



112-2 衛星系統實作

Program of On-Board Computer (OBC)

補充教學資料

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太空酬載實驗室

2024年02月27日



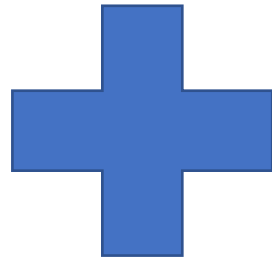


What is **OBC** Subsystem?

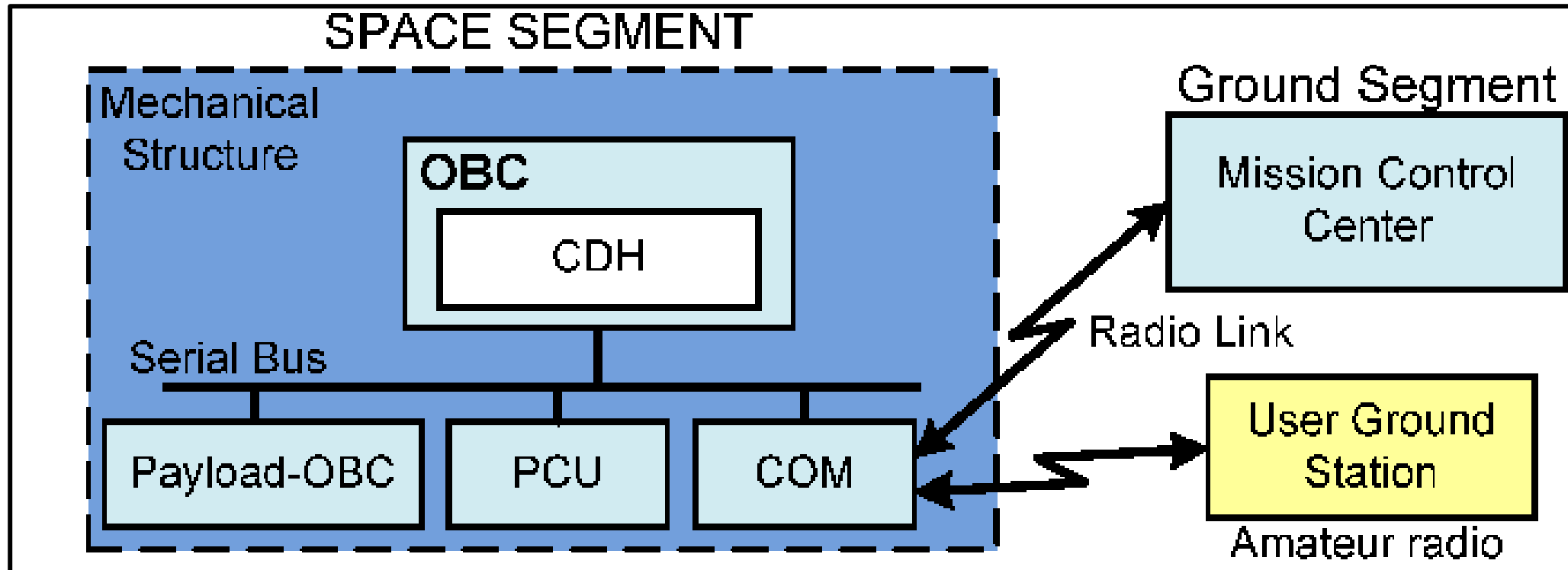
Connector

Supervisor

OBC






- The **OBC** (On-Board Computer) in CubeSat is the subsystem which acts as both **connector** (connects the subsystems with each other) and **supervisor** (supervise other subsystem)



- It supervises many of task/functions that are done by the different subsystems of satellite and performs housekeeping and monitoring to ensure the health and status of those subsystems.



How to design OBC Subsystem? (In Hardware)

HEPTA-SAT Case			
	Mbed LPC1768	Wired	PC

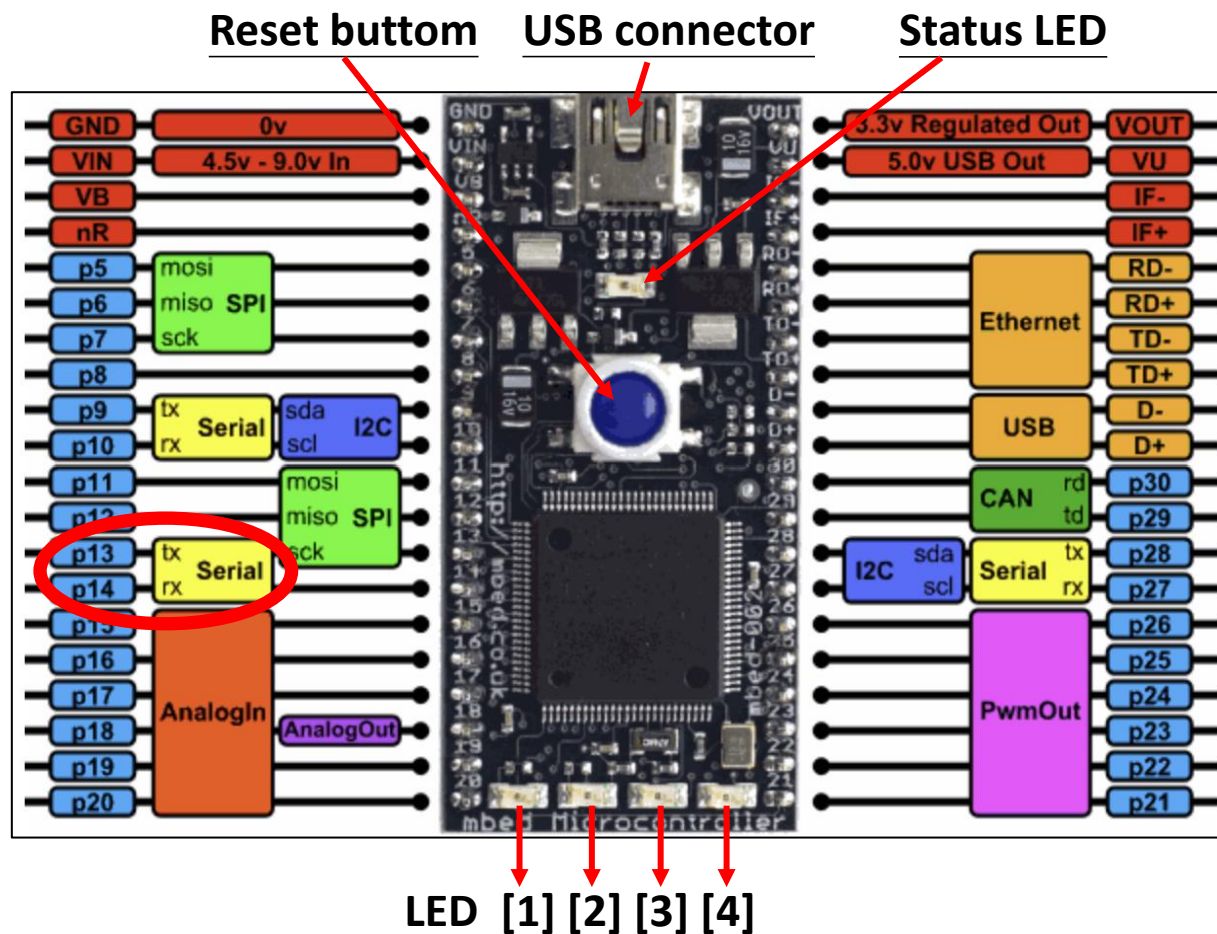
- Originally the satellite uses communication device to communicate with space and ground station. In this course, mbed LPC1768 is pretend to the satellite (The development environment of HEPTA-SAT is mbed website), the wired is pretend to the wireless device, and your PC act the role as the ground station.

