2024-1 Introduction to Internet of Things

: Progress Report

Team 6
201931322 김재영
202031415 임형섭 gudtjqdkwk@naver.com
202033502 강현준
202034909 김주혜

>> Table of contents

>> Table of contents

>> Brief Description

Develop a system using Wi-Fi sensing technology on Raspberry Pi to identify human activities or states in indoor environments

1

Project Overview

Part 1 >> Project Overview

Project objectives and needs

Part 1 >> Project Overview - Raspberry Pi os

Debian-based OS

Created for Raspberry Pi computers

Hardware Optimization

Pre-installed with various software packages

Active Community Support

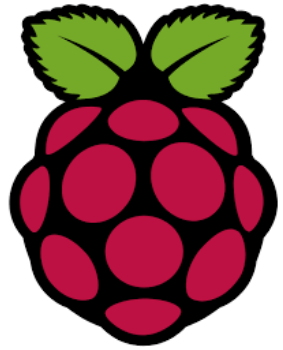
Ongoing development & collaborative problem-solving

Lightweight & Efficient

Suitable for diverse projects

Educational Use

Supports multiple programming languages & widely used in schools



Part 1 >> **Project Overview** - Nexmon

nexmon

Wi-Fi & Bluetooth

Handles communications

Community Project

continuously expand capabilities.

Raspberry Pi Compatible

Ideal for experimental & development purposes

Patches

Modifies & extends Bluetooth communication.

Software Framework

advanced wireless features for embedded system

2

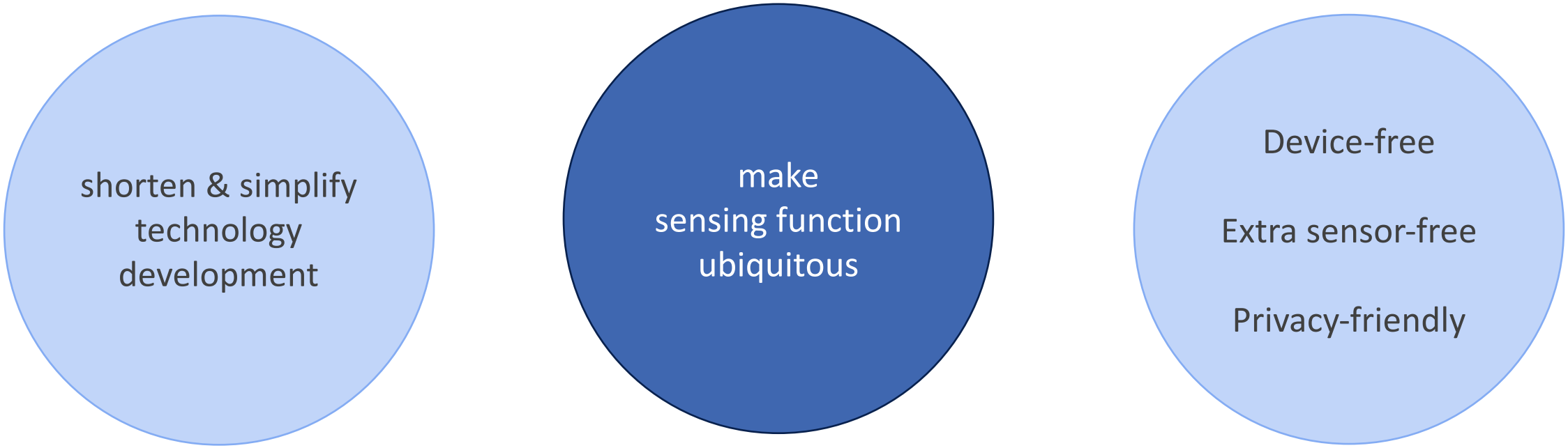
Technical Background

Part 2 >> Technical Background

Wi-Fi Sensing

Using existing standardized 802.11-based protocols to sense and track changes in the environment such as presence, range, angle, and velocity of non transceiver objects.

