



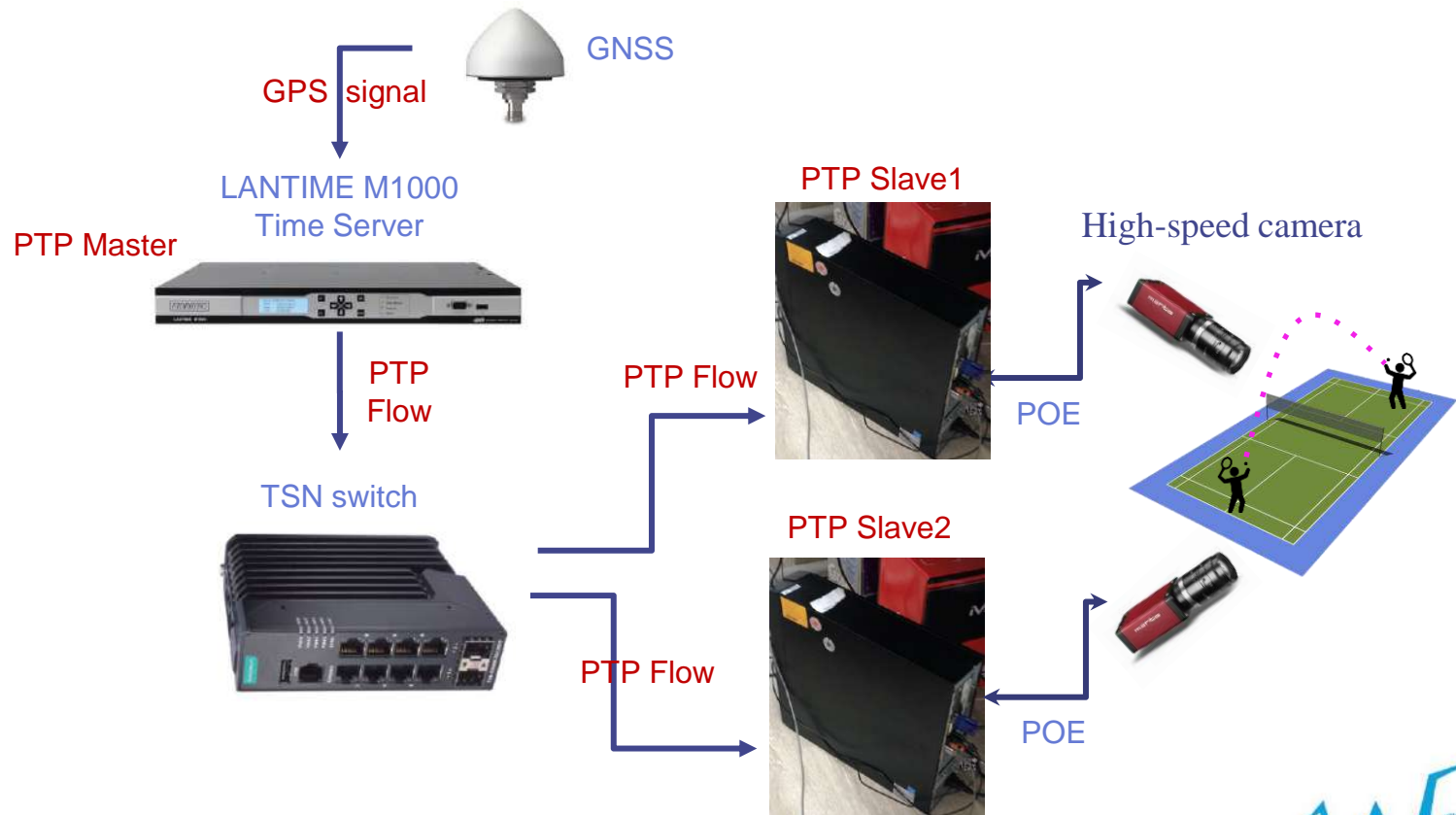
場域三：AI 智慧教練

Outline

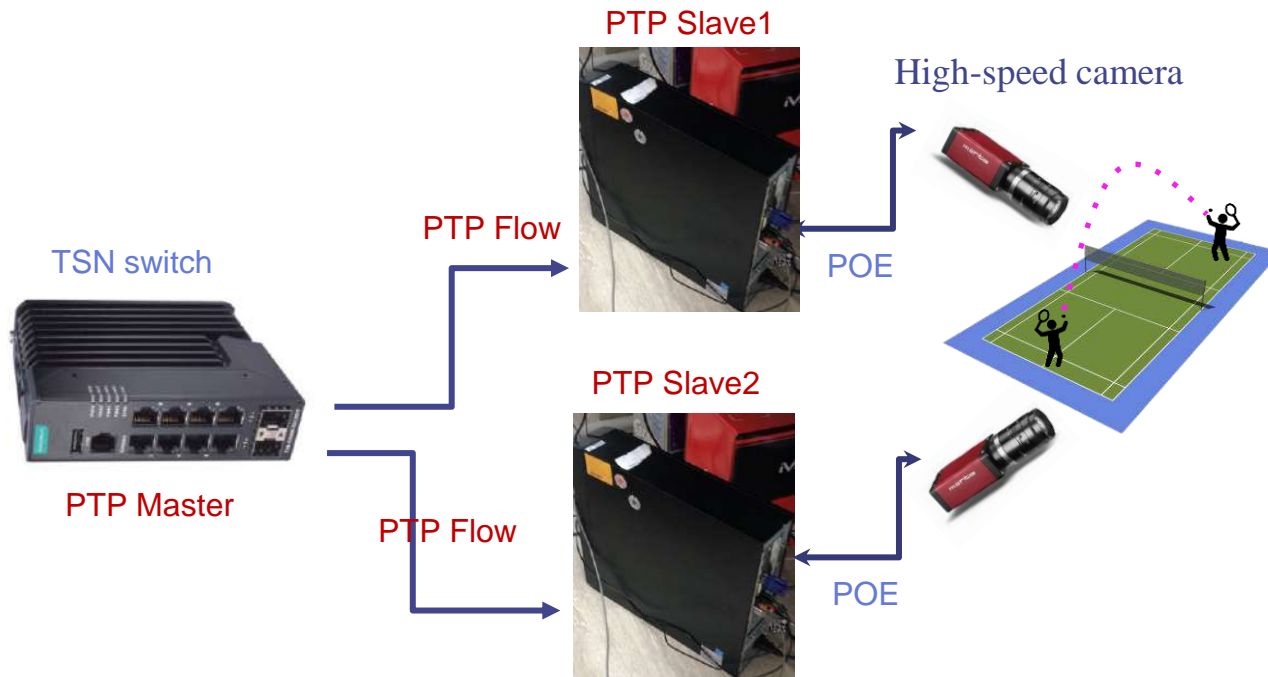
- 精確影像時間同步介紹與實作
 - 影像時間同步線路圖
 - PTP時間同步實作手冊
- AI智慧教練介紹與實作
 - 同步影像5G傳輸線路圖
 - 整體5G架構線路圖
 - 連接5G網路設定
 - AI智慧教練操作手冊

精確影像時間同步介紹與實作

影像時間同步線路圖-Option 1



影像時間同步線路圖-Option2









PTP時間同步實作手冊




Outline

- 設備規格
- Allied vision Vimba 套件安裝
- Allied vision g235c 設定
- Time Server 設定
 - TSN Switch 設定
- PTP Slave PC同步設定
- 結果呈現

設備規格-1

設備	數量	規格	照片
High-speed Camera	2	Allied vision Manta G-235C	
TSN switch	1	MOXA TSN- g5004	
PC	2	Ubuntu 20.04 LTS Python 3.8.10 Vimba 5.1	
Time Server	1	LANTIME M1000	

設備規格-2

設備	數量	規格	照片
5G USB 無線網卡	2	APAL	
5G SIM卡	2	free5GC	
POE Injector	2	EdiMAX GP-101IT	
支援TSN 網路介面卡	2	Intel i210 NIC	

Allied vision Vimba 套件安裝

- 下載 VimbaViewer 至使用者自定義位置，並解壓縮
- wget https://downloads.alliedvision.com/Vimba_v5.0_Linux.tgz
- tar xvf Vimba_v5.0_Linux.tgz

```
faker@faker:~/research_student/coachAI/Reader$ wget https://downloads.alliedvision.com/Vimba_v5.0_Linux.tgz
--2021-11-23 15:28:21-- https://downloads.alliedvision.com/Vimba_v5.0_Linux.tgz
Resolving downloads.alliedvision.com (downloads.alliedvision.com)... 13.35.30.45, 13.35.30.118, 13.35.30.34, ...
Connecting to downloads.alliedvision.com (downloads.alliedvision.com)|13.35.30.45|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 55020351 (52M) [application/octet-stream]
Saving to: 'Vimba_v5.0_Linux.tgz'

Vimba_v5.0_Linux.tgz          100%[=====>] 52.47M  110MB/s  in 0.5s
2021-11-23 15:28:21 (110 MB/s) - 'Vimba_v5.0_Linux.tgz' saved [55020351/55020351]

faker@faker:~/research_student/coachAI/Reader$ ls
Allied_Vision  CSVReader  example  FileReader  Image_Source  Vimba_5_0  Vimba_v5.0_Linux.tgz
faker@faker:~/research_student/coachAI/Reader$ tar xvf Vimba_v5.0_Linux.tgz
Vimba_5_0/
Vimba_5_0/VimbaUSBTL/
Vimba_5_0/VimbaUSBTL/SetGenTLPPath.sh
Vimba_5_0/VimbaUSBTL/Documentation/
```

Allied vision Vimba 套件安裝

- 進入 Vimba_x_x/VimbaGigETL

```
faker@faker:~/research_student/coachAI/Reader$ tree Vimba_5_0/VimbaGigETL/
Vimba_5_0/VimbaGigETL/
├── CTI
│   └── x86_64bit
│       ├── VimbaGigETL.cti
│       └── VimbaGigETL.xml
├── Documentation
│   ├── ReleaseNotes.txt
│   └── VimbaGigETLFeaturesManual.pdf
├── Install.sh
├── SetGenTLPath.sh
└── Uninstall.sh
```

- 安裝及更新環境變數
 - `sudo ./Install.sh ./SetGenTLPath.sh`

Allied vision Vimba 套件安裝

- 進入 Vimba_x_x/VimbaPython

```
faker@faker:~/research_student/coachAI/Reader/Vimba_5_0/VimbaPython$ tree
.
├── Documentation
│   └── Vimba Python Manual.pdf
├── Examples
│   ├── action_commands.py
│   ├── asynchronous_grab_opencv.py
│   ├── asynchronous_grab.py
│   ├── create_trace_log.py
│   ├── event_handling.py
│   ├── list_ancillary_data.py
│   ├── list_cameras.py
│   ├── list_features.py
│   ├── load_save_settings.py
│   ├── multithreading_opencv.py
│   ├── synchronous_grab.py
│   └── user_set.py
└── Install.sh
```

- 安裝 vimba python module
 - sudo ./Install.sh
- 重新開機
 - sudo shutdown -r now

Allied vision g235c 設定

- 設定接上 camera 之電腦網卡介面資訊



```
*interfaces (/etc/network) - gedit
File Edit View Search Tools Documents Help
Open Save Undo
*interfaces ✕
auto lo
iface lo inet loopback

auto eth1
iface eth1 inet dhcp

auto eth6
iface eth6 inet static
address 169.254.100.1
netmask 255.255.0.0
mtu 8228
Plain Text Tab Width: 8 Ln 13, Col 1 INS
```