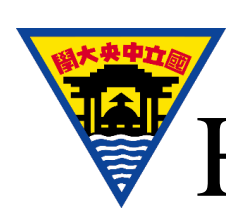


How to design OBC Subsystem? (In Hardware)

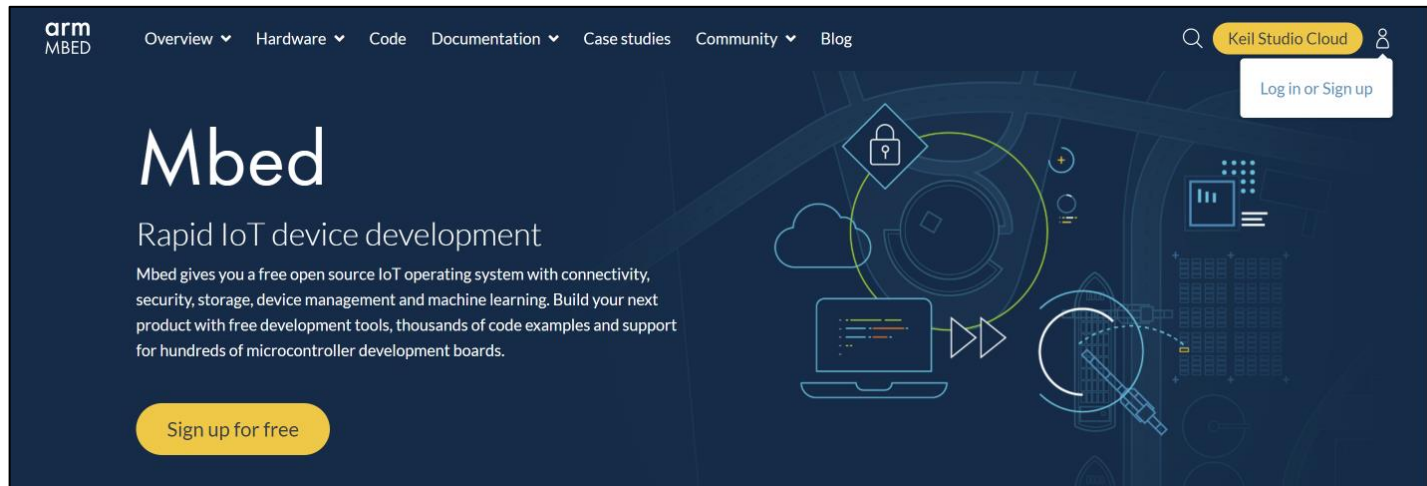


Mbed LPC1768

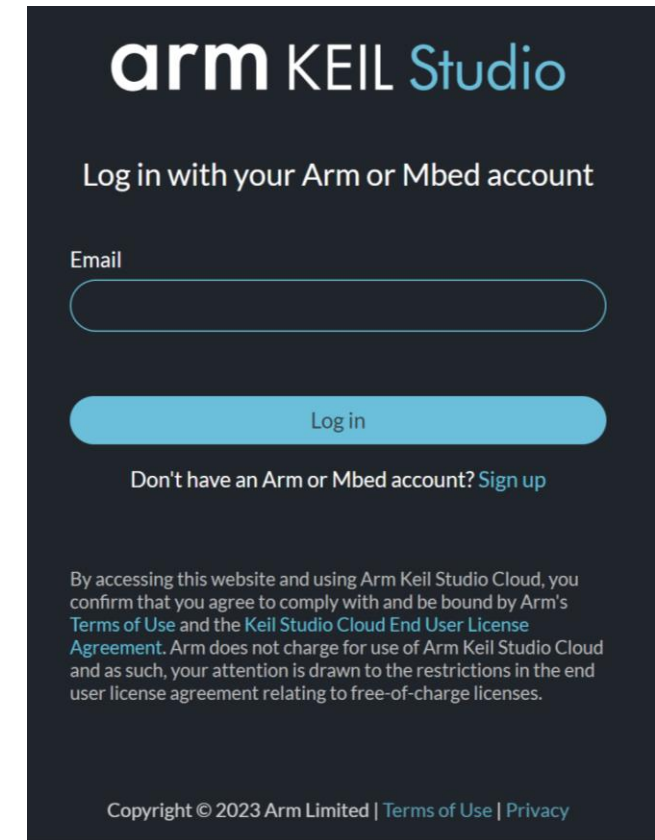




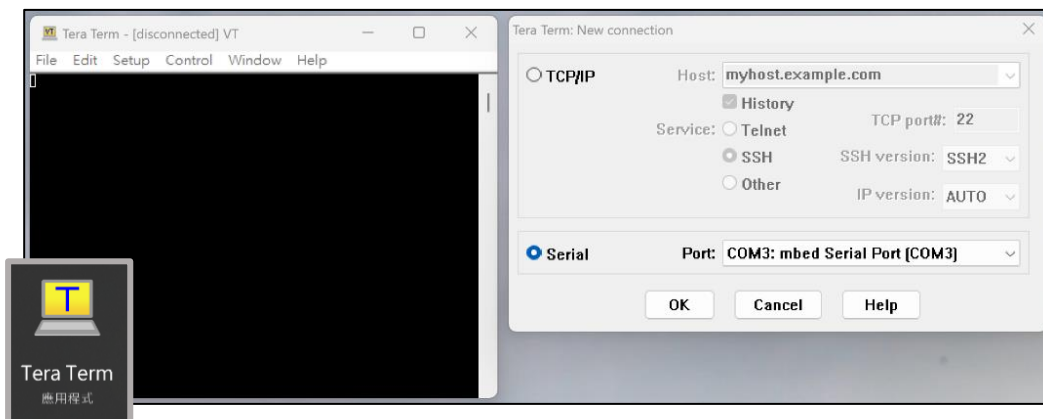
How to design OBC Subsystem? (In Software)



- Mbed (create your account)



