

\*\*\*\*\*Draft\*\*\*\*\*

**Steganography for Ultibo Bare Metal  
with Debug using QEMU  
adding Cryptography  
Using Crypto &  
APICrypto from the Ultitbo RTL  
02/17/22**

\*\*\*\*\*Draft\*\*\*\*\*

imgprocess1.lpr reads input.png writes GrayScale.png

```
Machine View

Ultibo Core (Release: Beetroot Version: 2.1.279 Date: 5 January 2022)

Calling ReadImage ReadFile input.png
img reader is assigned
CBC1.StrKeyAsc Now we are engaged in a great ci
CBC1.StrKeyHex
4e6f772077652061726520656e676167656420696e2061206772656174206369
This is the data in the buffer B Now we are engaged in a great ci
Setting PP to the value of BP the BufPtr
PP is the pointer passed to returnfromprocessstr
010011100110111101110111001000000110111011001010010000001100001011100100110010000001100101011011100110011101
100001011001110110010101100100000100000011010010110111000100000011000010010000001100111011100100110010101000010111
0100001000000110001101101001
In pascal ReturnFromProcessStr calling calling C returnfromprocessstr
010011100110111101110111001000000110111011001010010000001100001011100100110010000001100101011011100110011101
100001011001110110010101100100000100000011010010110111000100000011000010010000001100111011100100110010101000010111
0100001000000110001101101001
0 0 1 1 2 0 3 0 4 1 5 1 6 1 7 0 8 0 9 1 10 1 11 0 12 1 13 1 14 1 15 1 16 0 17 1 18 1 19 1 20 0 21 1 22 1 23 1 24 0
25 0 26 1 27 0 28 0 29 0 30 0 31 0 32 0 33 1 34 1 35 1 36 0 37 1 38 1 39 1 40 0 41 1 42 1 43 0 44 0 45 1 46 0 47
1 48 0 49 0 50 1 51 0 52 0 53 0 54 0 55 0 56 0 57 1 58 1 59 0 60 0 61 0 62 0 63 1 64 0 65 1 66 1 67 1 68 0 69 0 70
1 71 0 72 0 73 1 74 1 75 0 76 0 77 1 78 0 79 1 80 0 81 0 82 1 83 0 84 0 85 0 86 0 87 0 88 0 89 1 90 1 91 0 92 0 9
3 1 94 0 95 1 96 0 97 1 98 1 99 0 100 1 101 1 102 1 103 0 104 0 105 1 106 1 107 0 108 0 109 1 110 1 111 1 112 0 11
3 1 114 1 115 0 116 0 117 0 118 0 119 1 120 0 121 1 122 1 123 0 124 0 125 1 126 1 127 1 128 0 129 1 130 1 131 0 13
2 0 133 1 134 0 135 1 136 0 137 1 138 1 139 0 140 0 141 1 142 0 143 0 144 0 145 0 146 1 147 0 148 0 149 0 150 0 15
1 0 152 0 153 1 154 1 155 0 156 1 157 0 158 0 159 1 160 0 161 1 162 1 163 0 164 1 165 1 166 1 167 0 168 0 169 0 17
0 1 171 0 172 0 173 0 174 0 175 0 176 0 177 1 178 1 179 0 180 0 181 0 182 0 183 1 184 0 185 0 186 1 187 0 188 0 18
9 0 190 0 191 0 192 0 193 1 194 1 195 0 196 0 197 1 198 1 199 1 200 0 201 1 202 1 203 1 204 0 205 0 206 1 207 0 20
8 0 209 1 210 1 211 0 212 0 213 1 214 0 215 1 216 0 217 1 218 1 219 0 220 0 221 0 222 0 223 1 224 0 225 1 226 1 22
7 1 228 0 229 1 230 0 231 0 232 0 233 0 234 1 235 0 236 0 237 0 238 0 239 0 240 0 241 1 242 1 243 0 244 0 245 0 24
6 1 247 1 248 0 249 1 250 1 251 0 252 1 253 0 254 0 255 0
Height 256 Width 256
Decrypt Intial Steps
010011100110111101110111001000000110111011001010010000001100001011100100110010000001100101011011100110011101
100001011001110110010101100100000100000011010010110111000100000011000010010000001100111011100100110010101000010111
0100001000000110001101101001
Calling WriteImage WriteFile GrayScale.png P GrayScale
WriteImage, options=P GrayScale
Grayscale TRUE - Indexed FALSE - WordSized FALSE - UseAlpha FALSE
Options checked, now writing...
Transfer for GrayScale.png started.
Transfer for GrayScale.png complete.
```