Advantages of Wi-Fi Sensing



Part 2 >> # Technical Background

Channel State Information (CSI)

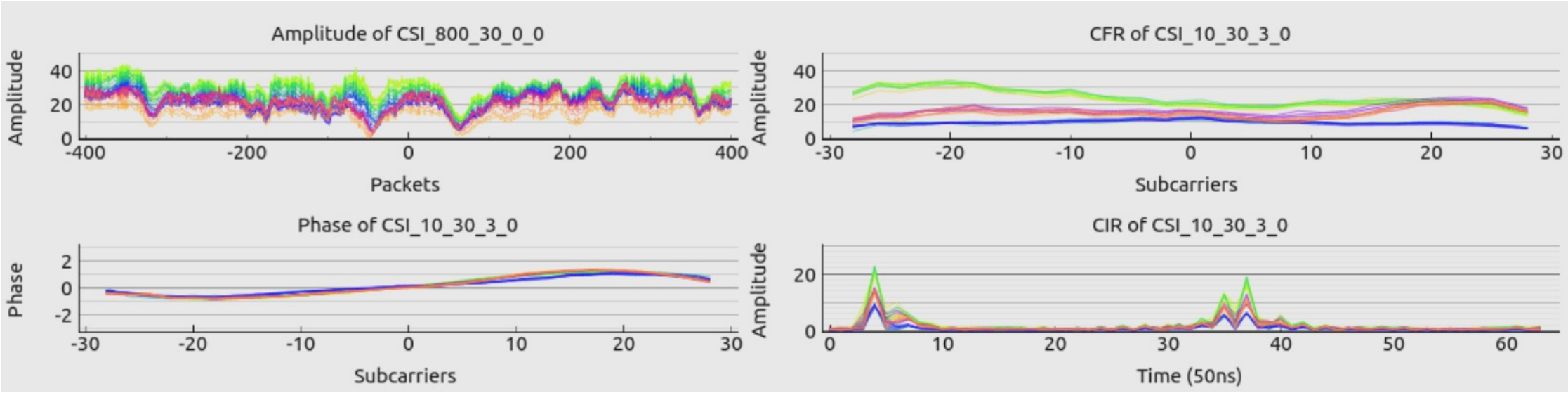
- the channel characteristics of communication links

adjust the **transmission** to the current channel conditions to **achieve reliable communication and high data rates.**

characterizes the propagation of radio signals from transmitter to receiver at specific frequencies.

Part 2 >> # Technical Background

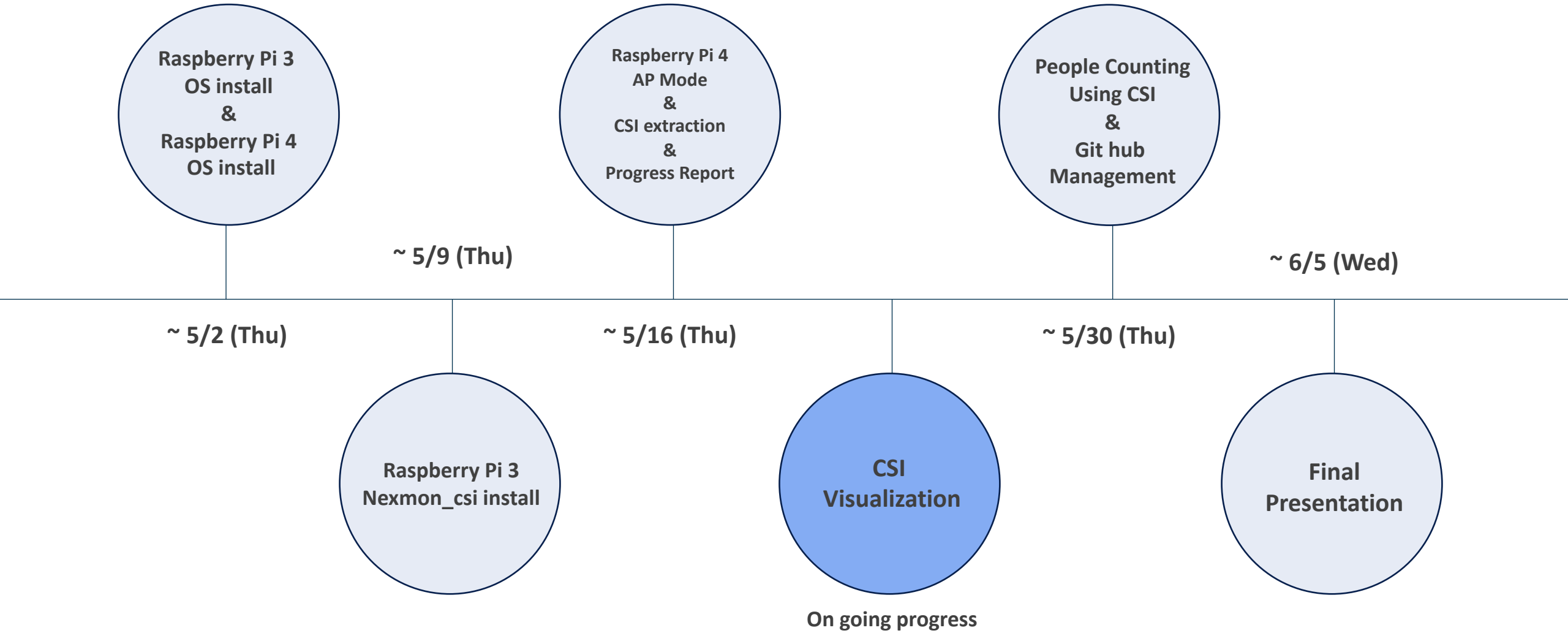
information can be used to **estimate the location of Wi-Fi devices**, which is done by **analyzing how signals propagate through space.**