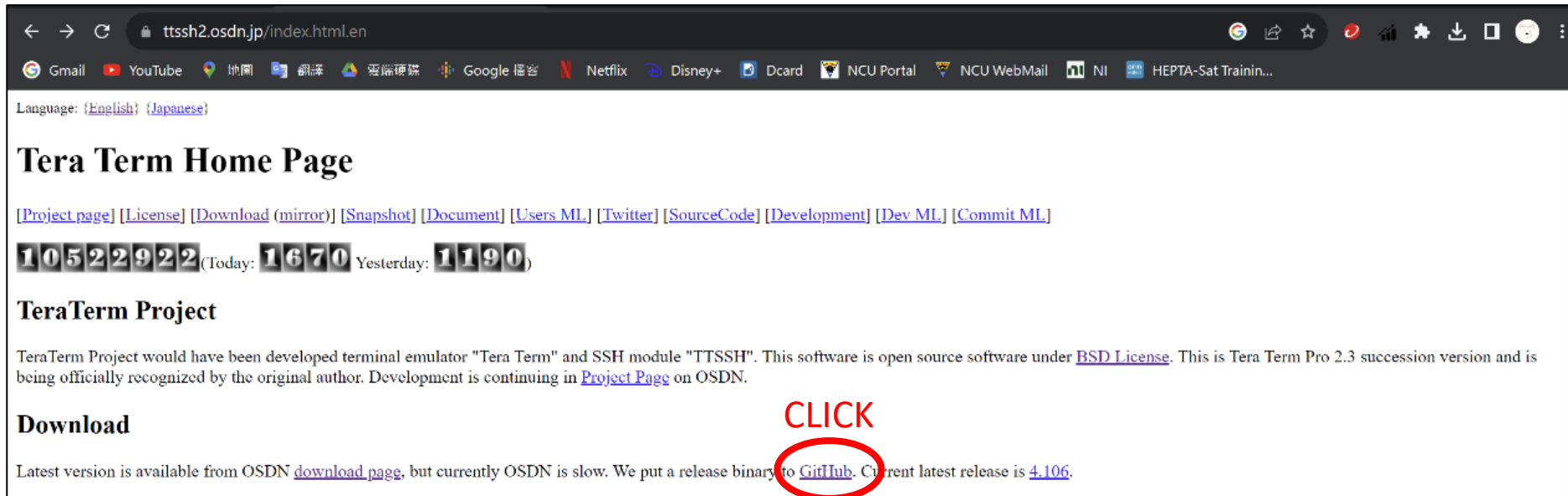
- Arm KEIL Studio (modify the code)



- Tera Term (show the data from Mbed LPC1768)



Tera Term (Installation)



ttssh2.osdn.jp/index.html.en

Language: [English](#) [Japanese](#)

Tera Term Home Page

[\[Project page\]](#) [\[License\]](#) [\[Download \(mirror\)\]](#) [\[Snapshot\]](#) [\[Document\]](#) [\[Users ML\]](#) [\[Twitter\]](#) [\[SourceCode\]](#) [\[Development\]](#) [\[Dev ML\]](#) [\[Commit ML\]](#)

10522922 (Today: **1670** Yesterday: **1190**)

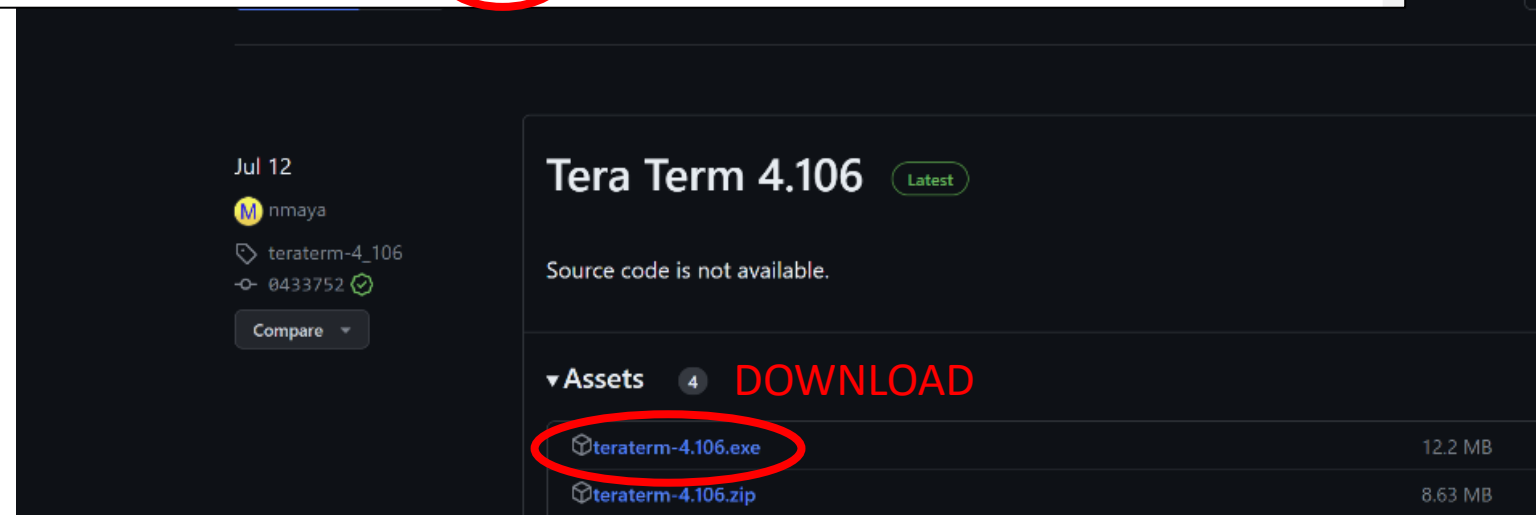
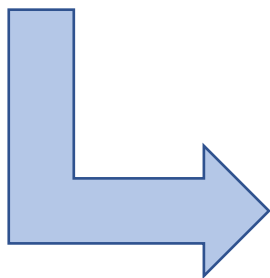
TeraTerm Project

TeraTerm Project would have been developed terminal emulator "Tera Term" and SSH module "TTSSH". This software is open source software under [BSD License](#). This is Tera Term Pro 2.3 succession version and is being officially recognized by the original author. Development is continuing in [Project Page](#) on OSDN.

Download

Latest version is available from OSDN [download page](#), but currently OSDN is slow. We put a release binary to [GitHub](#). Current latest release is [4.106](#).

CLICK



Jul 12

nmay

teraterm-4_106

0433752

Compare

Tera Term 4.106 Latest

Source code is not available.