imgprocess2.lpr reads GrayScale.png writes output.png

Ultibo Core (Release: Beetroot Version: 2.1.279 Date: 5 January 2022)

```

Starting FPIImage Imgconv
Waiting for drive C:\
C:\ drive is ready

Local Address 10.0.2.15
TFTP Ready.
Completed setting up WebStatus & IP
Initing
Reader png
Writer png
img create & UsePalette false
Calling ReadImage ReadFile GrayScale.png
img reader is assigned
CBC1.StrKeyAsc Now we are engaged in a great ci
CBC1.StrKeyHex
4e6f772077652061726520656e676167656420696e2061206772656174206369
01100010000101111100100101111001011010100001101110010101110100100100110110100011000111100011100110000110100110010
01010111101101100011111010010011000111010000000101111000010111110111010110101010101010010010000100011110000001000010
111001000110100001011101110
011000100001011111001001011110010110101000011101110010101110100100100110110100011000111100011100110000110100110010
01010111101101100011111010010011000111010000000101111000010111110111010110101010101010010010000100011110000001000010
1110010001101000010111011110
Calling WriteImage WriteFile output.png P
WriteImage, options=P
Grayscale FALSE - Indexed FALSE - WordSized FALSE - UseAlpha FALSE
Options checked, now writing...
Transfer for output.png started.
Transfer for output.png complete.

```

Several arrays are needed to perform the next phase of the process.

type

```

MODR = array[0..255,0..255] of word;
MODRPtr = ^MODR;
XORR = array[0..255,0..255] of word;
XORRPtr = ^XORR;
TLSB = array[0..255,0..255] of word;
TLSBPtr = ^TLSB;
Lsb = array[0..255] of byte;
lsbPtr = ^Lsb;
Buffer = String[255];
BufPtr = ^Buffer; ;

```

```

S1,S2:String;
xx,yy : LongWord;
databuffer :PChar;
B : Buffer;
BP : BufPtr;
PP : Pointer;
bb : Lsb;
bbp : LsbPtr;

```

```

modbuf : MODR;
xorbuf : XORR;
tlsbbuf : TLSB;

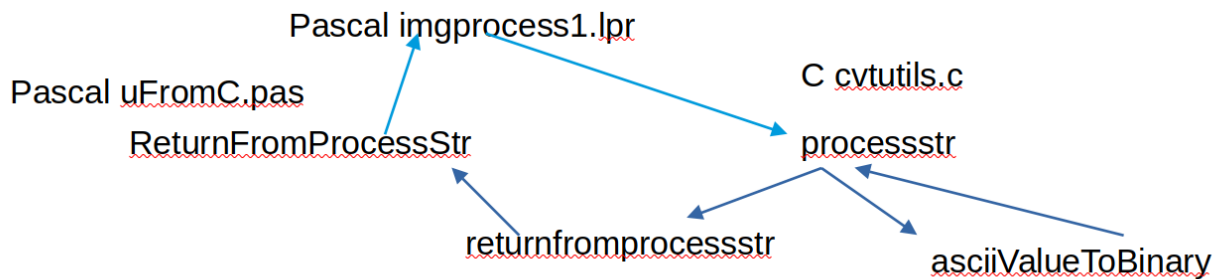
```

```
modbuf[i,j] := clr.red mod 2;
```

```

xx := modbuf[i,j] xor bbp^[i];
clr.red:=clr.red+xx;
After a 0 or 1 is added to red pixel
clr.green:=clr.red;
clr.blue:=clr.red;

```



Each char of the string is going to be place in a byte array as 0 or 1.

```

01001110011011110111011100100000011101110110010100100000011000010111001001100101
00100000011001010110111001100111011000010110011101100101011001000010000001101001
01101110001000000110000100100000011001110111001001100101011000010111010000100000
0110001101101001

