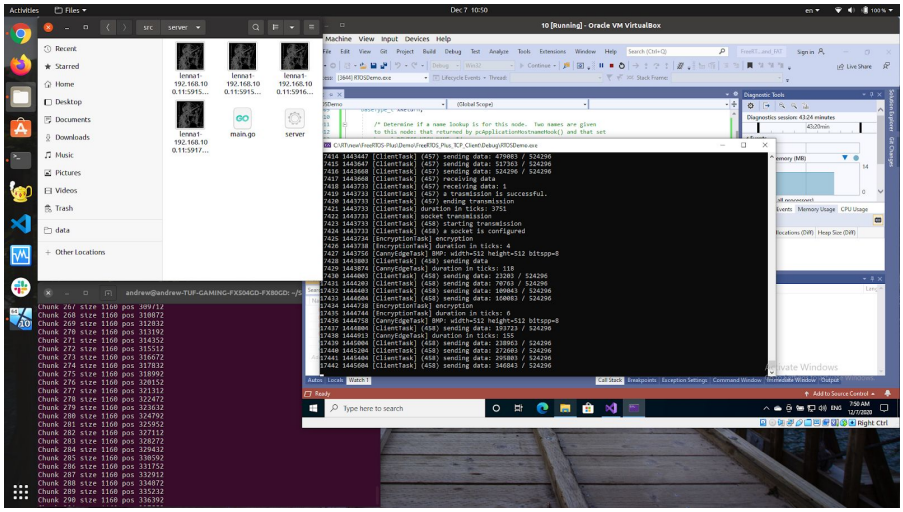


D1.a) Relevant configuration data for FreeRTOS
FreeRTOS general configuration is default from the project template.
Custom and changed parameters:
FreeRTOSConfig.h:

```
#define configNETWORK_INTERFACE_TO_USE 1
```

main.c:

```
// PC IP4 address
#define TCP_SERVER_ADDR1 192
#define TCP_SERVER_ADDR2 168
#define TCP_SERVER_ADDR3 100
#define TCP_SERVER_ADDR4 11
// VirtualBox IP4 address
//#define TCP_SERVER_ADDR1 10
//#define TCP_SERVER_ADDR2 0
//#define TCP_SERVER_ADDR3 2
//#define TCP_SERVER_ADDR4 15

#define TCP_SERVER_PORT 4040
```

D1.b) Report about create of tasks and the parameters used, attach c-code

```
xTaskCreate(prvClientTask, "ClientTask", mainTCP_SERVER_STACK_SIZE, NULL, mainTCP_SERVER_TASK_PRIORITY + 1, &xTCPClientTaskHandle);
xTaskCreate(prvCannyEdgeTask, "CannyEdgeTask", mainTCP_SERVER_STACK_SIZE, NULL, mainTCP_SERVER_TASK_PRIORITY, &xCannyTaskHandle );
xTaskCreate(prvEncryptionTask, "EncryptionTask", mainTCP_SERVER_STACK_SIZE, NULL, mainTCP_SERVER_TASK_PRIORITY, &xEncryptionTaskHandle );
```

D2.a) Relevant c-code for edge detection setup and screen shot of running algorithm. Provide result of picture with edge detection before/after

```
static void prvCannyEdgeTask( void *pvParameters )
{
        (void) pvParameters;

        message_t plainBuf;

   while(1)
```

```
  {
    static bitmap_info_header_t ih;
    const pixel_t* in_bitmap_data = load_bmp("lenna.bmp", &ih);

    if (in_bitmap_data == NULL)
    {
       FreeRTOS_printf(("BMP image is not loaded.\n"));
       break;
    }

    FreeRTOS_printf(("BMP: width=%d height=%d bitspp=%d\n", ih.width, ih.height,
ih.bitspp));

                TickType_t startTick = xTaskGetTickCount();

    const pixel_t* out_bitmap_data = canny_edge_detection(in_bitmap_data, &ih, 40, 80, 1.0);

    if (out_bitmap_data == NULL)
    {
       FreeRTOS_printf(("failed canny_edge_detection.\n"));
       free((pixel_t*)in_bitmap_data);
       break;
    }

    free((pixel_t*)in_bitmap_data);

    if (save_bmp("lenna_ce.bmp", &ih, out_bitmap_data)) {
       FreeRTOS_printf(("BMP image is not saved.\n"));
    }

    if(!pack_pixels(ih.width, ih.height, out_bitmap_data, &plainBuf.pData, &plainBuf.len))
    {
       FreeRTOS_printf(("failed to pack pixels.\n"));
       free((pixel_t*)out_bitmap_data);
       break;
    }

    free((pixel_t*)out_bitmap_data);

                TickType_t endTick = xTaskGetTickCount();
    FreeRTOS_printf(("duration in ticks: %d\n", endTick - startTick));

    if (xQueueSend(xEncryptQueue, &plainBuf, pdMS_TO_TICKS(1000)) != pdPASS)
    {
```

```
            free((uint8_t *)plainBuf.pData);
        }
        else
        {
          // the encryption task releases the buffer
        }
    }

    vTaskDelete(NULL);
}
```