▼ Assets 4 **DOWNLOAD**

- [teraterm-4.106.exe](#) 12.2 MB
- [teraterm-4.106.zip](#) 8.63 MB



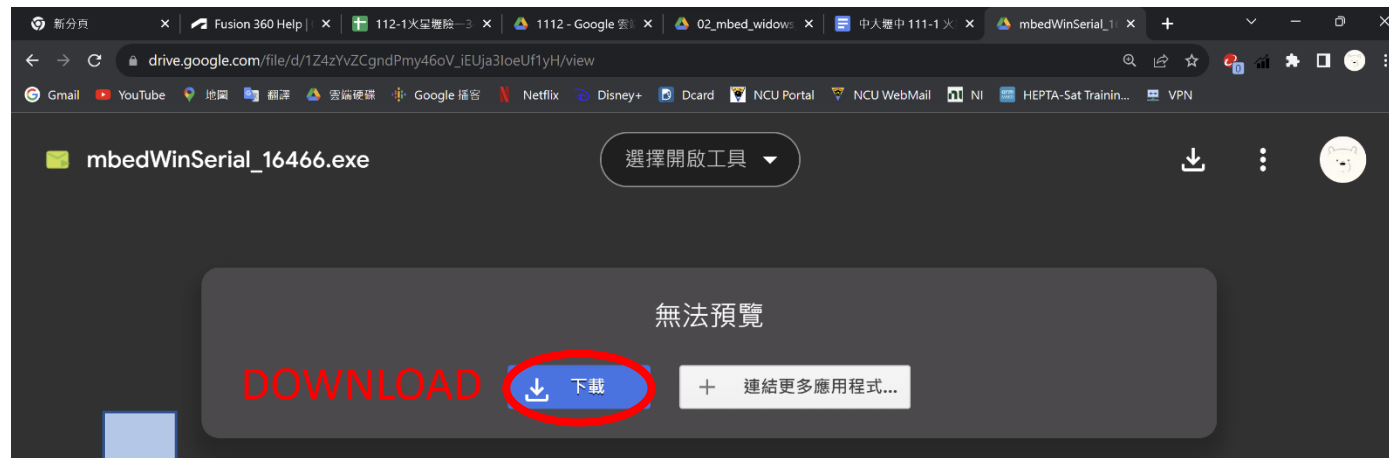
Tera Term (Installation) cont.

The installation wizard consists of the following steps:

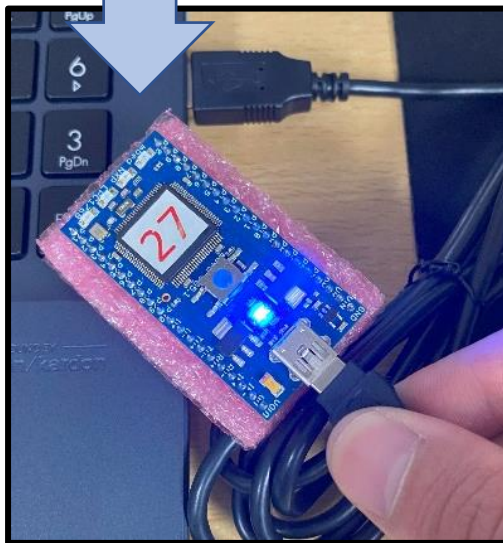
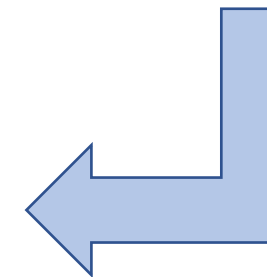
- License Agreement:** Displays the license terms. The "I accept the agreement" radio button is selected. The "Next >" button is circled in red.
- Select Components:** Shows a list of components to be installed. The "Standard installation" dropdown is selected. Components include Tera Term & Macro (9.0 MB), TTSSH (3.1 MB), CygTerm+ (0.2 MB), LogMeTT (4.1 MB), TTLEdit (2.1 MB), TeraTerm Menu (0.3 MB), TTProxy (0.3 MB), Collector (1.6 MB), and Additional Plugins (0.3 MB). The "Next >" button is circled in red.
- Select Language:** Shows language options. "English" is selected. Other options include Japanese, German, French, Russian, Korean, Chinese(Simplified), and Chinese(Traditional). The "Next >" button is circled in red.
- Select Additional Tasks:** Shows additional tasks to be performed. "Create Tera Term shortcut to Desktop" and "Create Tera Term shortcut to Quick Launch" are checked. Other options include adding to context menu, creating shortcuts, and associating file types. The "Next >" button is circled in red.
- Ready to Install:** Shows the final summary of the installation. The "Install" button is circled in red.



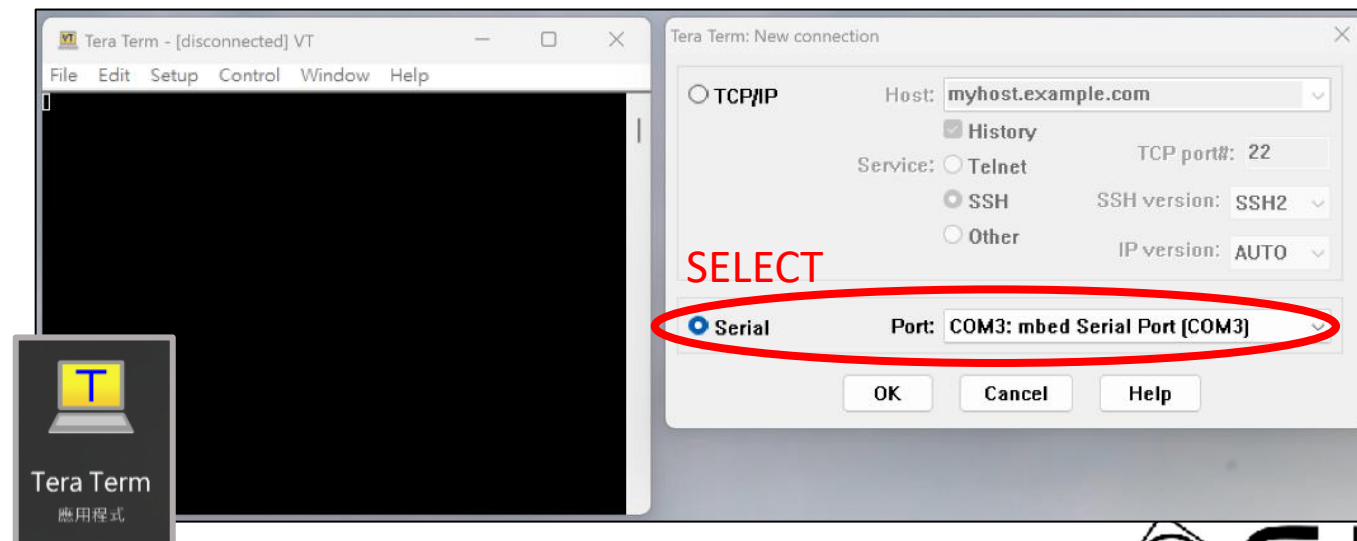
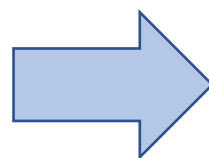
Tera Term (Installation) cont.



<https://reurl.cc/q01Zzy>



CONNECT MBED TO PC





Mbed (create account)

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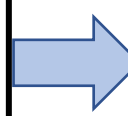
Log in

New to Mbed [Create an account](#)

Email address *

Next

Only know your username? [Get an email reminder.](#)



Log in

New to Mbed [Sign up](#)

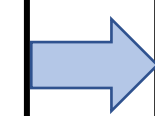
Email address *

Forgotten your email?