```

```

010011100110111101110111001000000111011101100101001000000110000101110010011001010010000001100101011011100110011101
100001011001110110010101100100001000000110100101101110001000000110000100100000011001110111001001100101011000010111
010000100000011000110110100
0 0 1 1 2 0 3 0 4 1 5 1 6 1 7 0 8 0 9 1 10 1 11 0 12 1 13 1 14 1 15 1 16 0 17 1 18 1 19 1 20 0 21 1 22 1 23 1 24 0
25 0 26 1 27 0 28 0 29 0 30 0 31 0 32 0 33 1 34 1 35 1 36 0 37 1 38 1 39 1 40 0 41 1 42 1 43 0 44 0 45 1 46 0 47
1 48 0 49 0 50 1 51 0 52 0 53 0 54 0 55 0 56 0 57 1 58 1 59 0 60 0 61 0 62 0 63 1 64 0 65 1 66 1 67 1 68 0 69 0 70
1 71 0 72 0 73 1 74 1 75 0 76 0 77 1 78 0 79 1 80 0 81 0 82 1 83 0 84 0 85 0 86 0 87 0 88 0 89 1 90 1 91 0 92 0 9
3 1 94 0 95 1 96 0 97 1 98 1 99 0 100 1 101 1 102 1 103 0 104 0 105 1 106 1 107 0 108 0 109 1 110 1 111 1 112 0 11
3 1 114 1 115 0 116 0 117 0 118 0 119 1 120 0 121 1 122 1 123 0 124 0 125 1 126 1 127 1 128 0 129 1 130 1 131 0 13
2 0 133 1 134 0 135 1 136 0 137 1 138 1 139 0 140 0 141 1 142 0 143 0 144 0

```

uFromC now returns the string with the call to **processstr('Now we are engaged in a great ci');**

**ProcessStrResult String** For 32 char passed the return string is 32 \* 8 which 256 char.

xx := modbuf[i,j] xor bbp^[i];

clr.red:=clr.red+xx;

After a 0 or 1 is added to red pixel

clr.green:=clr.red;

clr.blue:=clr.red

```
Height 256 Width 256
0 0 0 0 41668 41668
0 0 41668 41668 41668
1 0 0 1 41415 41414
1 0 41415 41415 41415
2 0 1 1 40860 40859
2 0 40860 40860 40860
3 0 0 0 41564 41564
3 0 41564 41564 41564
4 0 1 0 41683 41683
4 0 41683 41683 41683
5 0 1 0 41215 41215
5 0 41215 41215 41215
6 0 1 0 40709 40709
6 0 1 0 40709 40709
6 0 40709 40709 40709
7 0 1 1 40174 40173
7 0 40174 40174 40174
8 0 1 1 40012 40011
8 0 40012 40012 40012
9 0 1 0 41485 41485
9 0 41485 41485 41485
10 0 0 1 39553 39552
10 0 39553 39553 39553
11 0 0 0 39898 39898
11 0 39898 39898 39898
12 0 0 1 39995 39994
12 0 39995 39995 39995
13 0 1 0 39331 39331
13 0 39331 39331 39331
14 0 1 0 39717 39717
```



Current Issues:

1. Conversion of RGB to gray scale using fcl-image fpimage.pp

This issue can be resolved by adding to WriteOptions := 'P GrayScale';

. This requires writing to the disk.img.

10-2-22 16:34:52 57612 GrayScale.png

```
clr.red:=round(clr.red*0.29900);  
clr.blue:=round(clr.blue*0.11400);  
clr.green:=round(clr.green*0.58700);  
clr.green:=clr.red+clr.blue+clr.green;  
clr.red:=clr.green;  
clr.blue:=clr.green;
```

11-2-22 12:31:41 73068 GrayScale.png

This makes red, blue, and green all the same value. Which is what WriteOptions := 'P GrayScale'; did.

**Note: The size of GrayScale.png is 26.8%**



2 Need to determine how to return the results of calling processstr(S1); back to improcessing1.

Ultibo has provided some ideas on this I just do not under the steps.

This project Goal: To learn steganogrphy based on code

<https://github.com/TheAlgorithms/MATLAB-Octave/blob/master/algorithms/ImageProcessing/LSB%20based%20Image%20Steganography/steganography.m>

The file steganography.m RPi4B Octave only works by commenting some lines and creating bit string of the of the desired text to embed in the image.