VIMBA: LLL

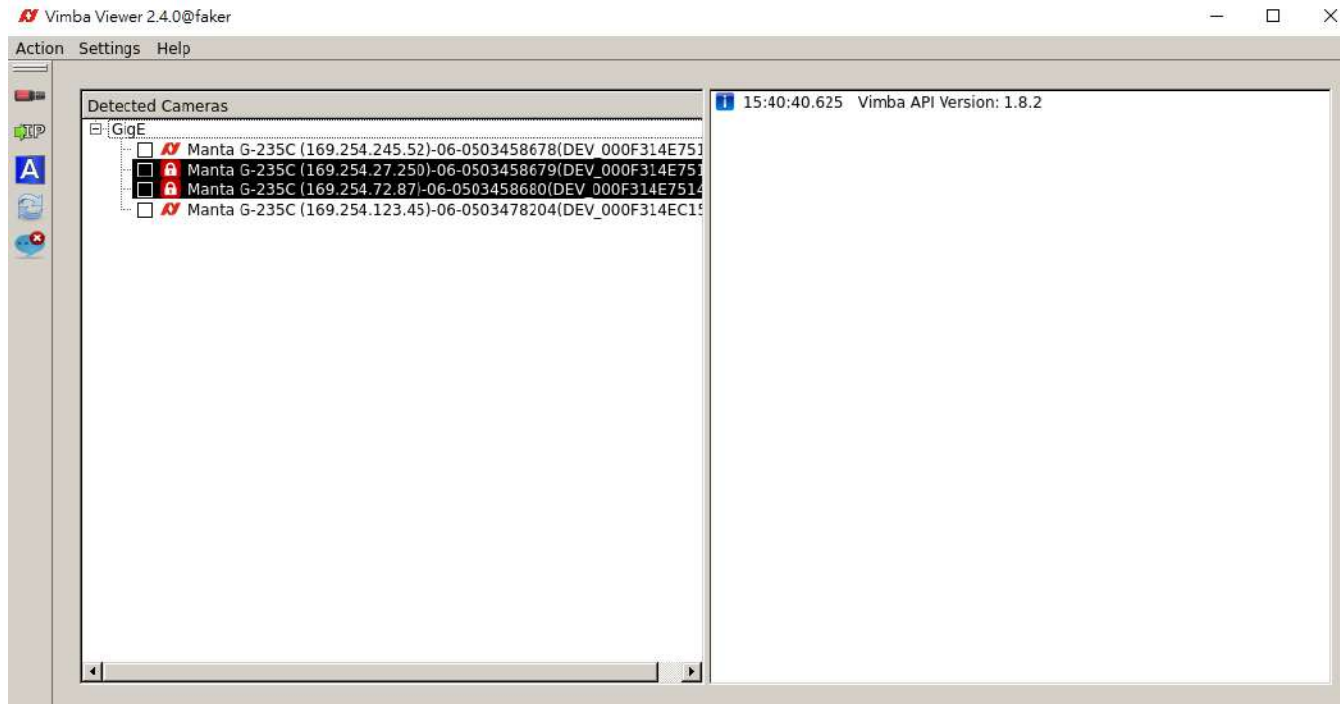
Obtain an IP address automatically

PvAPI: Auto IP

(169.254.xxx.xxx)