Password *

Forgotten your password?

Log in



arm MBED

Sign up

Already have an Mbed account? [Log in](#)

Create a free Mbed account to access Mbed tools and services and contribute to the developer community.

Email address *

Username *

Password *

FILL THE INFORMATION

First name *

Last name *

Country *

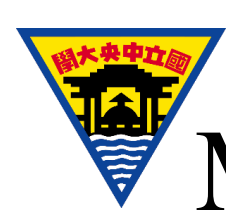
Taiwan

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Mbed (select the code)

<https://reurl.cc/WvXqDk>

arm MBED Overview Hardware Code Documentation Case studies Community Blog

HEPTA-Sat Training 2020

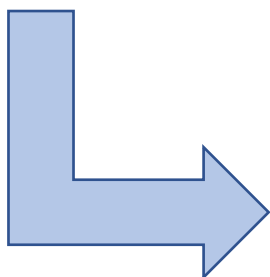
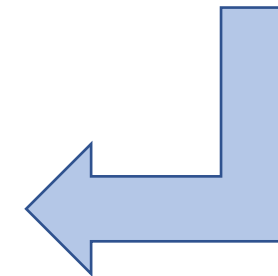
Library for HEPTA-Sat Training 2020

Summary Code Wiki Community

Code

Mbed 2 deprecated Lab1-0X_create_satellite_code_1b Last updated: 04 Dec 2021

20211204 1 22



arm MBED Overview Hardware Code Documentation Case studies Community Blog

HEPTA-Sat Training 2020 » Code » Lab1-01_pc_communication

HEPTA-Sat Training 2020 / Mbed 2 deprecated Lab1-01_pc_communication

for textbook v4.4

Dependencies: mbed

Home History Graph API Documentation Wiki Pull Requests

Repository toolbox

Import into Keil Studio

Export to desktop IDE

Build repository

CHOOSE THE CODE

IMPORT



Keil Studio (modify the code)

The screenshot displays the Keil Studio IDE interface. On the left, the Project Explorer shows the project 'Lab1-01_pc_communication' with a 'CONNECT DEVICE' label. The 'Connected device' is 'mbed LPC1768: 1010af6be131d6b98fcc79f...'. The file tree shows 'main.cpp' selected. The main editor window displays the following C++ code:

```
1  #include "mbed.h"
2
3  Serial pc(USBTX, USBRX);
4
5  int main(){
6      pc.baud(9600);
7      int i1=7;
8      float i2=7.5;
9      char i3='H';
10     char c;
11
12     pc.printf("Hello World!\r\n");
13     pc.printf("i1=%d\r\n", i1);
14     pc.printf("i2=%f\r\n", i2);
15     pc.printf("i3=%c\r\n", i3);
16     pc.putc(i3);
17     pc.printf("\r\n");
18
19     for(int j=0; j<10; j++){
20         pc.printf("j=%d -- enter any key --> ", j);
21         c = pc.getc();
22         pc.putc(c);
23         pc.printf("\r\n");
24     }
```

A 'MODIFY THE CODE' label is present in the bottom right of the code editor area. The status bar at the bottom indicates 'clangd: idle' and 'Run: mbed LPC1768'.



Keil Studio (modify the code) cont.

BUILD & COMPILE THE CODE

```
#include "mbed.h"

Serial pc(USBTX, USBRX);

int main(){
    pc.baud(9600);
    int i1=7;
    float i2=7.5;
    char i3='H';
    char c;

    pc.printf("Hello World!\r\n");
    pc.printf("i1=%d\r\n", i1);
    pc.printf("i2=%f\r\n", i2);
    pc.printf("i3=%c\r\n", i3);
    pc.putc(i3);
    pc.printf("\r\n");

    for(int j=0; j<10; j++){
        pc.printf("j=%d -- enter any key --> ", j);
        c = pc.getc();
        pc.putc(c);
        pc.printf("\r\n");
    }
}
```

Lab1-01_pc_communication.LPC1768 (1).bin
24.2 KB • 完成

Fusion 360 Client Downloader.exe
11.2 MB • 2 小時前

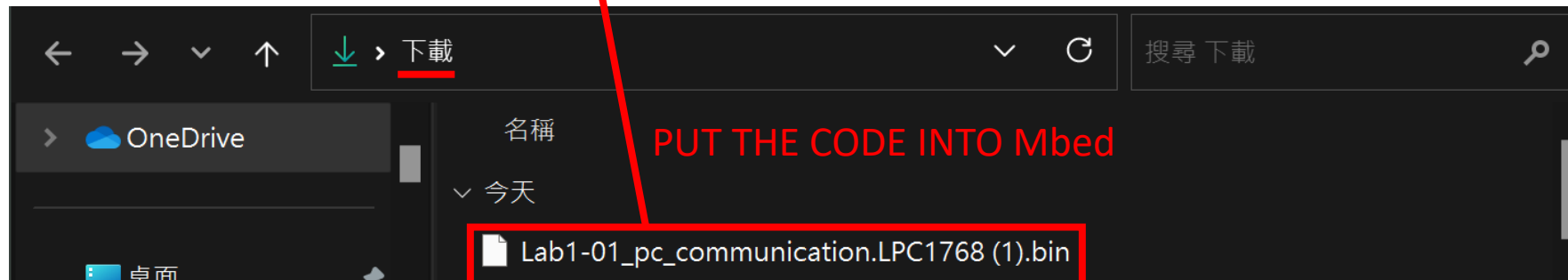
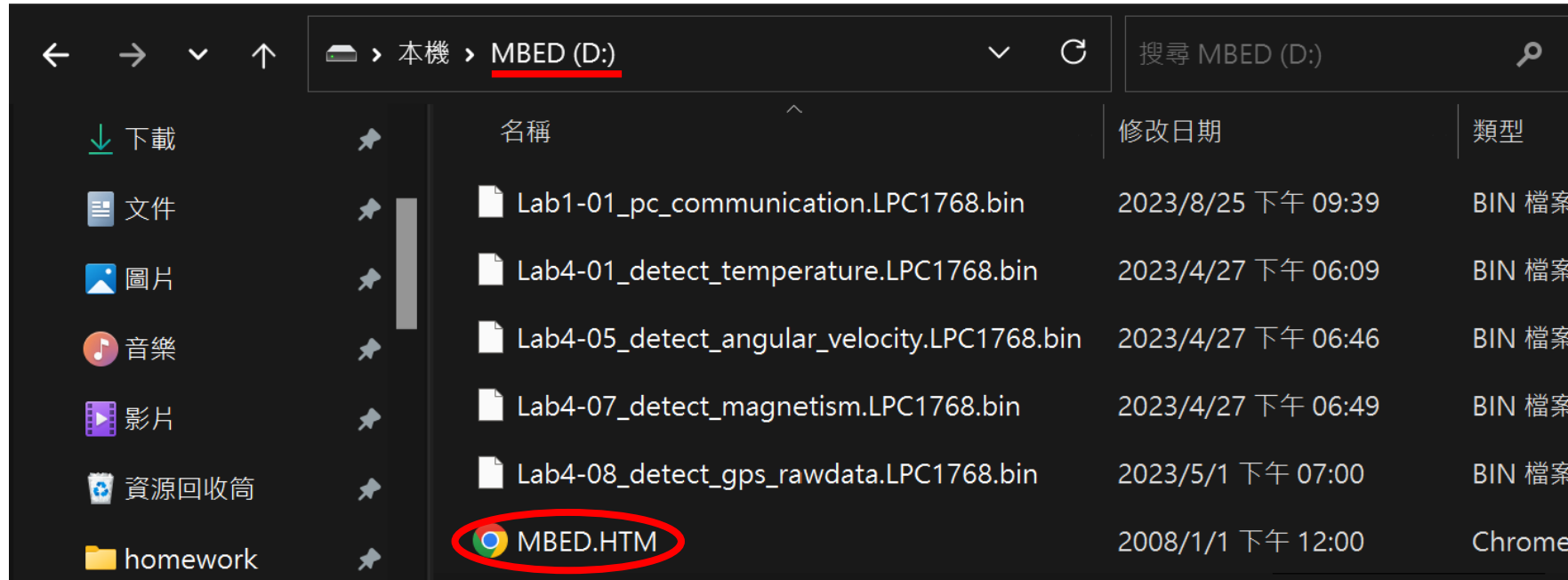
顯示所有下載內容