This repo [git@github.com:develone/MATLAB-Octave.git](https://github.com/develone/MATLAB-Octave)

which was forked from <https://github.com/TheAlgorithms/MATLAB-Octave>  
required minor modification to run on Raspberry Pi 4B 8Gb.

The following C program was written:

```
#include <stdio.h>
#include <string.h>

int asciiValueToBinary(int asciiInput)
{
    int res = 0, i = 1, rem;

    while (asciiInput > 0)
    {
        rem = asciiInput % 2;
        res = res + (i * rem);
        asciiInput = asciiInput / 2;
        i = i * 10;
    }
    //printf("%x\n",res);
    return(res);
}

void processstr(char *x) {
    int i,l;
    l=strlen(x);
    int outstr[l];
    //printf("C %d %s\n",l,x);
    for(i=0;i<l;i++) {
        printf("%d %08d ",i,asciiValueToBinary(*x));
        //printf("%08d",asciiValueToBinary(*x));
        outstr[i]=asciiValueToBinary(*x);
        x++;
    }
    printf("\n");
    for(i=0;i<l;i++) printf("%08d",outstr[i]);
    printf("\n");
}

int main() {
    char *p;
    char a[]="Now we are engaged in a great ci";
    p = a;
    processstr(p);
    return (0);
}
```

The methods void processstr(char \*x) & int asciiValueToBinary(int asciiInput) are found in a program cvtutils.c. The is compiled for usewith Ultibo using **./libuild.sh in Ultibo\_Projects/imgconv/QEMU**

gcc bitstring.c -o bitstring

./bitstring

```

0 01001110 1 01101111 2 01110111 3 00100000 4 01110111 5 01100101 6 00100000 7 01100001
8 01110010 9 01100101 10 00100000 11 01100101 12 01101110 13 01100111 14 01100001 15
01100111 16 01100101 17 01100100 18 00100000 19 01101001 20 01101110 21 00100000 22
01100001 23 00100000 24 01100111 25 01110010 26 01100101 27 01100001 28 01110100 29
00100000 30 01100011 31 01101001
0100111001101111011100100000011101110110010100100000011000010111001001100101
00100000011001010110111001100111011000010110011101100101011001000010000001101001
01101110001000000110000100100000011001110111001001100101011000010111010000100000
0110001101101001

```

This information is part of readme.md provided in the original repo.  
The encoding is done using the following steps:

1. Convert the image to greyscale
2. Resize the image if needed
3. Convert the message to its binary format
4. Initialize output image same as input image
5. Traverse through each pixel of the image and do the following:
  - Convert the pixel value to binary
  - Get the next bit of the message to be embedded
  - Create a variable temp
  - If the message bit and the LSB of the pixel are same, set temp = 0
  - If the message bit and the LSB of the pixel are different, set temp = 1
  - This setting of temp can be done by taking XOR of message bit and

the LSB of the pixel

Update the pixel of output image to input image pixel value + temp

Keep updating the output image till all the bits in the message are embedded

Finally, write the input as well as the output image to local system.

The decoding/decryption is done using the following steps:

1. Get the output image which was encoded earlier.
2. Input the length of the encoded message (character count).
3. Retrieve the LSBs of each pixel
4. Form a bit sequence from these LSBs
5. Arrange the bit sequence into a matrix of 8 rows and total\_message\_bits/8 columns  
(each column will represent a character of 8 bits, hence 8 rows)
  - Convert the binary value to decimal
  - Get the corresponding char from ascii

Finally, display the original message.

Now we are engaged in a great ci

octave

GNU Octave, version 6.2.0

Copyright (C) 2021 The Octave Project Developers.

This is free software; see the source code for copying conditions.

There is ABSOLUTELY NO WARRANTY; not even for MERCHANTABILITY or  
FITNESS FOR A PARTICULAR PURPOSE. For details, type 'warranty'.



Octave was configured for "arm-unknown-linux-gnueabi".

Additional information about Octave is available at <https://www.octave.org>.

Please contribute if you find this software useful.

For more information, visit <https://www.octave.org/get-involved.html>

Read <https://www.octave.org/bugs.html> to learn how to submit bug reports.

