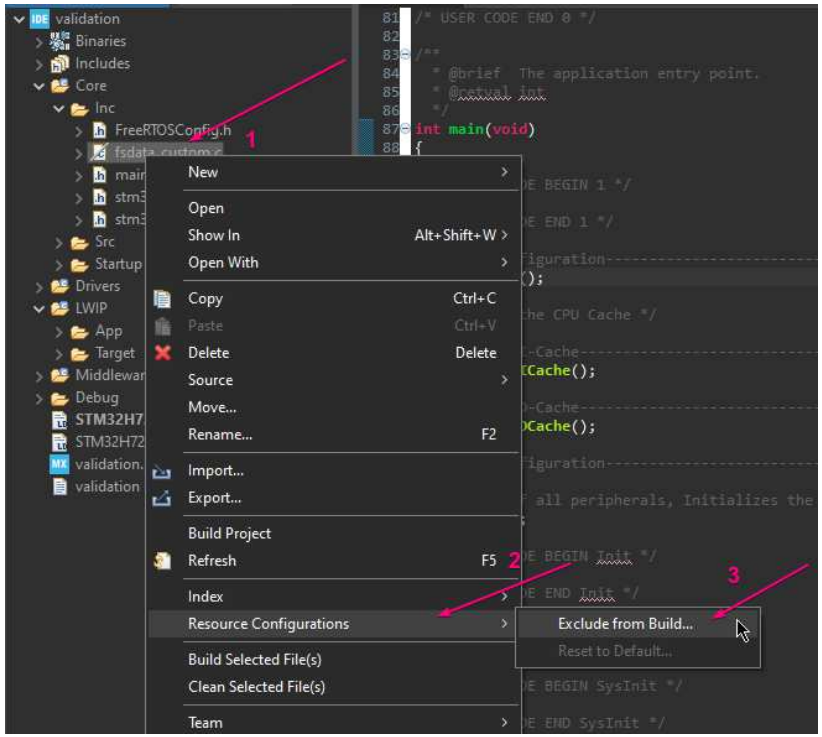
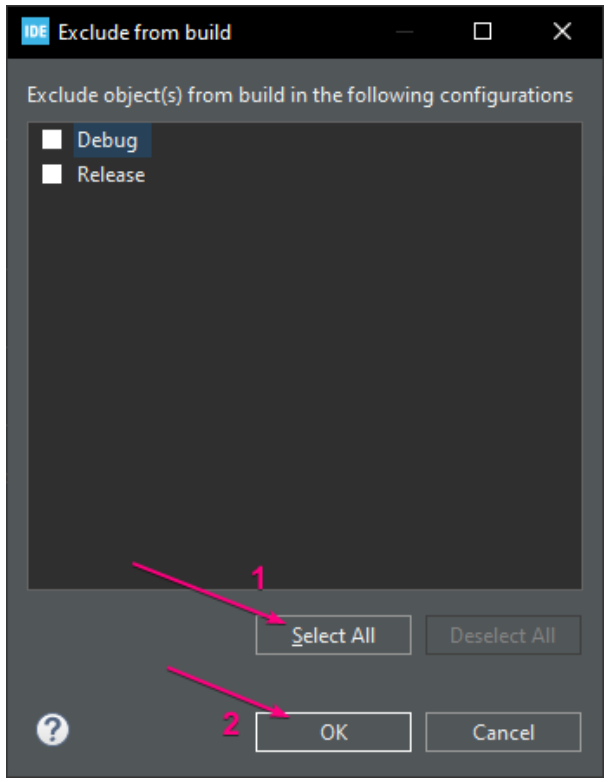
fsdata_custom.c