Output × Run: mbed LPC1768 Mbed Libraries Lab1-01_pc_communic...
elf2bin Lab1-01_pc_communication.LPC1768
post-build Lab1-01_pc_communication.LPC1768
compile main.cpp
Build succeeded

Lab1-01_pc_communication default* mbed LPC1768 21 0 clangd: idle Ln 10, Col 12 CRLF UTF-8 Spaces: 4 C++ 1



Keil Studio (modify the code) cont.





How to read the program code? (Lab1-01)

```
Lab1-01_pc_communication > G+ main.cpp > main
1  #include "mbed.h"
2
3  Serial pc(USBTX, USBRX);
4
5  int main(){
6      pc.baud(9600);
7      int i1=7;
8      float i2=7.5;
9      char i3='H';
10     char c;
11
12     pc.printf("Hello World!\r\n");
13     pc.printf("i1=%d\r\n", i1);
14     pc.printf("i2=%f\r\n", i2);
15     pc.printf("i3=%c\r\n", i3);
16     pc.putc(i3);
17     pc.printf("\r\n");
18
19     for(int j=0; j<10; j++){
20         pc.printf("j=%d -- enter any key --> ", j);
21         c = pc.getc();
22         pc.putc(c);
23         pc.printf("\r\n");
24     }
25
26     pc.printf("finish!!\r\n");
27 }
```

Include mbed library

Serial class declaration

Main function start

Set communication rate

Variable declaration

Display "Hello World" on PC

Display "i1, i2, i3" on PC

Display "i3" on PC

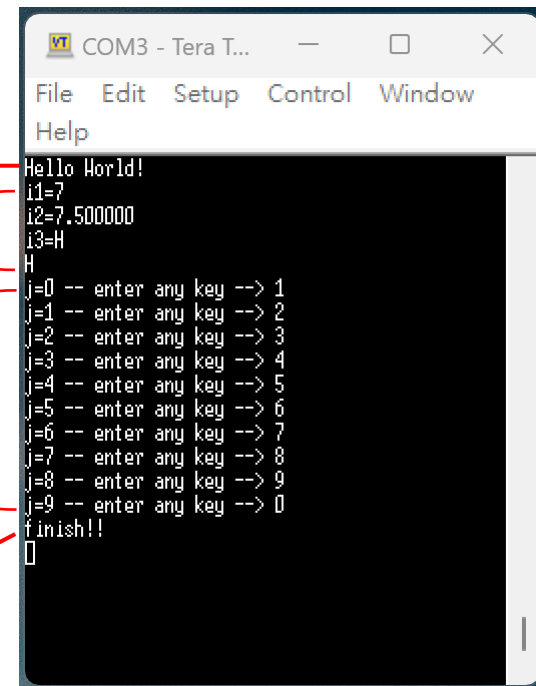
Loop 10 times

Display "j" on PC

Loop end

Display "finish!!" on PC

Main function end





How to read the program code? (Lab1-04)

Lab1-04_create_satellite_program_step1 > G+ main.cpp > ...

```
1  #include "mbed.h"
2
3  DigitalOut cond[]={LED1,LED2,LED3,LED4};
4  Serial gs(USBTX,USBRX); // for ground station
5
6  int main() {
7      gs.baud(9600);
8      gs.printf("From Sat : Operation Start...\r\n");
9      int flag = 0; // condition
10     float sattime=0.0,btvol,temp; //Voltage, Temperature
11     for(int i=0; i<100; i++){
12         //Sensing HK data(dummy)
13         btvol = 3.7;
14         temp = 28.5;
15
16         //Transmitting HK data
17         gs.printf("HEPTASAT::Condition = %d, Time = %f [s], batVol = %.2f [V],Temp = %.2f [C]\r\n",flag,sattime,btvol,temp);
18
19         //Condition
20         cond[0] = 1;
21
22         //Operation Interval
23         wait(1.0);
24         sattime = sattime+1.0;
25     }
26     gs.printf("From Sat : Operation Stop...\r\n");
27 }
```

Include mbed library

Led light declaration

Serial class declaration

Main function start

Set communication rate

Display "From Sat : Operation Start..."

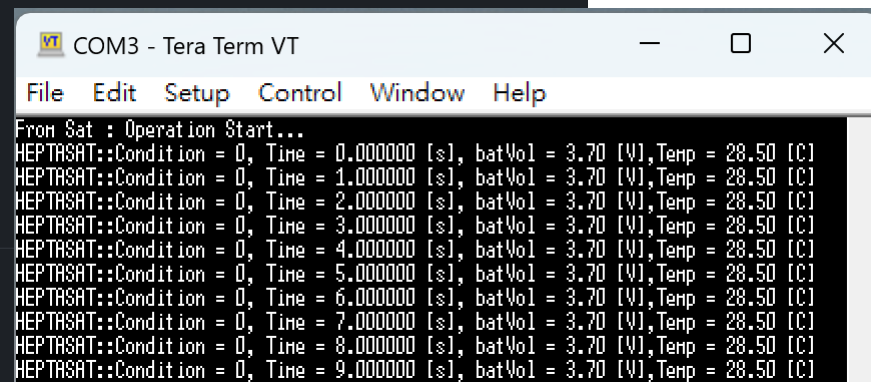
Float number

Loop 100 times

Variable declaration

Sattime=1,2,3...,100s

Main function end





How to read the program code? (Lab1-05)