For information about changes from previous versions, type 'news'.

```
octave:1>steganograpyhy
```

Input Image



Image with Hidden Data



```
1989.00, 173.346
```

```
octave:2> decrypt
```

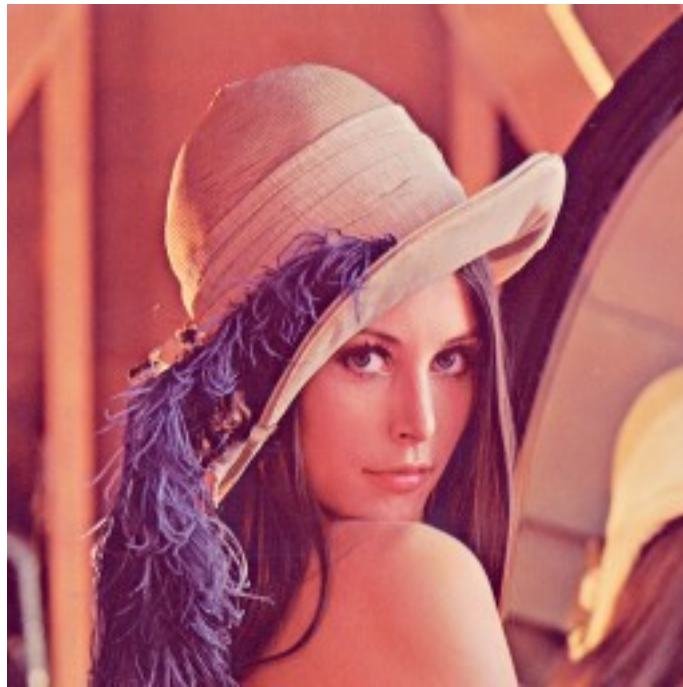
Enter the length (character count) of the message you are looking for:

Enter the length (character count) of the message you are looking for: 32

The original message is: Now we are engaged in a great ci

```
octave:3>
```

Testing using lena\_rgb\_256.png in input.png



```
octave:1>steganography
```

Input Image



Image with Hidden Data



```
325.825, -27.3639
```

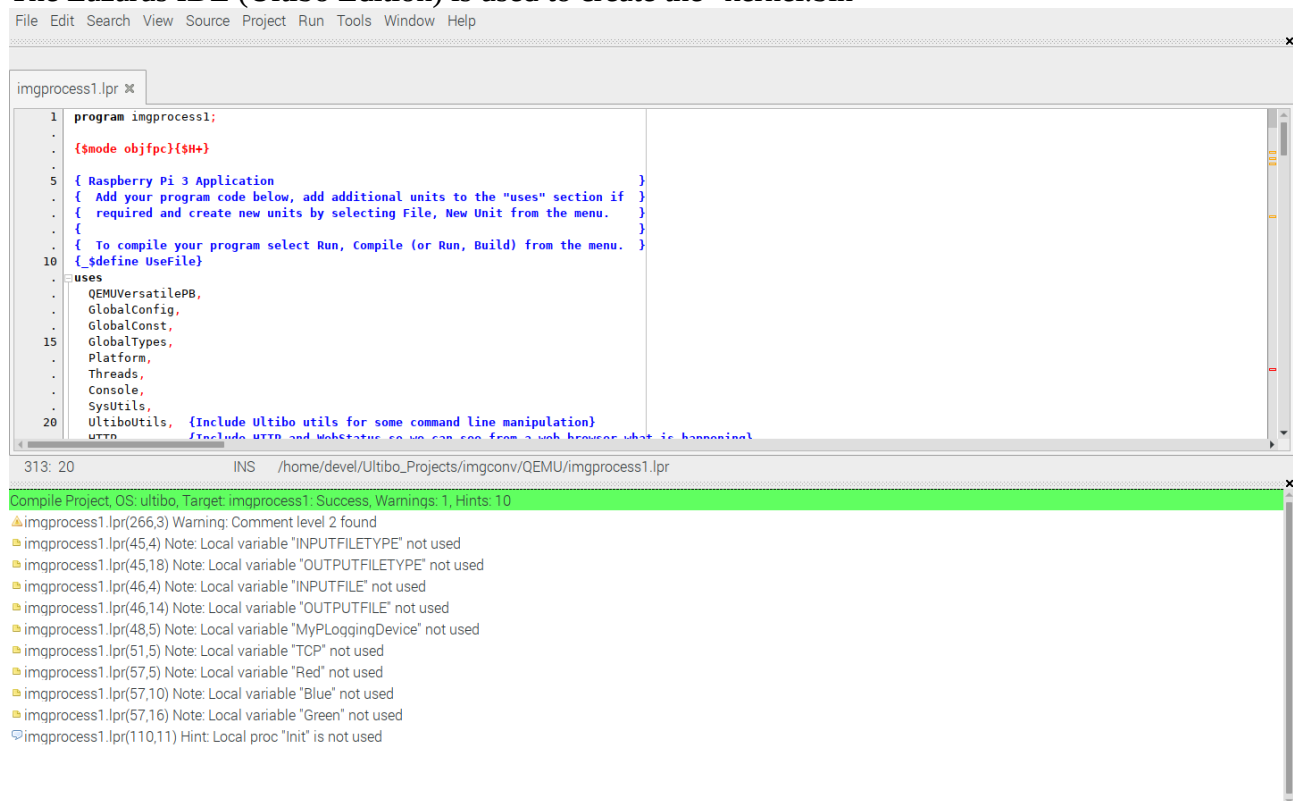
```
octave:2> decrypt
```

Enter the length (character count) of the message you are looking for:

Enter the length (character count) of the message you are looking for: 32

The original message is: Now we are engaged in a great ci  
octave:3>

The Lazarus IDE (Ultibo Edition) is used to create the "kernel.bin"



From the main menu Run/Compile. If no errors a green bar appers.

. Ultibo\_Projects/picoultibo.sh This sets the PATH

/home/devel/ultibo/core:/home/devel/qemu-6.1.0-rpios/bin:/home/devel/local/openocd/bin:/usr/  
local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/local/games:/usr/games

./libuild.sh in Ultibo\_Projects/imgconv/QEMU

cd Ultibo\_Projects/imgconv/QEMU

~/Ultibo\_Projects/imgconv/QEMU \$ ./startqemu.sh

```
Machine View

Ultibo Core (Release: Beetroot Version: 2.1.279 Date: 5 January 2022)

Local Address 10.0.2.15
TFTP Ready.
Completed setting up WebStatus & IP
Initing
Reader png
Writer png
img create & UsePalette false
Calling ReadImage ReadFile input.png
img reader is assigned
CBC1.StrKeyAsc Now we are engaged in a great ci
CBC1.StrKeyHex
4e6f772077652061726520656e676167656420696e2061206772656174206369
This is the data in the buffer B Now we are engaged in a great ci
Setting PP to the value of BP the BufPtr
PP is the pointer passed to returnfromprocessstr
01001110011011110111001000000111011101100101001000000110000101110010011001010010000001100101011011100111011101
100001011001110110010101100100001000000110100101101110001000000110000100100000011001110111001001100101011000010111
0100001000000110001101101001
In pascal ReturnFromProcessStr calling calling C returnfromprocessstr
01001110011011110111001000000111011101100101001000000110000101110010011001010010000001100101011011100111011101
100001011001110110010101100100001000000110100101101110001000000110000100100000011001110111001001100101011000010111
0100001000000110001101101001
0 0 1 1 2 0 3 0 4 1 5 1 6 1 7 0 8 0 9 1 10 1 11 0 12 1 13 1 14 1 15 1 16 0 17 1 18 1 19 1 20 0 21 1 22 1 23 1 24 0
25 0 26 1 27 0 28 0 29 0 30 0 31 0 32 0 33 1 34 1 35 1 36 0 37 1 38 1 39 1 40 0 41 1 42 1 43 0 44 0 45 1 46 0 47
1 48 0 49 0 50 1 51 0 52 0 53 0 54 0 55 0 56 0 57 1 58 1 59 0 60 0 61 0 62 0 63 1 64 0 65 1 66 1 67 1 68 0 69 0 70
1 71 0 72 0 73 1 74 1 75 0 76 0 77 1 78 0 79 1 80 0 81 0 82 1 83 0 84 0 85 0 86 0 87 0 88 0 89 1 90 1 91 0 92 0 9
3 1 94 0 95 1 96 0 97 1 98 1 99 0 100 1 101 1 102 1 103 0 104 0 105 1 106 1 107 0 108 0 109 1 110 1 111 1 112 0 11
3 1 114 1 115 0 116 0 117 0 118 0 119 1 120 0 121 1 122 1 123 0 124 0 125 1 126 1 127 1 128 0 129 1 130 1 131 0 13
2 0 133 1 134 0 135 1 136 0 137 1 138 1 139 0 140 0 141 1 142 0 143 0 144 0 145 0 146 1 147 0 148 0 149 0 150 0 15
1 0 152 0 153 1 154 1 155 0 156 1 157 0 158 0 159 1 160 0 161 1 162 1 163 0 164 1 165 1 166 1 167 0 168 0 169 0 17
0 1 171 0 172 0 173 0 174 0 175 0 176 0 177 1 178 1 179 0 180 0 181 0 182 0 183 1 184 0 185 0 186 1 187 0 188 0 18
9 0 190 0 191 0 192 0 193 1 194 1 195 0 196 0 197 1 198 1 199 1 200 0 201 1 202 1 203 1 204 0 205 0 206 1 207 0 20
8 0 209 1 210 1 211 0 212 0 213 1 214 0 215 1 216 0 217 1 218 1 219 0 220 0 221 0 222 0 223 1 224 0 225 1 226 1 22
7 1 228 0 229 1 230 0 231 0 232 0 233 0 234 1 235 0 236 0 237 0 238 0 239 0 240 0 241 1 242 1 243 0 244 0 245 0 24
6 1 247 1 248 0 249 1 250 1 251 0 252 1 253 0 254 0 255 0
Height 256 Width 256
Calling WriteImage WriteFile GrayScale.png P
WriteImage, options=P
Grayscale FALSE - Indexed FALSE - WordSized FALSE - UseAlpha FALSE
Options checked, now writing...
```