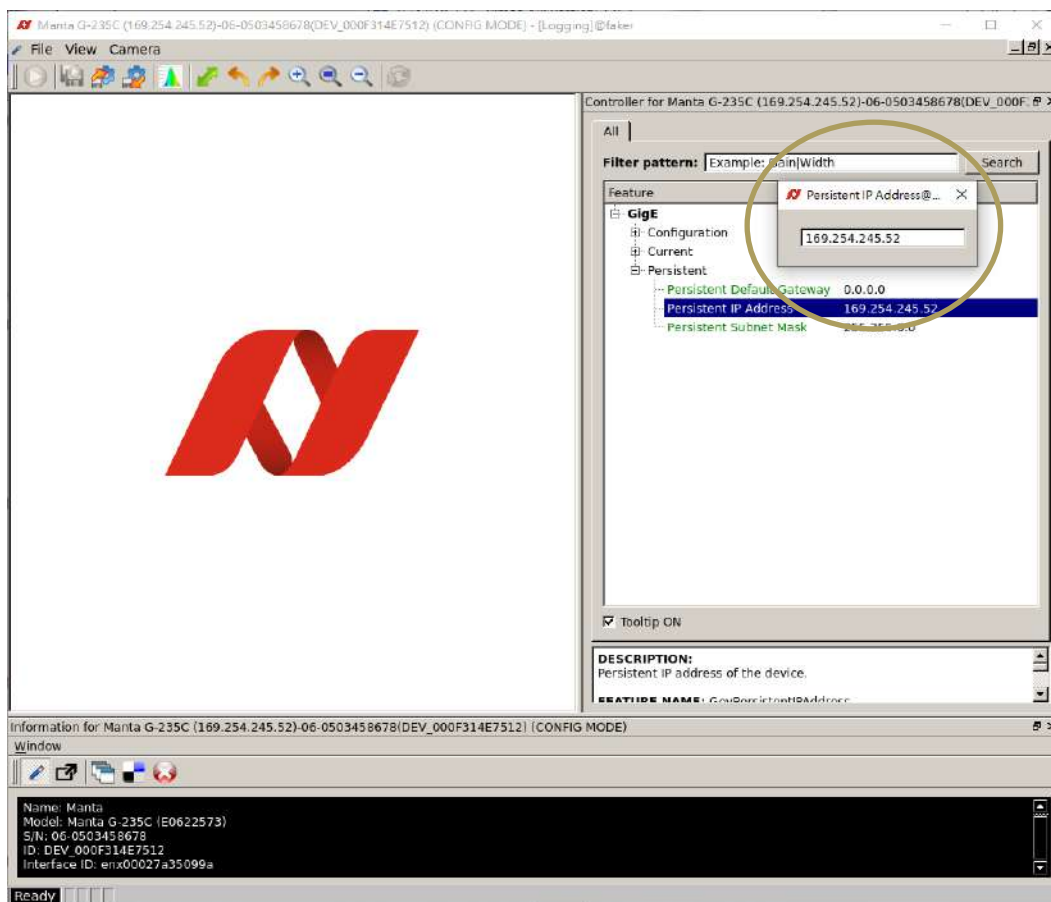
Allied vision g235c 設定

- 開啟 VimbaViewer
 - `./Vimba_x_x/Tools/Viewer/Bin/x86_64bit/VimbaViewer`



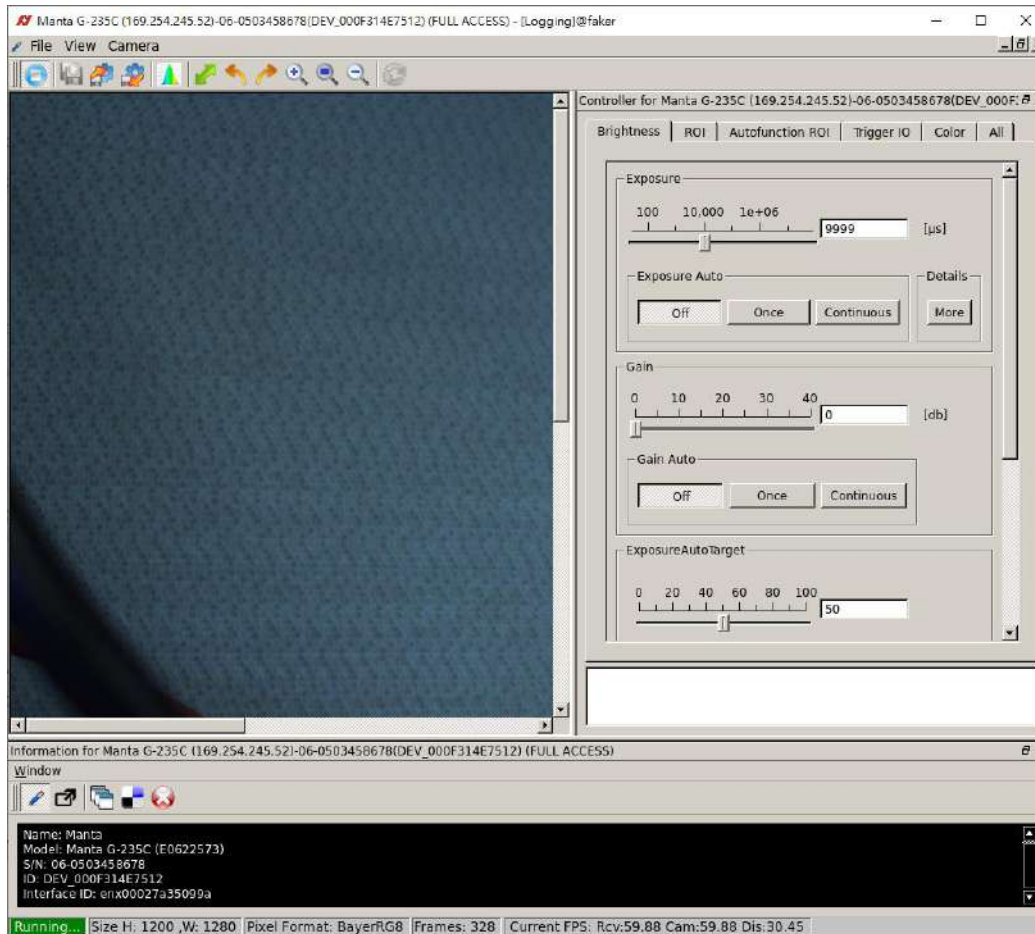
Allied vision g235c 設定

- 依使用者自定義相機之 IP，同時也要將連接之網卡 IP 改至自定義 IP



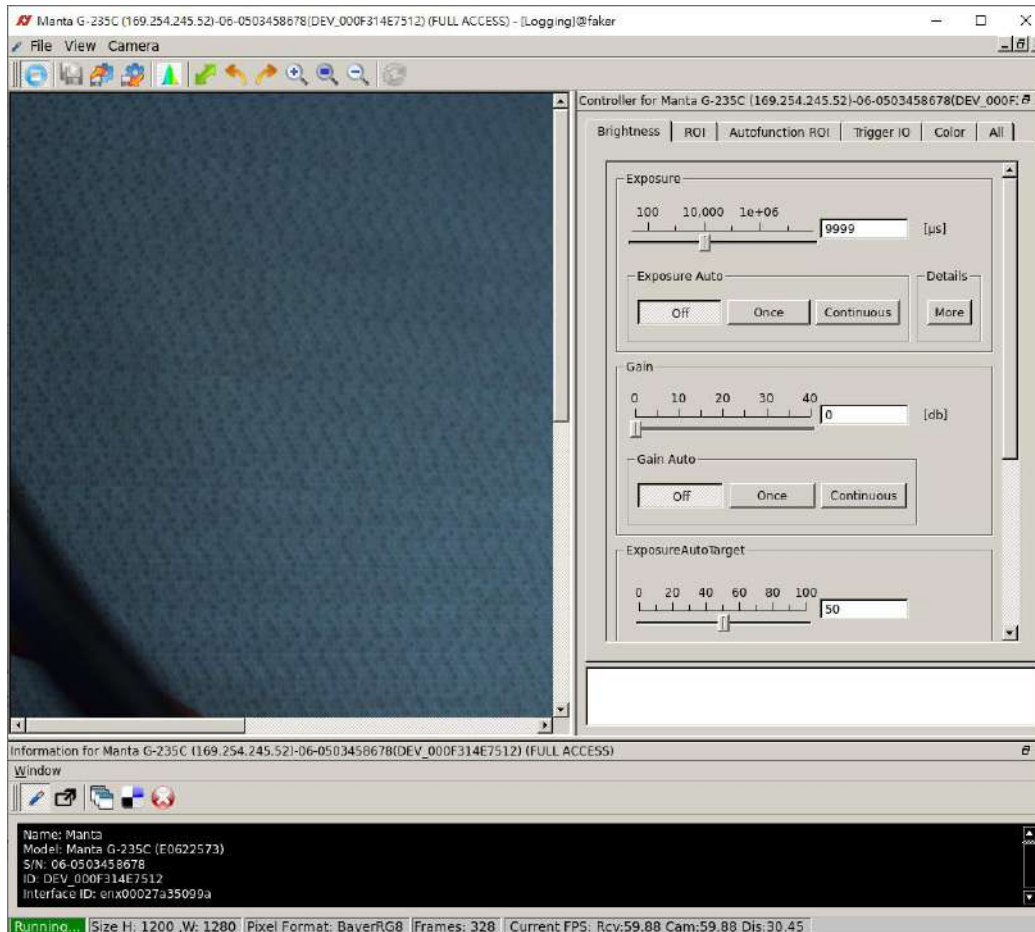
Allied vision g235c 設定

- VimbaViewer 測試，確認相機可以接收拍攝畫面



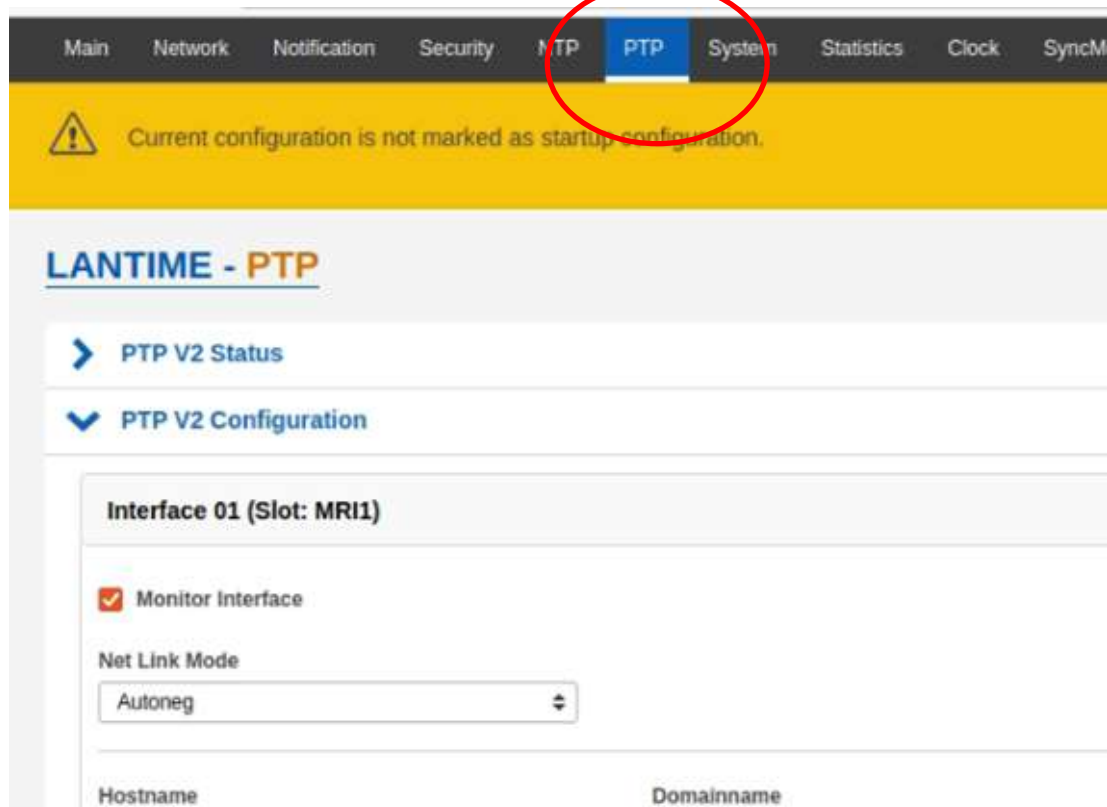
Allied vision g235c 設定

- VimbaViewer 測試，確認相機可以接收拍攝畫面



Time Server 設定

- 進入 Time Server 設定頁面，並選擇設定 PTP



The screenshot displays the configuration page for PTP (Precision Time Protocol) in a network management system. The navigation menu at the top includes Main, Network, Notification, Security, NTP, PTP (highlighted with a red circle), System, Statistics, Clock, and SyncM. A yellow warning banner indicates that the current configuration is not marked as startup configuration. The main content area is titled "LANTIME - PTP" and contains two expandable sections: "PTP V2 Status" and "PTP V2 Configuration". The "PTP V2 Configuration" section is expanded, showing settings for "Interface 01 (Slot: MRI1)". Under this section, the "Monitor interface" checkbox is checked. Below it, the "Net Link Mode" is set to "Autoneg" via a dropdown menu. At the bottom of the configuration area, there are fields for "Hostname" and "Domainname".

Time Server 設定

- 在PTP V2 Configuration 中設定 Network config，主要需更改TCP/IP Address

PTP V2 Status

PTP V2 Configuration

Interface 01 (Slot: MRI1)

Network Global SyncE Misc Outputs NTP

Monitor Interface

Net Link Mode
Autoneg

Hostname: PTPv2 Domainname:

Nameserver 1: 0.0.0.0 Nameserver 2: 0.0.0.0

Enable DHCP-Client
No

TCP/IP Address: 192.168.1.6 Netmask: 255.255.255.0 Default Gateway: 192.168.1.1

Time Server 設定

- 在PTP V2 Configuration 中設定 Global config，選擇 Profile，並更改 Intervals 與 Receipt Timeout 值

Operating Mode
 Disabled PTP V2 PTP V1 NTP Monitor

Select Profile
Default E2E IEEE1588-2008

PTP Mode
Multicast Master Hybrid-Mode

Unicast Master Address 1: 172.29.9.210
Unicast Master Address 2: 0.0.0.0

Delay Mechanism: E2E
Domain Number: 0
Network Protocol: UDP/IPv4 (L3)

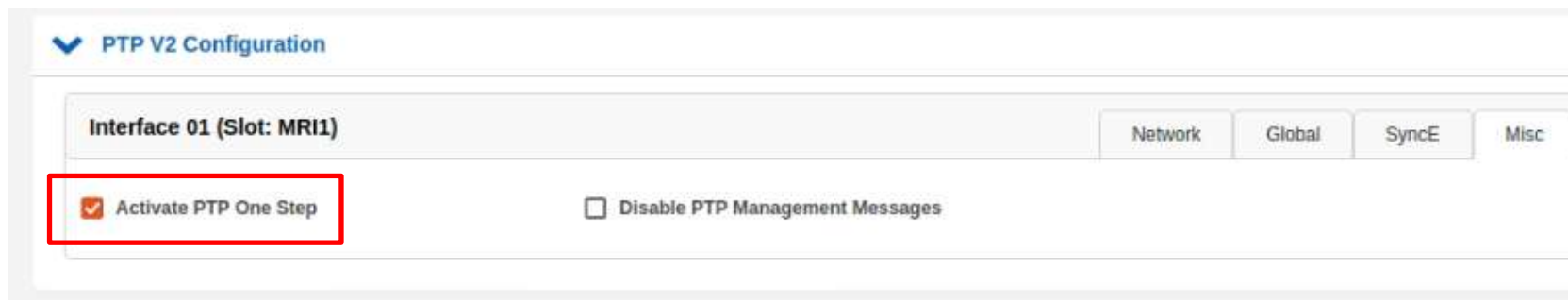
Timescale: PTP Standard (TAI)
Priority1: 128
Priority2: 128

Announce Interval: 1 announce message every 2 seconds
Sync Interval: 1 sync message per second
Delay Request Interval: 1 request message per second

Interval Duration [s]: 60
Announce Receipt Timeout: 8
Alternate Time Offset Indicator: No

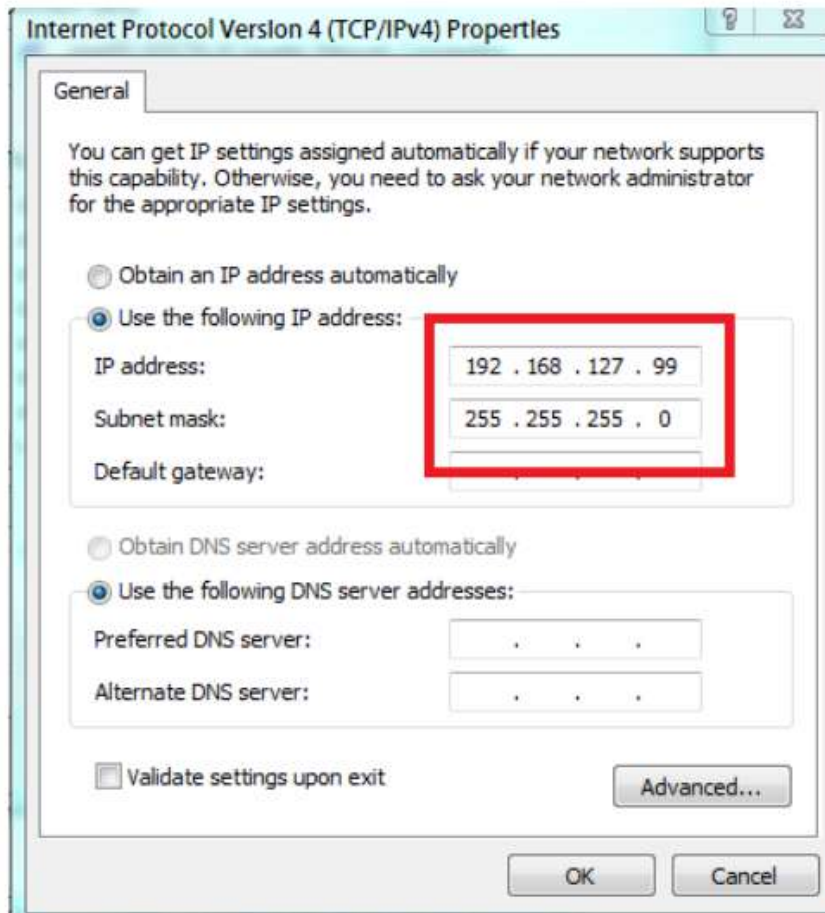
Time Server 設定

- 在PTP V2 Configuration 中設定 Misc config，啟用 PTP One Step 選項



TSN Switch 設定

- 將對接的網路介面IP設定為192.168.127.253/24



TSN Switch 設定

- 進入 <http://192.168.127.253> 為 switch 的 web console
- account : admin
- password : moxa



TSN Switch 設定

- 觀看系統資訊
- 設定系統時鐘

Time Zone

System Uptime
0d3h30m56s

Current Time
Fri Dec 21 2018 22:24:24 UTC+00:00

Time Zone
UTC+00:00

Daylight Saving
Disabled

Start Date * 1/9/2020 Start Time * 04:33 PM

End Date * 1/9/2020 End Time * 04:33 PM

Offset
00:00

Apply

PTP Slave PC 同步設定 (1/6)