3

Project Progress

Part 3 >> # Project Progress



4

Setup and Data Collection

Part 4 >> # Setup and Data Collection

Raspberry Pi OS install

STEP 1	STEP 2	STEP 3	STEP 4
Download Raspberry Pi Imager https://www.raspberrypi.com/software/	Search and download compatible Raspberry Pi OS img file Our version: 2022-01-28-raspios-bullseye-armhf.img https://downloads.raspberrypi.com/	Select user custom OS file and proper Raspberry Pi model & SD card	Insert SD card to Raspberry pi model

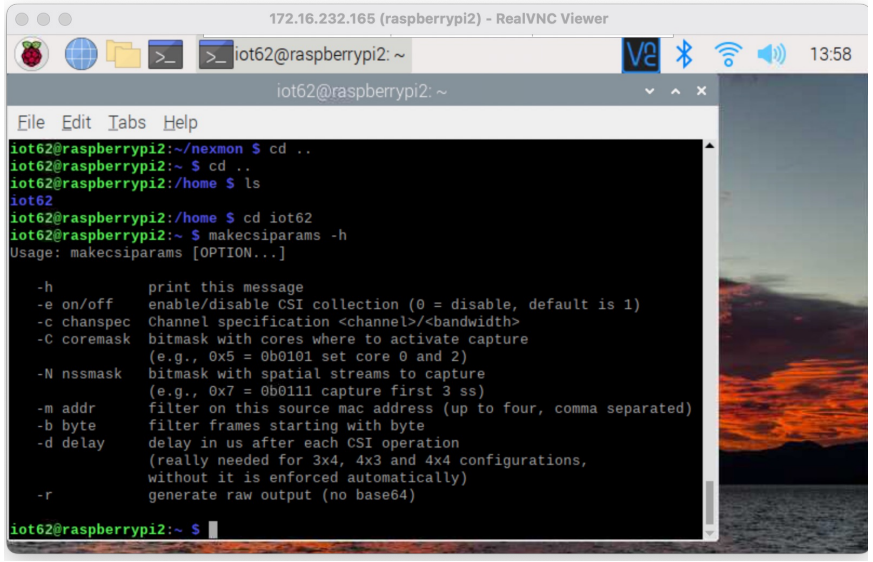
Part 4 >> # Setup and Data Collection

Nexmon & Nexmon CSI install

STEP 1	STEP 2	STEP 3	STEP 4
Dependency & Kernel header setting	Git clone Nexmon https://github.com/seemoo-lab/nexmon	Git clone Nemon_CSI https://github.com/seemoo-lab/nexmon_csi	Check install completed properly $makecsiparams -h

> >

Nexmon CSI install



* more documents on ch 7.