While QEMU is running telnet, tftp and a webserver are provided.

~/Ultibo\_Projects/imgconv/QEMU \$ telnet xx.xx.xx.xx 5023

(Type HELP for a list of available commands)

>dir

Directory of C:\

28-7-21 18:41:54	53	Another File.txt
28-7-21 18:41:54	31	Test File.txt
28-7-21 18:41:54	<DIR>	www
10-1-22 12:25:18	24	testfile
10-1-22 23:54:30	24	junk

```

10-1-22 12:25:18      24 256com
5-2-22 17:32:46      65536 red
28-7-21 18:44:28      24 256decom
28-7-21 18:44:28     196730 lena_rgb_256.bmp
28-7-21 18:44:28     196730 MyBitmap.bmp
5-2-22 17:41:56       7848 test.j2k
5-2-22 17:32:48      65536 green
5-2-22 17:32:48      65536 blue
5-2-22 17:32:48     196730 test_wr.bmp
5-2-22 17:57:08     125663 lena_rgb_256.png
7-2-22 12:54:36     196662 lena_rgb_256_fpng.bmp
    15 file(s) 1117151 bytes
    1 dir(s)

```

```

C:\>logout
Goodbye!
Connection closed by foreign host.

```

```

~/Ultibo_Projects/imgconv/QEMU $ tftp xx.xx.xx.xx 5069
tftp> binary
tftp> get lena_rgb_256_fpng.bmp
Received 196662 bytes in 2.8 seconds
tftp> quit

```

<http://xx.xx.xx.xx:5080/status>

Ultibo Core (Release: Beetroot Version: 2.1.279 Date: 5 January 2022)		
General	General	
Platform	Release Name:	Beetroot
Memory	Release Version:	2.1.279
Heap Blocks	Release Date:	5 January 2022
CPU	Time (Local):	7-2-22 13:02:05
FPU	Time (UTC):	7-2-22 13:02:05
GPU	Timezone:	UTC
RTL	Daylight Start:	None
Clock	Daylight Date:	N/A
Locale	Standard Start:	None
Threading	Standard Date:	N/A
Thread List	Temperature (SoC):	0 degrees Celcius
Scheduler	Uptime:	0 days 00:07:46
Devices		
Drivers		
Handles		
USB		
PCI		
MMC / SD / SDIO		
Network		
Storage		
Filesystem		
Disk Cache		
Keyboard		
Mouse		
Touch		
Framebuffer		
Environment		
Page Tables		
Vector Tables		
IRQ / FIQ / SWI		
GPIO		
Configuration		
Device Tree		

xxx