- 在 Ubuntu 環境中安裝 ethtool，並確認完成安裝

```
user@user-VirtualBox:~$ sudo apt-get install ethtool
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  ethtool
0 upgraded, 1 newly installed, 0 to remove and 41 not upgraded.
Need to get 0 B/97.5 kB of archives.
After this operation, 318 kB of additional disk space will be used.
Selecting previously unselected package ethtool.
(Reading database ... 223753 files and directories currently installed.)
Preparing to unpack .../ethtool_1%3a4.5-1_amd64.deb ...
Unpacking ethtool (1:4.5-1) ...
Processing triggers for man-db (2.7.5-1) ...
Setting up ethtool (1:4.5-1) ...
user@user-VirtualBox:~$ ethtool --version
ethtool version 4.5
user@user-VirtualBox:~$ █
```

PTP Slave PC 同步設定 (2/6)

- 確認網卡是否支援 PTP ，且有能力收送time-stamping 封包
- Ethtool -T 網卡名稱

```
~]# ethtool -T eth3
Time stamping parameters for eth3:
Capabilities:
  hardware-transmit      (SOF_TIMESTAMPING_TX_HARDWARE)
  software-transmit     (SOF_TIMESTAMPING_TX_SOFTWARE)
  hardware-receive      (SOF_TIMESTAMPING_RX_HARDWARE)
  software-receive      (SOF_TIMESTAMPING_RX_SOFTWARE)
  software-system-clock (SOF_TIMESTAMPING_SOFTWARE)
  hardware-raw-clock    (SOF_TIMESTAMPING_RAW_HARDWARE)
PTP Hardware Clock: 0
Hardware Transmit Timestamp Modes:
  off      (HWTSTAMP_TX_OFF)
  on       (HWTSTAMP_TX_ON)
Hardware Receive Filter Modes:
  none     (HWTSTAMP_FILTER_NONE)
  all      (HWTSTAMP_FILTER_ALL)
```

支援Software time stamping

支援Hardware time stamping

PTP Slave PC 同步設定 (3/6)

- 安裝 linuxptp 套件

```
user@user-VirtualBox:~$ sudo apt-get install linuxptp
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  linuxptp
0 upgraded, 1 newly installed, 0 to remove and 41 not upgraded.
Need to get 0 B/109 kB of archives.
After this operation, 414 kB of additional disk space will be used.
Selecting previously unselected package linuxptp.
(Reading database ... 223741 files and directories currently installed.)
Preparing to unpack .../linuxptp_1.6-1_amd64.deb ...
Unpacking linuxptp (1.6-1) ...
Processing triggers for man-db (2.7.5-1) ...
Setting up linuxptp (1.6-1) ...
```

- 確認 ptp4l 與 phc2sys 成功安裝

```
user@user-VirtualBox:~$ ptp4l -v
1.6
user@user-VirtualBox:~$ phc2sys -v
1.6
```

PTP Slave PC 同步設定 (4/6)

- 若網卡有支援 Hardware time stamping，加入 -H 開啟 ptp4l
 - 已連接 foreign mater time server，ID 為 Time server 的UUID
 - 狀態 s0、s1、s2代表 clock 的不同階段，在 s2 時為穩定狀態，offset 值不會有大改動，並真正成為 PTP Slave

```
^Cfree5gc@free5gc:~/linuxptp$ sudo ptp4l -i eno1 -mHS
ptp4l[1385.375]: selected /dev/ptp0 as PTP clock
ptp4l[1385.375]: port 1 (eno1): INITIALIZING to LISTENING on INIT_COMPLETE
ptp4l[1385.375]: port 0 (/var/run/ptp4l): INITIALIZING to LISTENING on INIT_COMPLETE
ptp4l[1385.375]: port 0 (/var/run/ptp4lro): INITIALIZING to LISTENING on INIT_COMPLETE
ptp4l[1385.386]: port 1 (eno1): new foreign master ec4670.ffff.0aa6cd-1
ptp4l[1389.386]: selected best master clock ec4670.ffff.0aa6cd
ptp4l[1389.386]: port 1 (eno1): LISTENING to UNCALIBRATED on RS_SLAVE
ptp4l[1391.386]: master offset      292862 s0 freq +18669 path delay 11230
ptp4l[1392.386]: master offset      294625 s1 freq +20432 path delay 11230
ptp4l[1393.386]: master offset      -2466 s2 freq +17966 path delay 11230
ptp4l[1393.386]: port 1 (eno1): UNCALIBRATED to SLAVE on MASTER_CLOCK_SELECTED
ptp4l[1394.386]: master offset      -1296 s2 freq +18396 path delay 11230
ptp4l[1395.386]: master offset         703 s2 freq +20006 path delay 11198
ptp4l[1396.386]: master offset       -851 s2 freq +18663 path delay 11230
ptp4l[1397.386]: master offset       -436 s2 freq +18823 path delay 11230
ptp4l[1398.386]: master offset       -167 s2 freq +18961 path delay 11183
ptp4l[1399.386]: master offset       -761 s2 freq +18317 path delay 11141
ptp4l[1400.386]: master offset       -352 s2 freq +18498 path delay 11141
ptp4l[1401.386]: master offset         52 s2 freq +18796 path delay 11114
ptp4l[1402.386]: master offset        1918 s2 freq +20678 path delay 11013
ptp4l[1403.386]: master offset       -772 s2 freq +18563 path delay 11013
ptp4l[1404.386]: master offset       1025 s2 freq +20140 path delay 10999
```

UUID

EC:46:70:FF:FE:0A:A6:CD

PTP Slave PC 同步設定 (5/6)

- 以 ptp4l 之時間實際調整系統時間
- phc2sys -s 網卡名稱 -O 0，狀態 s0、s1、s2代表 clock 的不同階段，在 s2 時為穩定狀態，offset 值不會有大改動

```
Free5gc@Free5gc:~/linuxptp$ sudo phc2sys -s eno1 -m -O 0
phc2sys[2103.165]: CLOCK_REALTIME phc offset -25771248258 s0 freq -100000000 delay 1008
phc2sys[2104.165]: CLOCK_REALTIME phc offset -25680278214 s1 freq +19349 delay 1003
phc2sys[2105.166]: CLOCK_REALTIME phc offset 10429 s2 freq +29778 delay 945
phc2sys[2106.166]: CLOCK_REALTIME phc offset -290 s2 freq +22188 delay 882
phc2sys[2107.166]: CLOCK_REALTIME phc offset -3993 s2 freq +18398 delay 896
phc2sys[2108.166]: CLOCK_REALTIME phc offset -3399 s2 freq +17794 delay 882
phc2sys[2109.167]: CLOCK_REALTIME phc offset -1753 s2 freq +18420 delay 869
phc2sys[2110.167]: CLOCK_REALTIME phc offset -828 s2 freq +18819 delay 898
phc2sys[2111.167]: CLOCK_REALTIME phc offset -364 s2 freq +19035 delay 882
phc2sys[2112.167]: CLOCK_REALTIME phc offset -446 s2 freq +18844 delay 865
phc2sys[2113.167]: CLOCK_REALTIME phc offset 352 s2 freq +19508 delay 902
phc2sys[2114.168]: CLOCK_REALTIME phc offset -140 s2 freq +19121 delay 882
phc2sys[2115.168]: CLOCK_REALTIME phc offset -423 s2 freq +18796 delay 867
phc2sys[2116.168]: CLOCK_REALTIME phc offset 47 s2 freq +19139 delay 866
phc2sys[2117.168]: CLOCK_REALTIME phc offset 617 s2 freq +19724 delay 862
phc2sys[2118.168]: CLOCK_REALTIME phc offset 744 s2 freq +20036 delay 852
phc2sys[2119.169]: CLOCK_REALTIME phc offset -534 s2 freq +18981 delay 849
phc2sys[2120.169]: CLOCK_REALTIME phc offset -413 s2 freq +18942 delay 913
phc2sys[2121.169]: CLOCK_REALTIME phc offset 54 s2 freq +19285 delay 899
phc2sys[2122.169]: CLOCK_REALTIME phc offset -133 s2 freq +19114 delay 882
phc2sys[2123.169]: CLOCK_REALTIME phc offset 523 s2 freq +19730 delay 902
^Cphc2sys[2123.983]: CLOCK_REALTIME phc offset 633 s2 freq +19997 delay 911
```

PTP Slave PC 同步設定 (6/6)

- 利用 pmc 取得時間同步之詳細資訊
 - `sudo pmc -u -b 0 'GET TIME_STATUS_NP'`

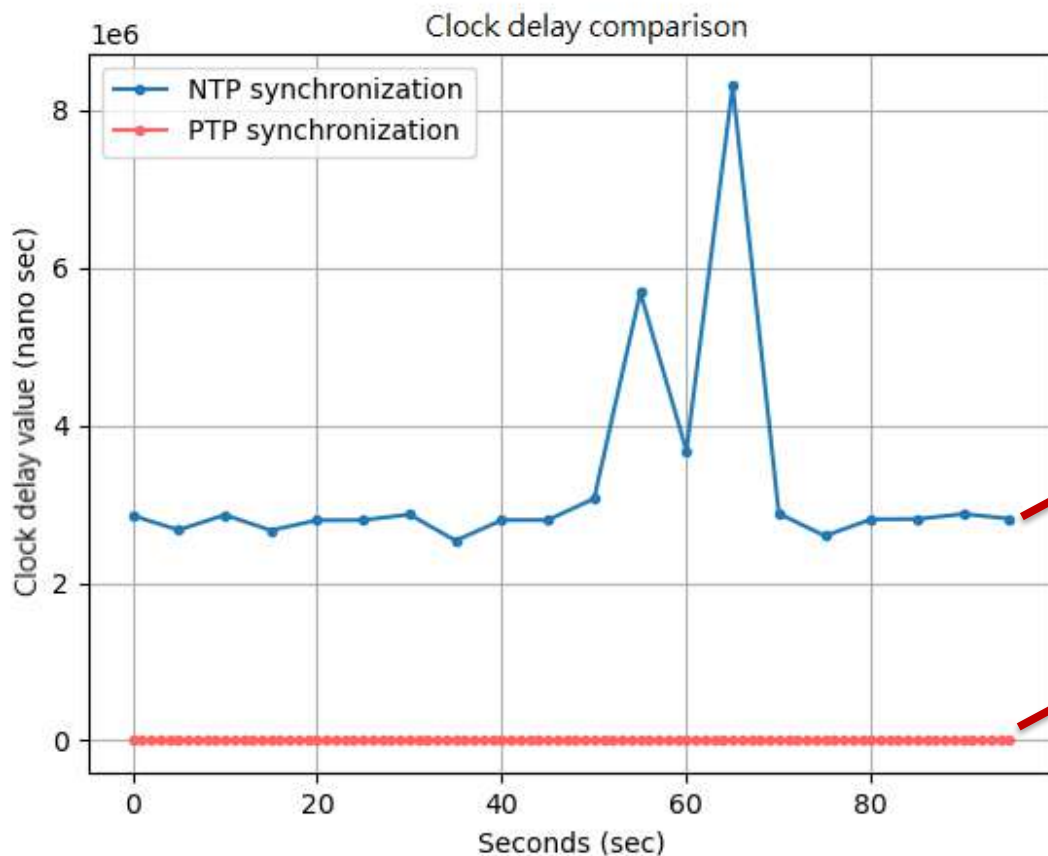
```
free5gc@free5gc:~/linuxptp$ sudo pmc -u -b 0 'GET TIME_STATUS_NP'
[sudo] password for free5gc:
sending: GET TIME_STATUS_NP
e03f49.ffff.e87037-0 seq 0 RESPONSE MANAGEMENT TIME_STATUS_NP
  master_offset          834
  ingress_time           1637902746601475375
  cumulativeScaledRateOffset +0.000000000
  scaledLastGmPhaseChange 0
  gmTimeBaseIndicator    0
  lastGmPhaseChange      0x0000'0000000000000000.0000
  gmPresent              true
  gmIdentity              ec4670.ffff.0aa6cd
```