D2.b) Relevant c-code for integrated encryption task running system. Provide output for some encrypted data

```
// p = 61, q = 53
// n = p * q
// de = 1 mod (p - 1)(q - 1)
// de = 413 * 17 = 1 mod 780
#define N 3233
#define E 17
#define D 413

static void prvEncryptionTask( void *pvParameters )
{
    (void) pvParameters;

          message_t plainBuf;
          message_t encBuf;

    while(1)
    {
        if(xQueueReceive(xEncryptQueue, &plainBuf, pdMS_TO_TICKS(1000)) == pdPASS)
        {
            if(plainBuf.pData != NULL)
            {
                                    TickType_t startTick = xTaskGetTickCount();

                                    FreeRTOS_printf(("encryption\n"));
```

```
                                int32_t nx = *((int32_t*)plainBuf.pData);
                                int32_t ny = ((int32_t*)plainBuf.pData)[1];
                                pixel_t* pixels = &(pixel_t*)((int32_t*)plainBuf.pData)[2];

                                pixel_t* enc = encrypt_image(pixels, nx, ny, N, E);
                                if (enc == NULL) {
                                        FreeRTOS_printf(("failed to allocate an encryption
buffer.\n"));
                                        free((uint8_t*)plainBuf.pData);
                                }
                                else
                                {
                                        free((uint8_t*)plainBuf.pData);

                                        if (!pack_pixels(nx, ny, enc, &encBuf.pData, &encBuf.len))
                                        {
                                                FreeRTOS_printf(("failed to pack pixels.\n"));
                                                free((pixel_t*)enc);
                                        }
                                        else
                                        {
                                                free((pixel_t*)enc);

                                                TickType_t endTick = xTaskGetTickCount();
                                                FreeRTOS_printf(("duration in ticks: %d\n", endTick
- startTick));

                                                if (xQueueSend(xTCPClientQueue, &encBuf,
pdMS_TO_TICKS(1000)) != pdPASS)
                                                {
                                                        free((uint8_t*)encBuf.pData);
                                                }
                                        }
                                }
                        }
                }
        }

        vTaskDelete(NULL);
}
```

D2.c) Relevant c-code TCP client tasks running system. Provide output transmitted packets

```
static void prvClientTask( void *pvParameters )
```

```
{
	(void)pvParameters;

   message_t uploadBuf;
	int frame = 1;

   ulTaskNotifyTake(pdTRUE, portMAX_DELAY); // wait for IP link is UP

   while(1)
   {
		if (xQueueReceive(xTCPClientQueue, &uploadBuf, pdMS_TO_TICKS(1000)) ==
pdPASS)
		{
			if (uploadBuf.pData != NULL)
			{
				TickType_t startTick = xTaskGetTickCount();

				FreeRTOS_printf(("socket transmission\n"));

				socket_transmission(uploadBuf.pData, uploadBuf.len, frame++);

				free((uint8_t*)uploadBuf.pData);

				TickType_t endTick = xTaskGetTickCount();
				FreeRTOS_printf(("duration in ticks: %d\n", endTick - startTick));
			}
		}
   }

   vTaskDelete(NULL);
}
```

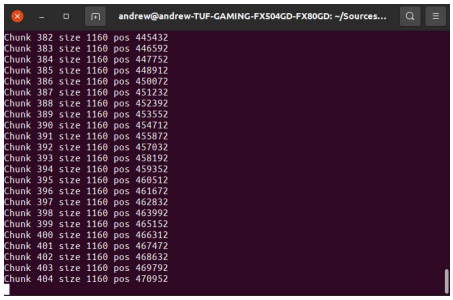
D3.a) Relevant c-code for setting up communications channels between FreeRTOS task

```
if (xQueueSend(xTCPClientQueue, &encBuf, pdMS_TO_TICKS(1000)) != pdPASS)
{
	free((uint8_t*)encBuf.pData);
}

if (xQueueReceive(xTCPClientQueue, &uploadBuf, pdMS_TO_TICKS(1000)) == pdPASS)
{

}
```

D4.a) Report and screen shot for TCP server executing on cloud system and accessing transmitted packets. Provide output of received packets



D5.c) Technique and hardware for interconnecting the camera onto the real platform resolution/picture quality, energy consumption, speed of communications, reliability, financial estimation

Picture quality: 512 x 512 pixels
Energy consumption: maximum 1W
Speed of Communications: 25 fps, 6MB/s
Financial estimation: maximum $20

D6.c) Report including references to relevant hardware OS chosen as most significant for creating the
real hardware platform:
OS: FreeRTOS
Hardware: ESP32 ($4-10)