Lab1-05_create_satellite_code_1b > C:\main.cpp > ...

```
1  #include "mbed.h"           → Include mbed library
2  DigitalOut condition(LED1); → Led light declaration
3  Serial gs(USBTX,USBRX,9600); → Serial class declarationSet & Setcommunication rate
4  Timer sattime;
5  int rcmd = 0, cmdflag = 0; //command variable → Command variable declaration
6
7  //getting command and command flag
8  void commandget()
9  {
10     rcmd = gs.getc();
11     cmdflag = 1;
12 }
13 //interrupting process by command receive
14 void receive(int rcmd, int cmdflag)
15 {
16     gs.attach(commandget,Serial::RxIrq);
17 }
18 //initializing
19 void initialize()
20 {
21     rcmd = 0;
22     cmdflag = 0;
23     condition = 0;
24 }
```

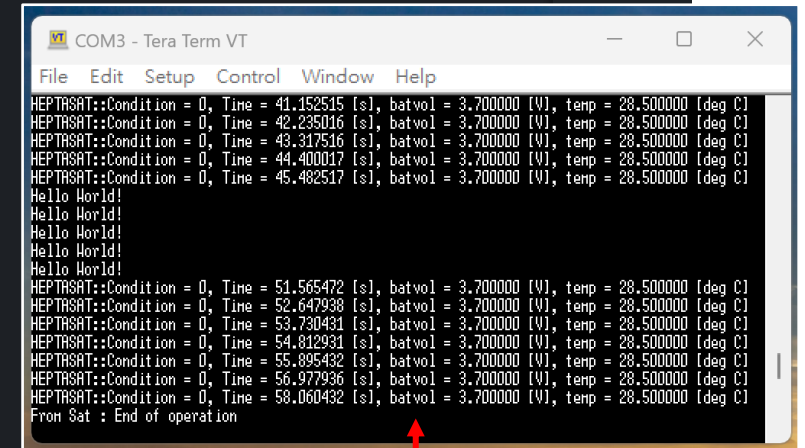
Get command

Receive command

Variable initialize



```
26 int main() —————> Main function start
27 {
28     gs.printf("From Sat : Nominal Operation\r\n"); —————> Display "From Sat : Nominal Operation"
29     int flag = 0; //condition flag
30     float batvol, temp; //voltage, temperature —————> Float number
31     sattime.start();
32     receive(rcmd,cmdflag); //interrupting
33     for(int i=0;i<50;i++){ —————> Loop 50 times
34         //satellite condition led
35         condition = !condition;
36
37         //sensing HK data(dummy data)
38         batvol = 3.7;
39         temp = 28.5; —————> Variable declaration
40
41         //Transmitting HK data to Ground Station(GS)
42         gs.printf("HEPTASAT::Condition = %d, Time = %f [s], batvol = %2f [V], temp = %2f [deg C]\r\n",flag,sattime.read(),batvol,temp);
43         wait_ms(1000);
44
45         if(cmdflag == 1){
46             if(rcmd == 'a'){ —————> Command 'a'
47                 for(int j=0;j<5;j++){
48                     gs.printf("Hello World!\r\n");
49                     condition = 1;
50                     wait_ms(1000);
51                 }
52             }
53             initialize(); //initializing
54         }
55     }
56     sattime.stop();
57     gs.printf("From Sat : End of operation\r\n"); —————> Display "End of operation."
58 }
```





課堂練習A

Reference Lab1-01, modify the code and show your result on Tera Term

```
VT COM3 - Tera T...
File Edit Setup Control Window
Help
Hello World!
i1=7
i2=7.500000
i3=H
H
j=0 -- enter any key --> 1
j=1 -- enter any key --> 2
j=2 -- enter any key --> 3
j=3 -- enter any key --> 4
j=4 -- enter any key --> 5
j=5 -- enter any key --> 6
j=6 -- enter any key --> 7
j=7 -- enter any key --> 8
j=8 -- enter any key --> 9
j=9 -- enter any key --> 0
finish!!

```



```
VT COM3 - Tera Term VT
File Edit Setup Control Window Help
Hello Bro!
I am a satellite haha
My name is pearl 1C
i1=6
i2=8.200
i3=N
N
j=0 -- enter any key --> 0
j=1 -- enter any key --> 1
j=2 -- enter any key --> 2
j=3 -- enter any key --> 3
j=4 -- enter any key --> 4
finish!!

```

```
Hello Bro!
I am a satellite haha
My name is pearl 1C
i1=6
i2=8.200
i3=N
N
j=0 -- enter any key --> 0
j=1 -- enter any key --> 1
j=2 -- enter any key --> 2
j=3 -- enter any key --> 3
j=4 -- enter any key --> 4
finish!!

```

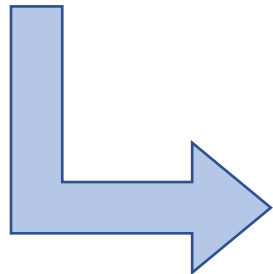


課堂練習B

Reference [Lab1-04](#), modify the code and show your result on Tera Term

```
COM3 - Tera Term VT
File Edit Setup Control Window Help
From Sat : Operation Start...
HEPTASAT::Condition = 0, Time = 0.000000 [s], batVol = 3.70 [V], Temp = 28.50 [C]
HEPTASAT::Condition = 0, Time = 1.000000 [s], batVol = 3.70 [V], Temp = 28.50 [C]
HEPTASAT::Condition = 0, Time = 2.000000 [s], batVol = 3.70 [V], Temp = 28.50 [C]
HEPTASAT::Condition = 0, Time = 3.000000 [s], batVol = 3.70 [V], Temp = 28.50 [C]
HEPTASAT::Condition = 0, Time = 4.000000 [s], batVol = 3.70 [V], Temp = 28.50 [C]
HEPTASAT::Condition = 0, Time = 5.000000 [s], batVol = 3.70 [V], Temp = 28.50 [C]
HEPTASAT::Condition = 0, Time = 6.000000 [s], batVol = 3.70 [V], Temp = 28.50 [C]
HEPTASAT::Condition = 0, Time = 7.000000 [s], batVol = 3.70 [V], Temp = 28.50 [C]
HEPTASAT::Condition = 0, Time = 8.000000 [s], batVol = 3.70 [V], Temp = 28.50 [C]
HEPTASAT::Condition = 0, Time = 9.000000 [s], batVol = 3.70 [V], Temp = 28.50 [C]
```

```
From Pearl 1C : Operation Start...
Pearl 1C::Condition = 0,Friend = 0 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 1 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 2 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 3 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 4 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 5 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 6 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 7 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 8 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 9 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
From Pearl 1C : Operation Stop...
```



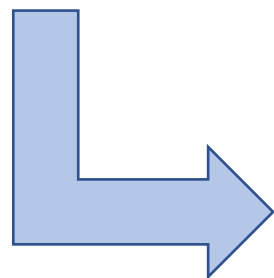
```
COM3 - Tera Term VT
File Edit Setup Control Window Help
From Pearl 1C : Operation Start...
Pearl 1C::Condition = 0,Friend = 0 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 1 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 2 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 3 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 4 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 5 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 6 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 7 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 8 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
Pearl 1C::Condition = 0,Friend = 9 [people],Height = 30.00 [cm],Weight = 1.500 [Kg]
From Pearl 1C : Operation Stop...
```