- `sudo pmc -u -b 0 'GET CURRENT_DATA_SET'`

```
free5gc@free5gc:~/linuxptp$ sudo pmc -u -b 0 'GET CURRENT_DATA_SET'
sending: GET CURRENT_DATA_SET
e03f49.ffff.e87037-0 seq 0 RESPONSE MANAGEMENT CURRENT_DATA_SET
  stepsRemoved          1
  offsetFromMaster      -627.0
  meanPathDelay         16979.0
```

結果呈現

- 使用 Network Time Protocol (NTP) 與 Precision Time Protocol (PTP) 之系統時鐘差異值差別

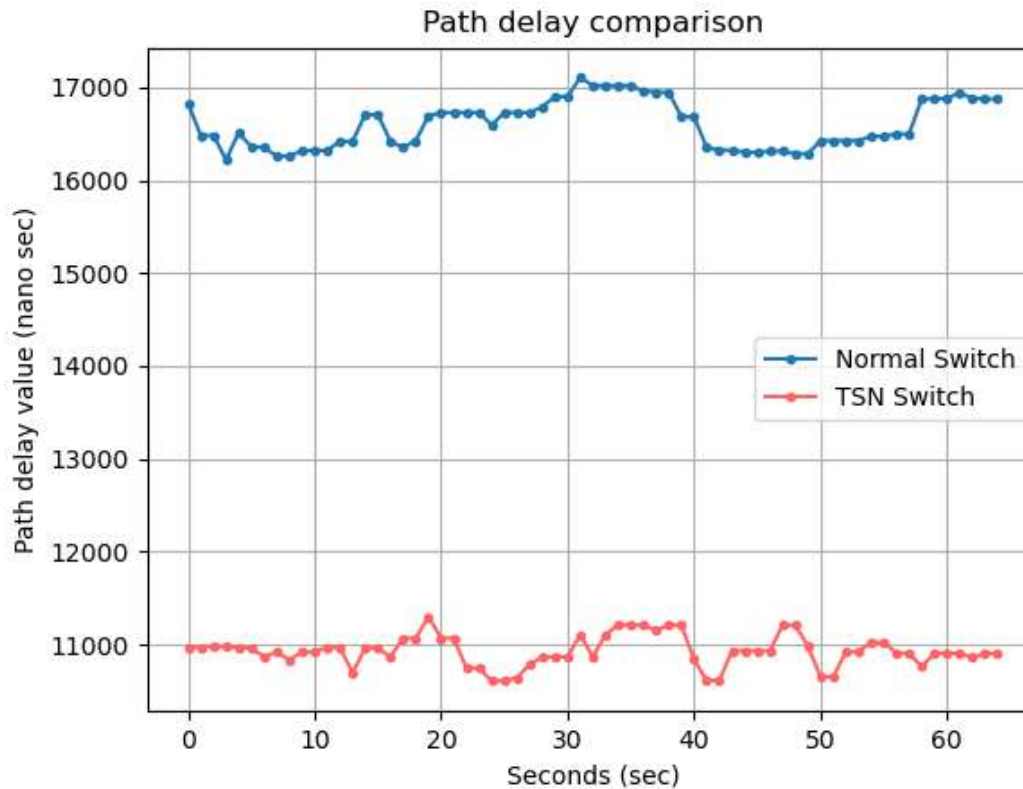


Avg : 3,258,450 ns

Avg : 757 ns

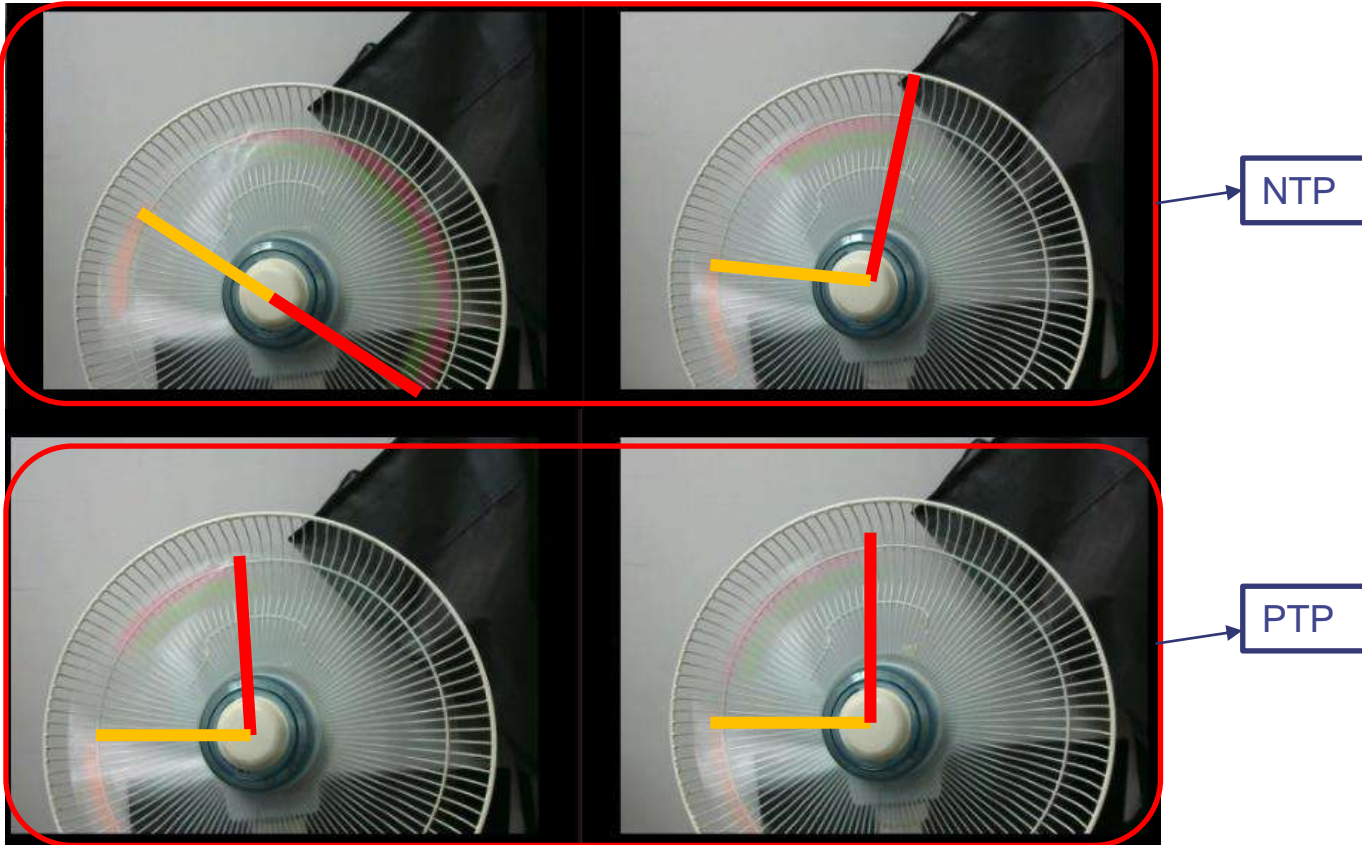
結果呈現

- 使用 TSN Switch 與使用非 TSN Switch 進行時間同步，其封包轉送至目標電腦的時間差異



結果呈現

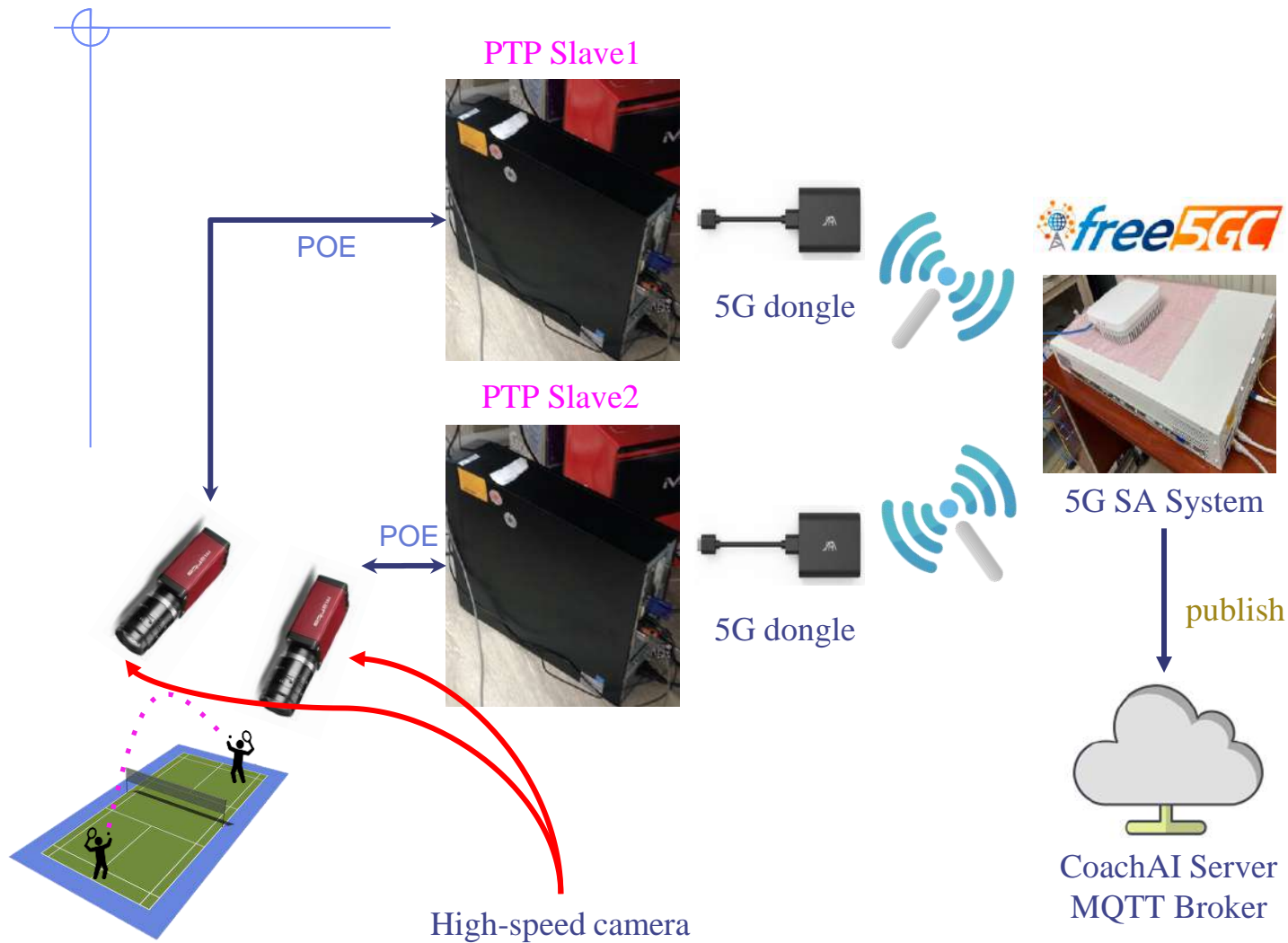
- 使用現實世界之電風扇，比較NTP與PTP差異





AI智慧教練介紹與實作

同步影像5G傳輸線路圖



整體5G架構線路圖





連接5G網路設定

Step 1

- 1) 在桌上型電腦安裝好free5gc，並切換至free5gc資料夾內
- 2) 先輸入 ./force_kill.sh
- 3) 再輸入 ./run.sh，啟動free5gc

```
021-11-25T14:14:29+08:00 [INFO][NRF][Main] NRF exited
cslab@free5GC-HP:~/free5gc_v3.1.1/free5gc$ ./force_kill.sh
[sudo] password for cslab:
nrf: no process found
amf: no process found
smf: no process found
udr: no process found
pcf: no process found
udm: no process found
nssf: no process found
ausf: no process found
n3iwf: no process found
free5gc-upfd: no process found
go-upf: no process found
go-gtpu: no process found
tcpdump: no process found
Cannot find device "upfgtp"
Cannot find device "upfgtp0"
rm: cannot remove '/dev/mqueue/*': No such file or directory
cslab@free5GC-HP:~/free5gc_v3.1.1/free5gc$ ./run.sh
```