More detail about install nexmon_csi
https://pio-ji.notion.site/Nexmon-CSI-2653217c26644723a5f91e45f37b8a5a

Part 4 >> # Setup and Data Collection

Wi-Fi CSI Extraction

STEP 1

Make one Raspberry Pi as AP Mode and activate it

https://limjunhogithub.io/2020/08/25/Raspberry-Pi-AP%EB%A7%8C%EB%93%A4%EA%B8%B0.html

>>

STEP 2

Extract CSI using

$makecsiparams -c 40/20/ -C 1 –N 1 –m 88:36:6c:c7:95:fe

* channel/band width & MAC address

>>

STEP 3

Set to monitor mode

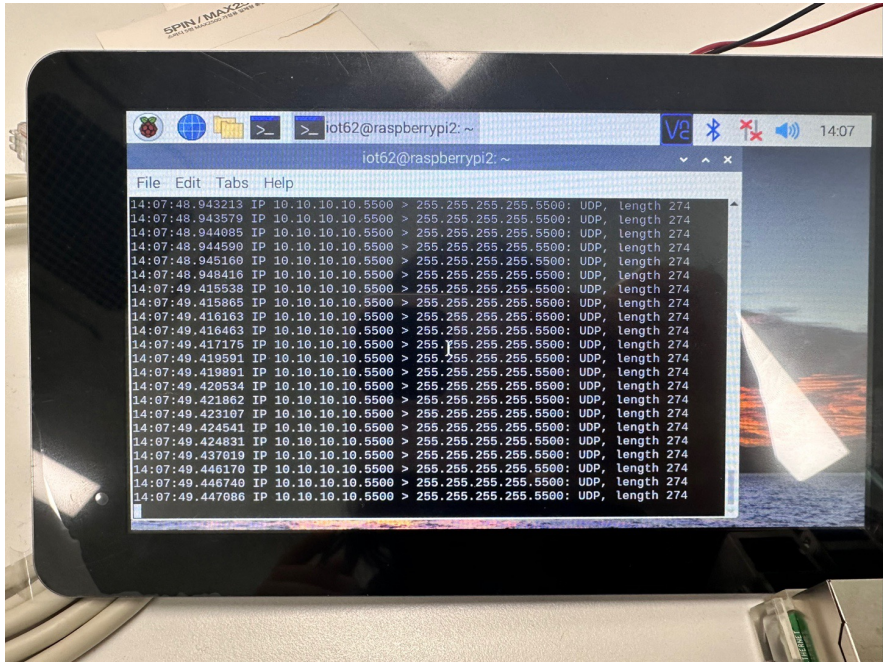
>>

STEP 4

Store the CSI extraction

$tcpdump –I wlan0 dst port 5500 –w –w outputpcap –c 1000 outputpcap

CSI Extract



* more documents on ch 7.

More detail about CSI extraction
https://pio-ji.notion.site/CSI-3ddf719f41934575bddda406732b2ccf