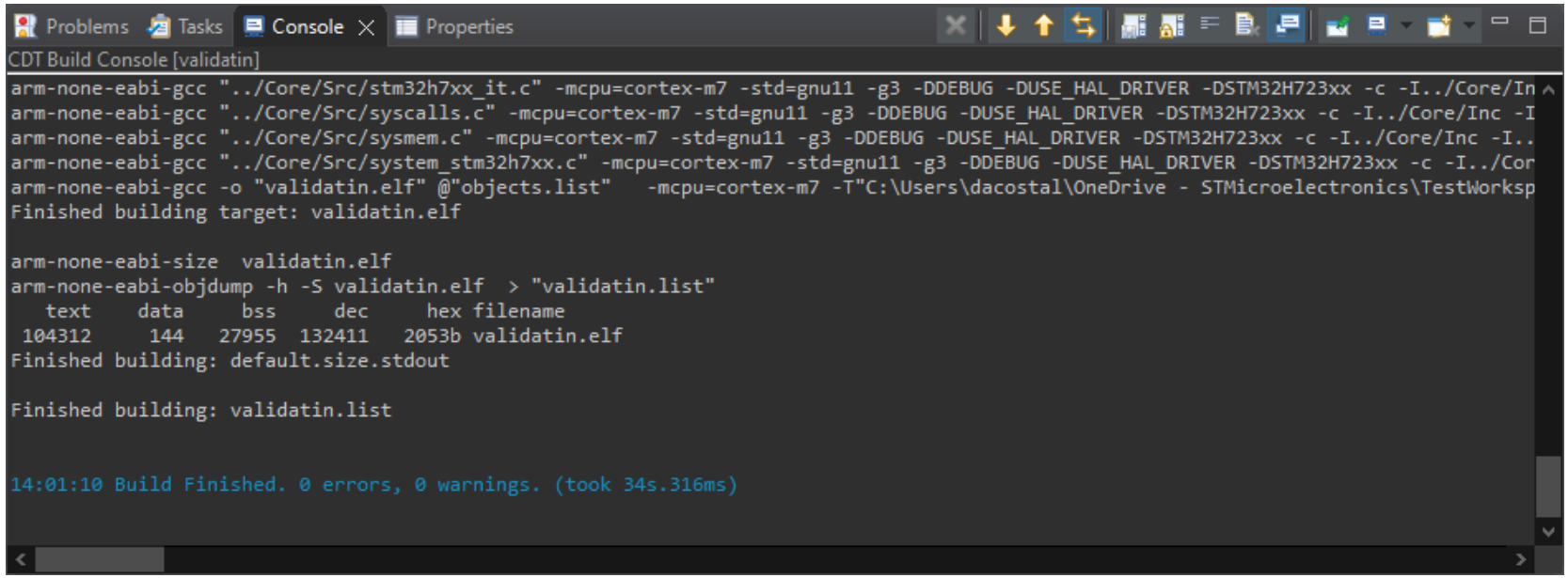
- The fsdata file must not be built with the project, only loaded. Left click it and follow the steps bellow