課堂練習C

Reference Lab1-05, continue above question, modify the code. By the command 'b', the satellite transmit **“My team members include 000, 000 and 000!”** 3times and show your result on Tera Term (30 points)

```
COM3 - Tera Term VT
File Edit Setup Control Window Help
HEPTASAT::Condition = 0, Time = 41.152515 [s], batvol = 3.700000 [V], temp = 28.500000 [deg C]
HEPTASAT::Condition = 0, Time = 42.235016 [s], batvol = 3.700000 [V], temp = 28.500000 [deg C]
HEPTASAT::Condition = 0, Time = 43.317516 [s], batvol = 3.700000 [V], temp = 28.500000 [deg C]
HEPTASAT::Condition = 0, Time = 44.400017 [s], batvol = 3.700000 [V], temp = 28.500000 [deg C]
HEPTASAT::Condition = 0, Time = 45.482517 [s], batvol = 3.700000 [V], temp = 28.500000 [deg C]
Hello World!
Hello World!
Hello World!
Hello World!
Hello World!
HEPTASAT::Condition = 0, Time = 51.565472 [s], batvol = 3.700000 [V], temp = 28.500000 [deg C]
HEPTASAT::Condition = 0, Time = 52.647938 [s], batvol = 3.700000 [V], temp = 28.500000 [deg C]
HEPTASAT::Condition = 0, Time = 53.730431 [s], batvol = 3.700000 [V], temp = 28.500000 [deg C]
HEPTASAT::Condition = 0, Time = 54.812931 [s], batvol = 3.700000 [V], temp = 28.500000 [deg C]
HEPTASAT::Condition = 0, Time = 55.895432 [s]
HEPTASAT::Condition = 0, Time = 56.977936 [s]
HEPTASAT::Condition = 0, Time = 58.060432 [s]
From Sat : End of operation
```



```
COM3 - Tera Term VT
File Edit Setup Control Window Help
From Pearl 1C : Nominal Operation
Pearl 1C::Condition = 0, Friend = 0.000010 [people],
Pearl 1C::Condition = 0, Friend = 1.100000 [people],
Write down the reflection in the last question!
Write down the reflection in the last question!
Write down the reflection in the last question!
Pearl 1C::Condition = 0, Friend = 5.329682 [people],
Pearl 1C::Condition = 0, Friend = 6.412177 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 7.494676 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 8.577176 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 9.659677 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 10.742176 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 11.824682 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 12.907182 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
From Pearl 1C : End of operation
```

```
From Pearl 1C : Nominal Operation
Pearl 1C::Condition = 0, Friend = 0.000010 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Write down the reflection in the last question!
Write down the reflection in the last question!
Write down the reflection in the last question!
Pearl 1C::Condition = 0, Friend = 4.247182 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 5.329676 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 6.412176 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 7.494676 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 8.577176 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 9.659676 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 10.742176 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 11.824682 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
Pearl 1C::Condition = 0, Friend = 12.907182 [people], Height = 30.00 [cm], Weight = 1.500 [Kg]
From Pearl 1C : End of operation
```

Modify the statement



沒錯，第一次上課就要交作業！

- 各組將完成的三題課堂練習結果截圖，用PPT整理好，email至我的信箱
- elmoforwork@gmail.com
- 內容一定要有組別、組員、以及作業結果，還有每人第一次學程式的心得！
- 其餘內容不拘



相關補充資料

- 想必大家都迫不及待的想學好程式，推薦一個網站可以玩中學 C 語言



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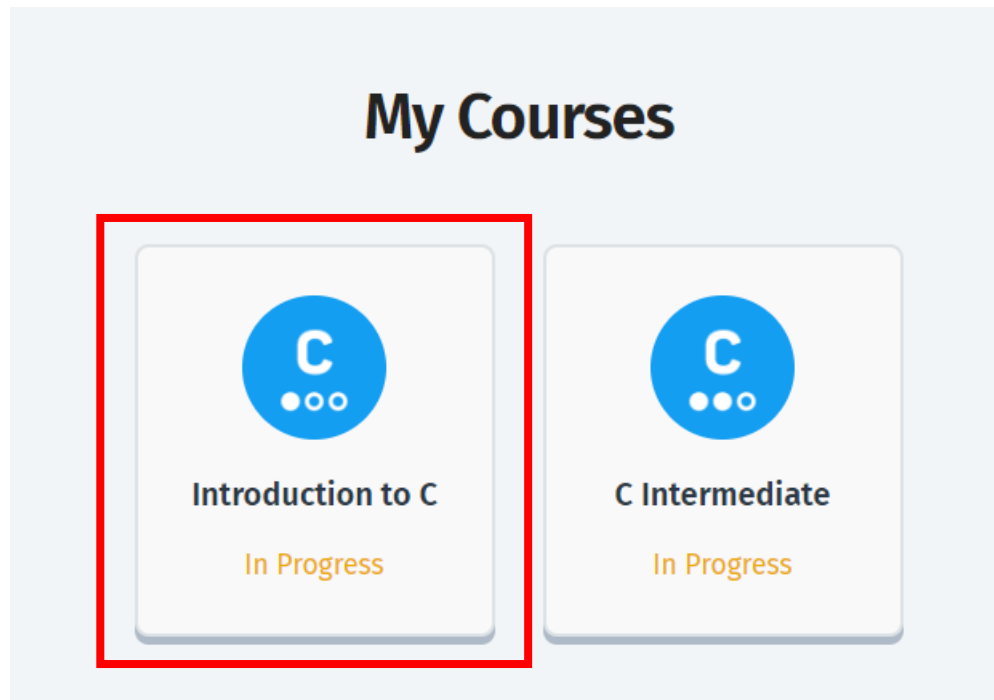
or





相關補充資料

- 註冊完成後，課程當中選擇「Introduction to C」





相關補充資料

- 其中有四個章節，請同學回家完成前兩章節的學習

C Introduction to C

Our C tutorial covers basic concepts, data types, arrays, pointers, conditional statements, loops, functions, strings, structures, unions, and much more. No coding experience is required, and you can learn in just 5 minutes a day!

- ▶ Basic Concepts
- 🔒 Conditionals and Loops
- 🔒 Arrays & Strings
- 🔒 Functions & Pointers



🔒 Conditionals and Loops

- Lesson 🔒
Taking Input
XP +10
- Lesson 🔒
Conditionals
XP +10
- Lesson 🔒
The switch Statement



回家作業

- 完成sololearn的「Introduction to C」課程前兩章節
- 下週進行有趣(?)的小測驗，測驗內容包含sololearn內容，以及HeptaSat第一章相關內容 (包含程式選擇題)
- Enjoy~
- 最重要的部分... (下週回家作業選擇)
(1. 很難，但改很寬 2. 很簡單，但改很嚴)