Step 2

- 1) 插入5G SA基地台的電源
- 2) 並按下啟動鍵



Step 3

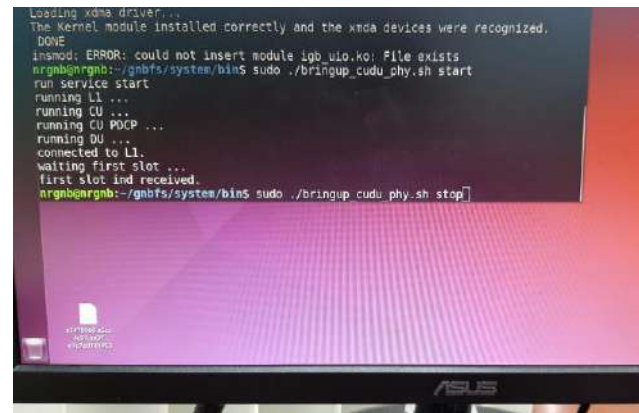
- 1) 切換至~/gnbfs/system/bin資料夾
- 2) 輸入sudo ./bringup_cudu_phy.sh init
- 3) 輸入sudo ./bringup_cudu_phy.sh start
- 4) 等待畫面出現如右圖所示最後一行

waiting first slot...

```
rgnrb@rgnrb:~/gnbfs/system/bin$ sudo ./bringup_cudu_phy.sh start
run system start
redis-server start successfully
netopeer2-server start successfully
sysrepo-plugind start successfully
run service start
CPU usage not suitable.
running L1 ...
running CU ...
running CU PDCP ...
running DU ...
connected to L1
waiting first slot ...
```


Step 4

- 1) 將POE網路線插入OUT孔
- 2) 並等待畫面呈現如右下角所示



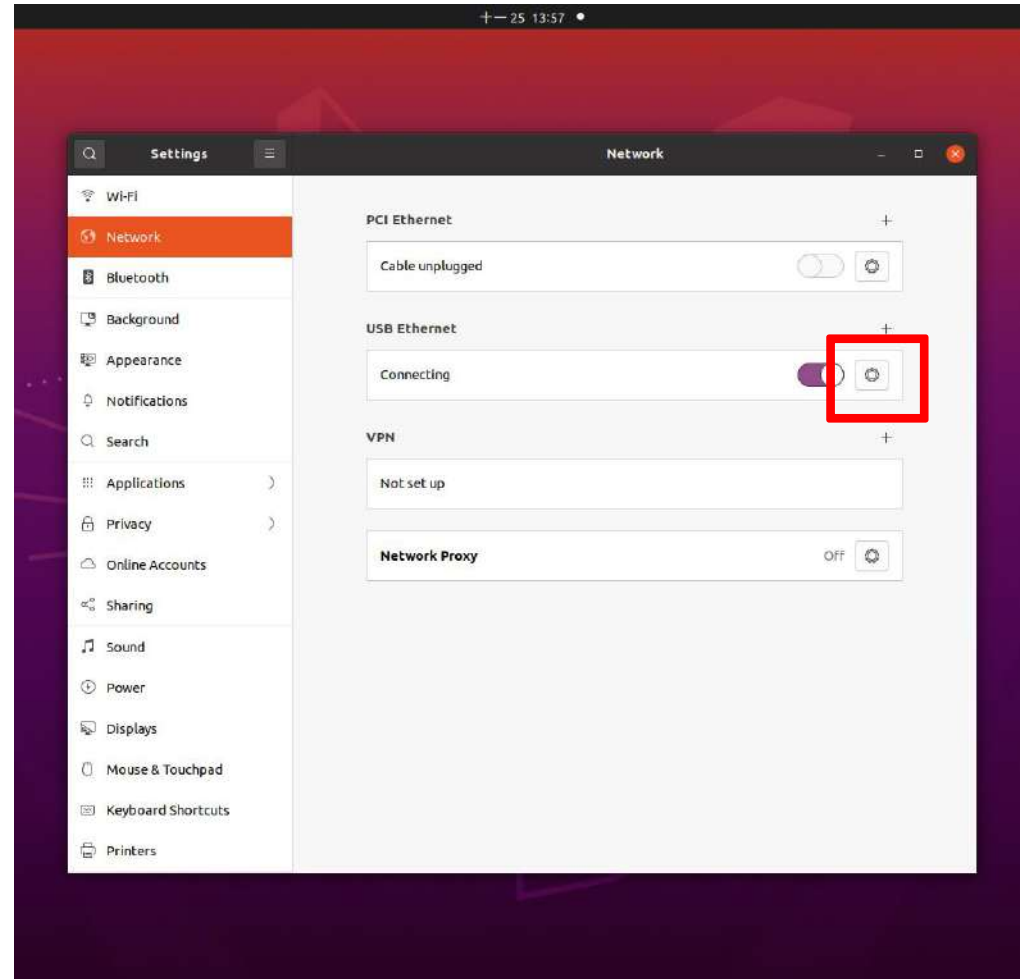
Step 5

- 1) 將5G SIM卡插入5G USB無線網卡
- 2) 並透過連接線將5G USB無線網卡接上筆記型電腦



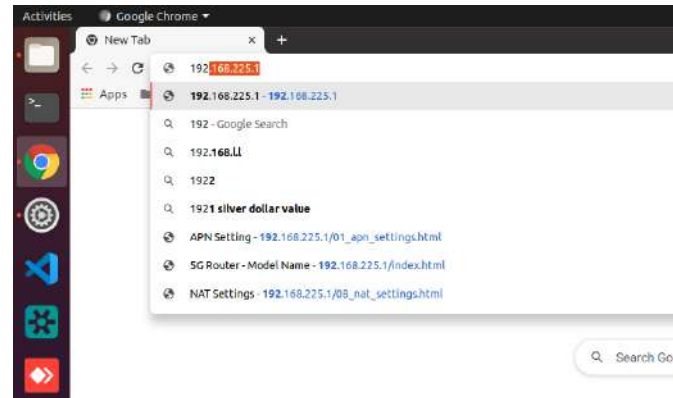
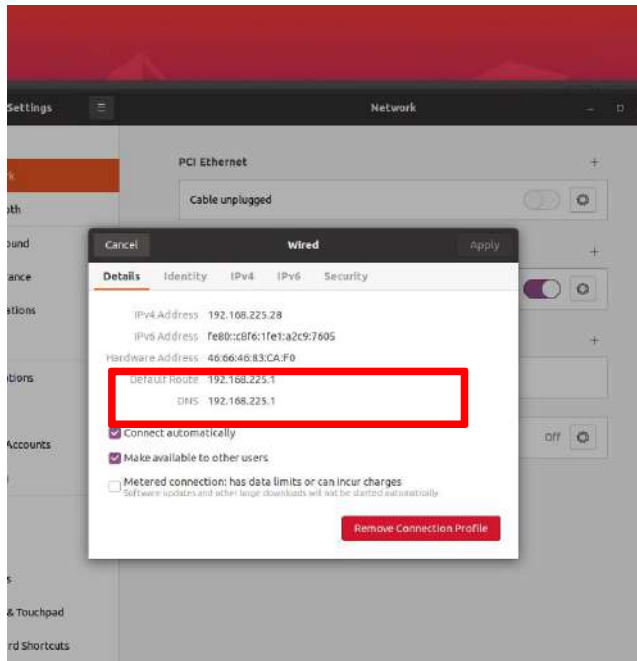
Step 6