The moment of truth

- Compile the project
  - We expect 0 erros and 0 warnings

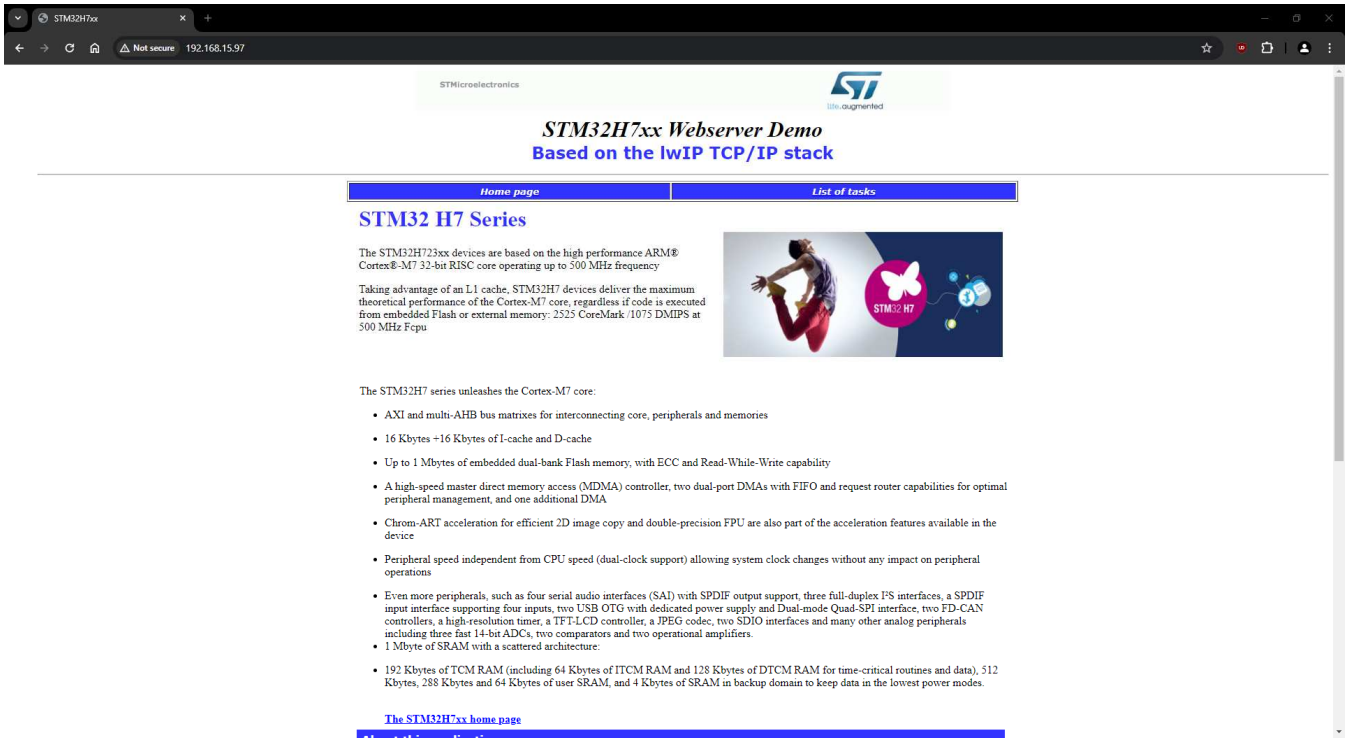


How to test it?

- To test the web server application, follow these steps:
  - Build and program the code we've just made.
  - Open your preferred virtual com terminal software and connect to the micro's COM port
  - On the remote PC, open a web client (Mozilla Firefox. Google Chrome or Internet Explorer) and type the board IP address in a web browser.

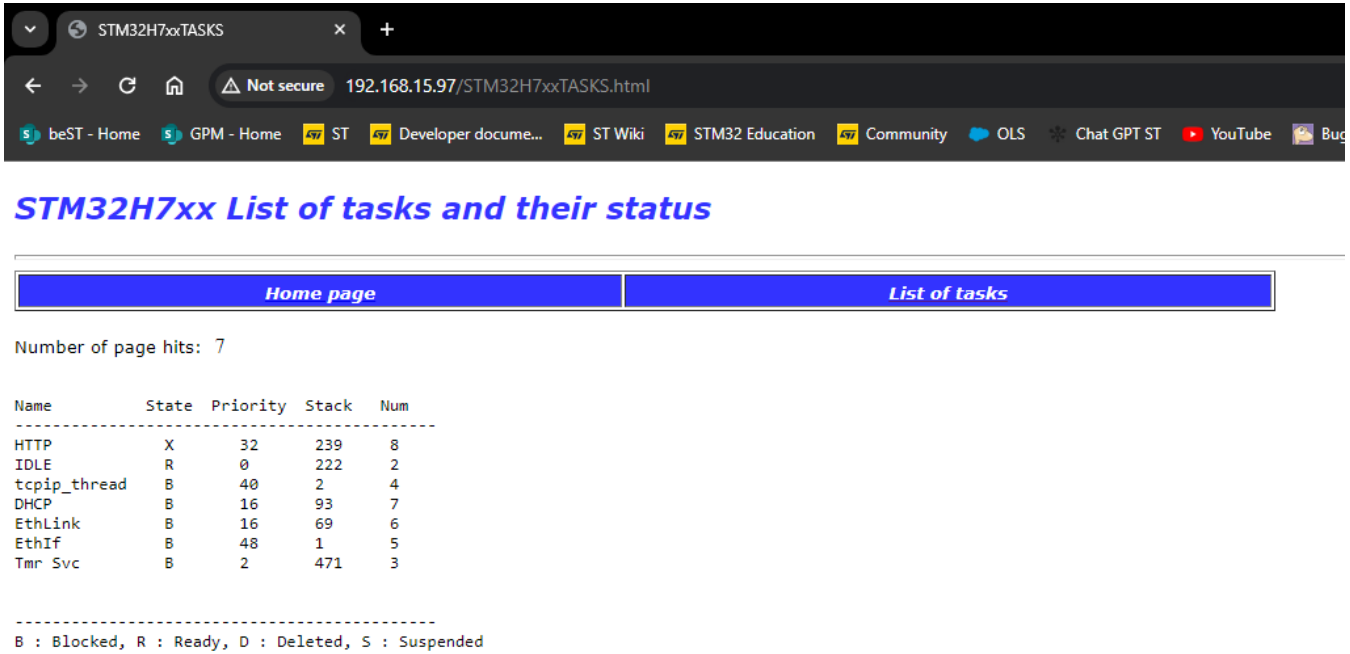
How to test it?

- The webserver home page is like this:



How to test it?

- Clicking the ‘list of tasks’ button will take us to the dynamic page we created, containing our RTOS stats



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