- 1) 進入電腦Setting
- 2) 切換至Network介面
- 3) 等待Connecting成功
- 4) 點擊紅框內的圖標



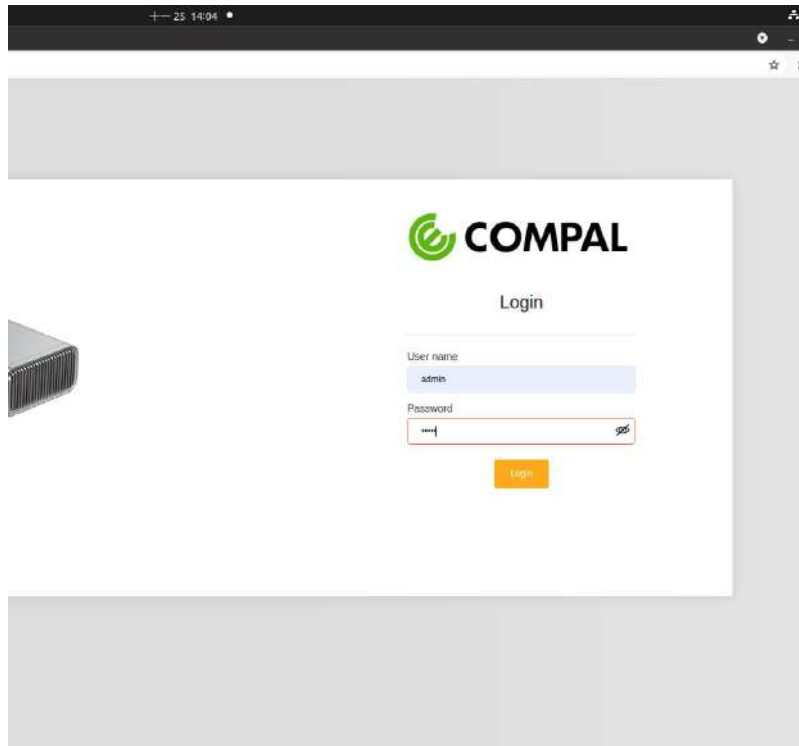
Step 7

- 1) 確認畫面有出現紅框內的IP後
- 2) 開啟瀏覽器，並輸入192.168.255.1



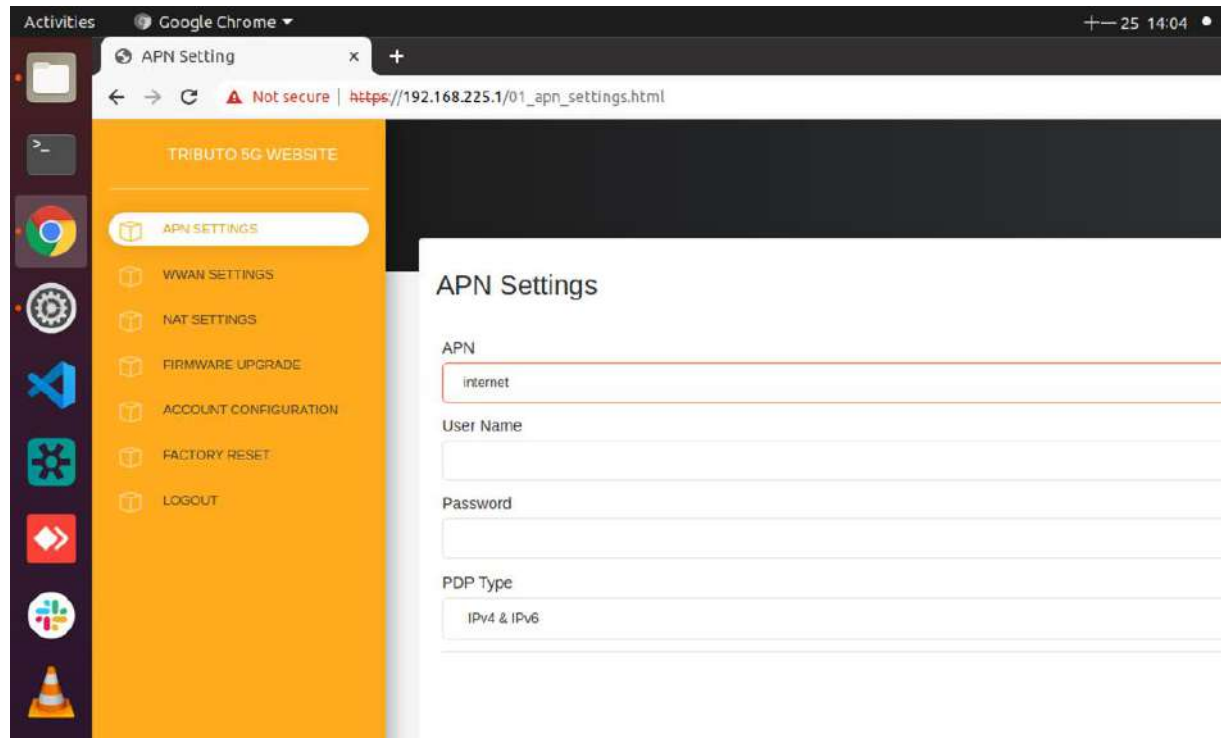
Step 8

- 1) 進入網頁後
- 2) 輸入帳號及密碼



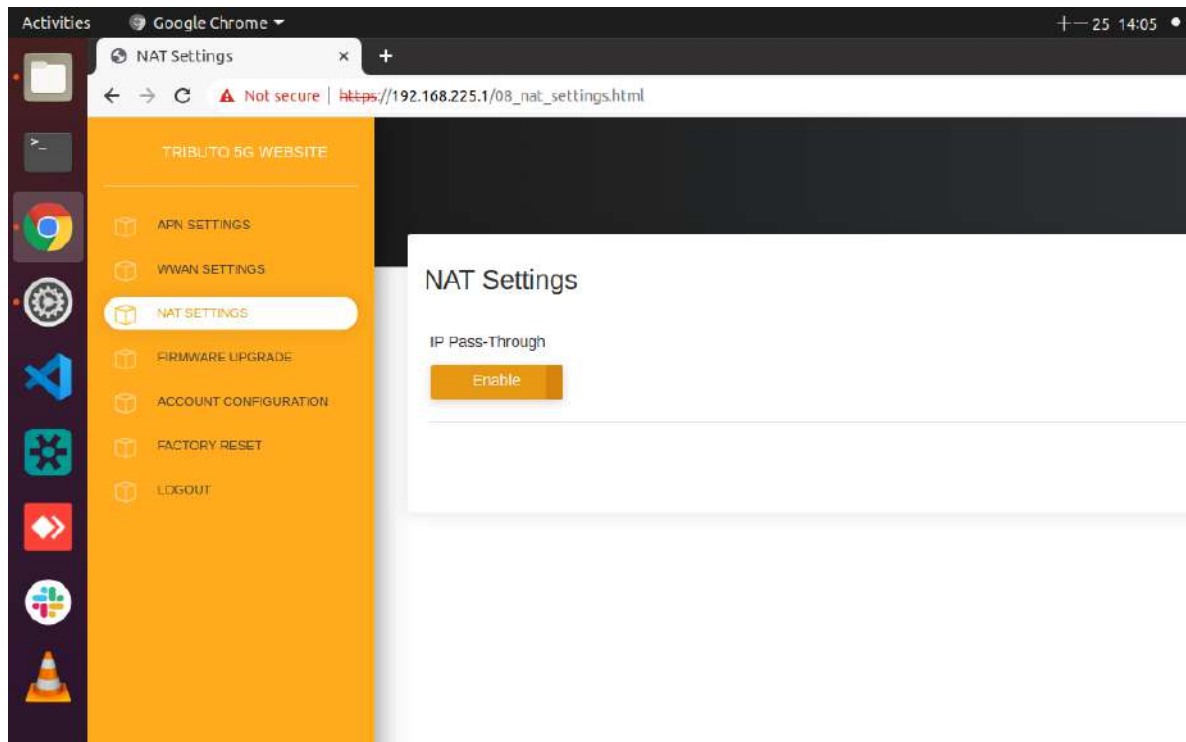
Step 9

- 1) 至APN Settings頁面
- 2) 在APN欄位輸入internet
- 3) 點擊Update按鈕



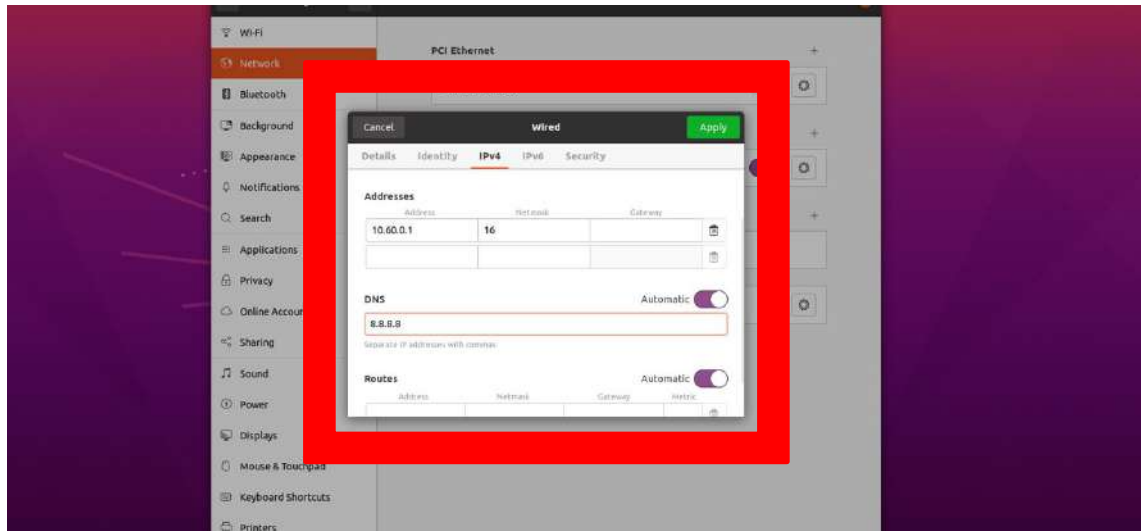
Step 10

- 1) 至NAT Settings頁面
- 2) 開啟IP Pass-Through
- 3) 點擊Update按鈕



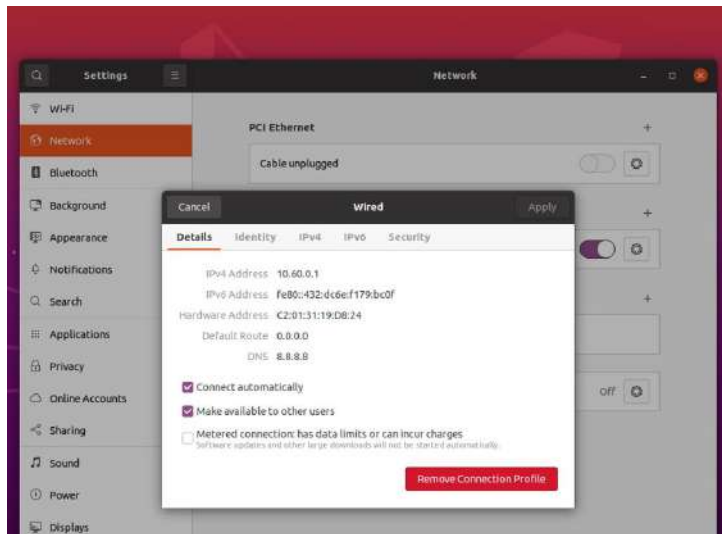
Step 12

- 1) 重複Step 6
- 2) 進入IPv4介面
- 3) 選擇Manual
- 4) 在Addresses欄位輸入Step 11分配的PDUAddress，以及16，如右下圖
- 5) 在DNS欄位輸入8.8.8.8
- 6) 點擊Apply，以儲存變更設定



Step 13

- 1) 等待電腦重新連結，確認Connect的Details介面中IPv4 Address變為剛剛輸入之PDUAddress
- 2) 到Terminal中輸入ifconfig，複製類似紅框中的字串



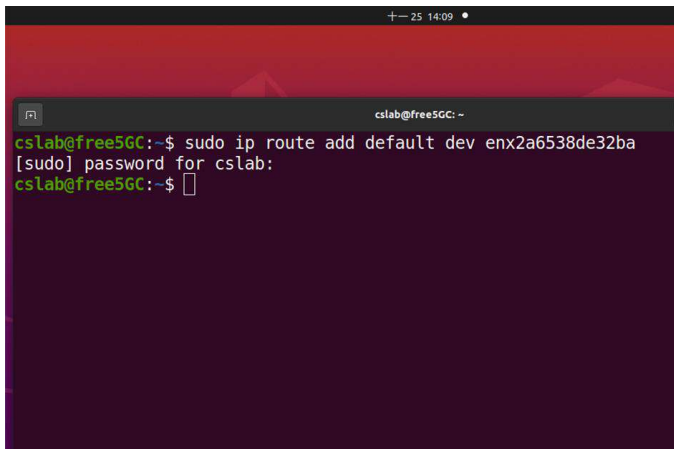
```
csllab@free5GC: ~$ ifconfig
enp0s31f6: flags=4099<UP,BROADCAST,MULTICAST> mtu 1500
ether ec:79:49:43:13:a1 txqueuelen 1000 (Ethernet)
RX packets 0 bytes 0 (0.0 B)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 0 bytes 0 (0.0 B)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
device interrupt 16 memory 0x5c400000-5c420000

enx2a6538de32ba: flags=63<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 10.60.0.2 netmask 255.255.0.0 broadcast 10.60.255.255
ether 2a:65:38:de:32:ba txqueuelen 1000 (Ethernet)
RX packets 13935 bytes 10506947 (10.5 MB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 11549 bytes 1194932 (1.1 MB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

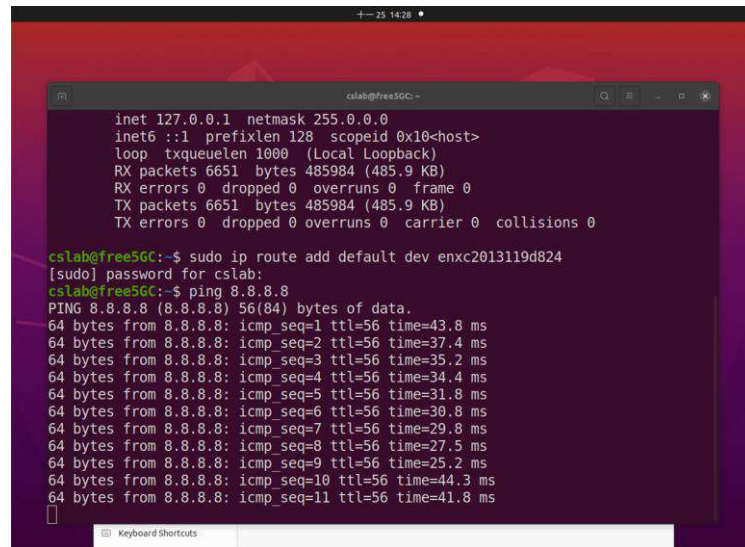
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
inet6 ::1 prefixlen 128 scopeid 0x10<host>
loop txqueuelen 1000 (Local Loopback)
RX packets 3179 bytes 232314 (232.3 KB)
RX errors 0 dropped 0 overruns 0 frame 0
```

Step 14

- 1) 在Terminal中輸入：`sudo ip route add default dev [剛複製的字串]`
- 2) 在Terminal中輸入：`ping 8.8.8.8`
- 3) 如果有出現右下角圖示的結果，代表成功連接5G網路了



```
cslab@free5GC:~$ sudo ip route add default dev enx2a6538de32ba
[sudo] password for cslab:
cslab@free5GC:~$
```



```
cslab@free5GC:~$ sudo ip route add default dev enx2013119d824
[sudo] password for cslab:
cslab@free5GC:~$ ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data:
64 bytes from 8.8.8.8: icmp_seq=1 ttl=56 time=43.8 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=56 time=37.4 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=56 time=35.2 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=56 time=34.4 ms
64 bytes from 8.8.8.8: icmp_seq=5 ttl=56 time=31.8 ms
64 bytes from 8.8.8.8: icmp_seq=6 ttl=56 time=30.8 ms
64 bytes from 8.8.8.8: icmp_seq=7 ttl=56 time=29.8 ms
64 bytes from 8.8.8.8: icmp_seq=8 ttl=56 time=27.5 ms
64 bytes from 8.8.8.8: icmp_seq=9 ttl=56 time=25.2 ms
64 bytes from 8.8.8.8: icmp_seq=10 ttl=56 time=44.3 ms
64 bytes from 8.8.8.8: icmp_seq=11 ttl=56 time=41.8 ms
```



AI智慧教練操作手冊

更改 CoachAI config 檔案

- vim coachAI/projects/coachbox.cfg
- 更改相機設定至本場域所使用之Allied Vision相機

```
[CameraReaderL]
node_type = Reader
brand = Image_Source
hw_id = 28124278
general_topic = cam_control
output_topic = raw_data_l
monitor_topic = cam_data_l
publish_fps = 0
```

```
[CameraReaderR]
node_type = Reader
brand = Image_Source
hw_id = 16124946
general_topic = cam_control
output_topic = raw_data_r
monitor_topic = cam_data_r
publish_fps = 0
```



```
[CameraReaderL]
node_type = Reader
brand = Allied_Vision
hw_id = DEV_000F314E65A0
general_topic = cam_control
output_topic = raw_data_l
monitor_topic = cam_data_l
publish_fps = 0
```

```
[CameraReaderR]
node_type = Reader
brand = Allied_Vision
hw_id = DEV_000F314EC157
general_topic = cam_control
output_topic = raw_data_r
monitor_topic = cam_data_r
publish_fps = 0
```

更改 CoachAI 時間機制

- 將 `frame.get_timestamp()` 改為 `datetime.now().timestamp()`，使夾帶的時間資訊為先前同步過的系統時間。

```
while self.alive:
    if len(self.frame_queue) > 0:
        frame = self.frame_queue.pop(0)
        timestamp = frame.get_timestamp()
        if (timestamp - self.last_send_t) > self.interval and frame != None:
            # publish raw image
            frame.convert_pixel_format(PixelFormat.Bgr8)
            cv_image = frame.as_opencv_image()
            if self.recorder is not None:
                self.recorder.try_put_frame(cv_image)
            ret, buf = cv2.imencode('.jpg', cv_image)
            if ret == True:
                imdata = pickle.dumps(buf)
                payload = { 'id': frame.get_id(), 'timestamp': timestamp, 'raw_data':
```

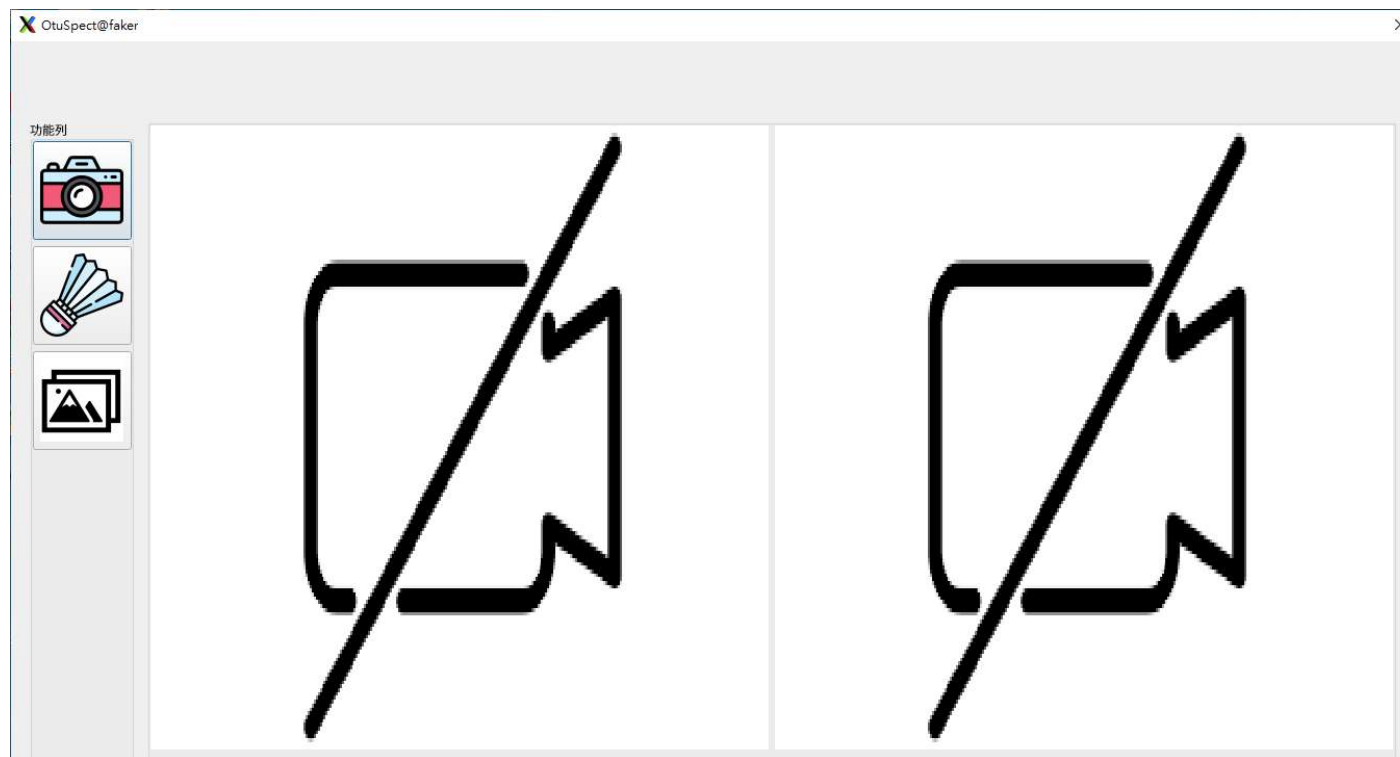

UI介面

- 進入 CoachAI/UI
- 執行 `python3 main.py`



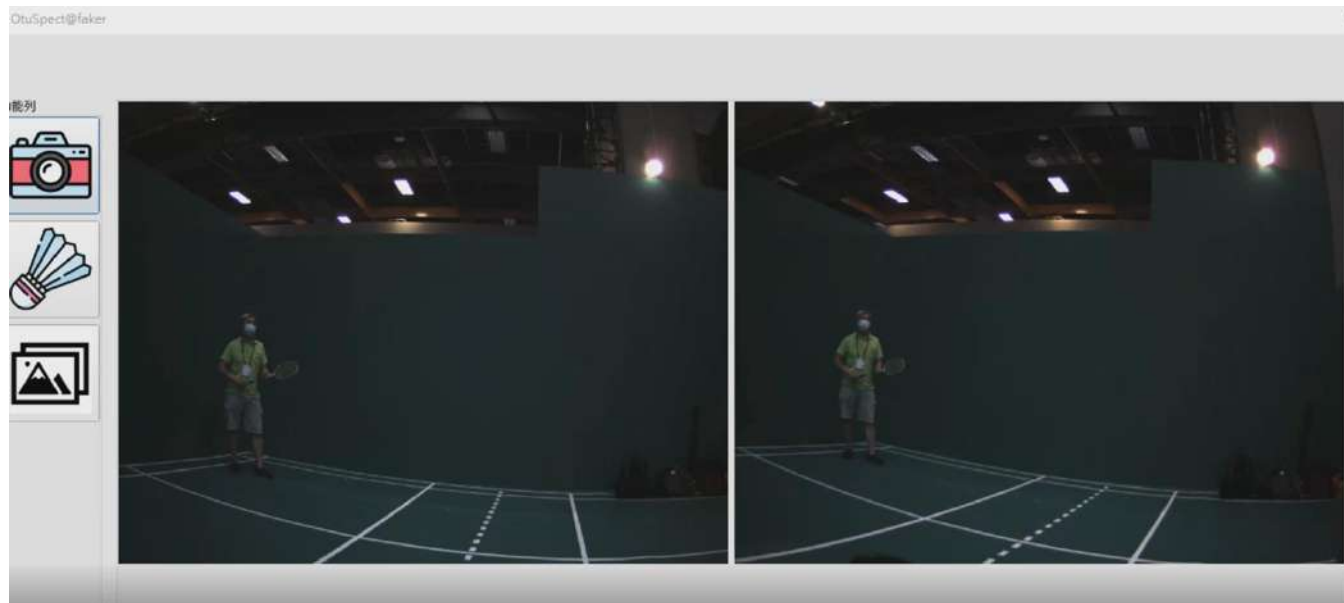
球路軌跡預測

- 點選 OtuSpect，等待相機開啟，在連接相機的電腦開啟CoachAI的 CameraReader.py，開始拍攝



球路軌跡預測

- 開始拍攝人員擊球情況，可在此 UI 看見直播同步畫面



球路軌跡預測

- 點選左邊之羽球圖案，可進行羽球軌跡分析，並得到結果圖