Part 4 >> Setup and Data Collection

pcap to CSV

STEP 1

Move pcap file in RPI to laptop for easier progress

>
>

STEP 2

Use 'gigasheet' to convert the file to CSV

https://www.gigasheet.com/

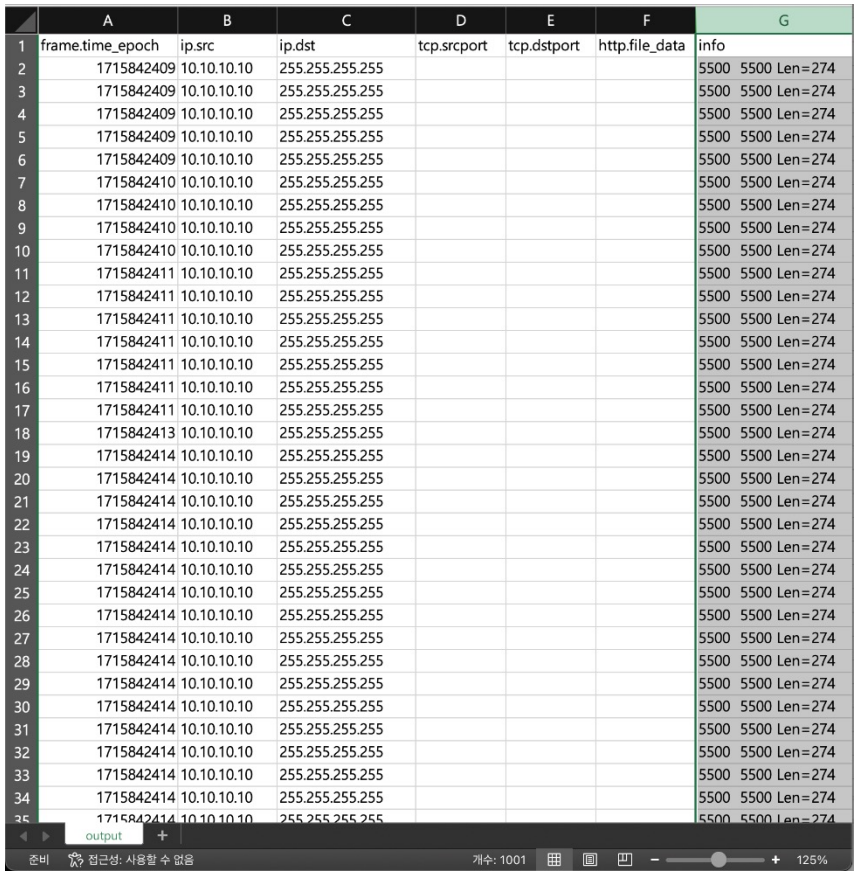
>
>

STEP 3

Check if the packet has stored thoroughly

we tried to use the module given by TA, but somehow it didn't work

CSI.CSV



	A	B	C	D	E	F	G
1	frame.time_epoch	ip.src	ip.dst	tcp.srcport	tcp.dstport	http.file_data	info
2	1715842409	10.10.10.10	255.255.255.255				5500 5500 Len=274
3	1715842409	10.10.10.10	255.255.255.255				5500 5500 Len=274
4	1715842409	10.10.10.10	255.255.255.255				5500 5500 Len=274
5	1715842409	10.10.10.10	255.255.255.255				5500 5500 Len=274
6	1715842409	10.10.10.10	255.255.255.255				5500 5500 Len=274
7	1715842410	10.10.10.10	255.255.255.255				5500 5500 Len=274
8	1715842410	10.10.10.10	255.255.255.255				5500 5500 Len=274
9	1715842410	10.10.10.10	255.255.255.255				5500 5500 Len=274
10	1715842410	10.10.10.10	255.255.255.255				5500 5500 Len=274
11	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
12	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
13	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
14	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
15	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
16	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
17	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
18	1715842413	10.10.10.10	255.255.255.255				5500 5500 Len=274
19	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
20	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
21	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
22	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
23	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
24	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
25	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
26	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
27	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
28	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
29	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
30	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
31	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
32	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
33	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
34	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
35	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274

output

준비 접근성: 사용할 수 없음 개수: 1001 125%

There was no obstacle between AP and the client, which has resulted 255.255.255.255 I guess

5

Discussion and Future Plans

Part 5 >> # Discussion and Future Plans

Problems

Problem 1

Tried to set constant IP to use VNC server, however it ended up with 'wlan0 not associated'

Problem 2

When rebooting RPI after installing CSI, the wlan interface kept shutting down and never come back

Problem 3

'pcap' -> 'csv' doesn't work with the given module from TA.

>>

>>

Solutions

Solution 1

We googled a lot and also asked to TA. The solution was simply reformatting the RPI.

Solution 2

We found out website that does the task 'pcap' -> 'csv'.

Part 5 >> # Discussion and Future Plans

WLAN connection issue is quite difficult in Raspberry Pi's os, not only in our team, but also in other teams.

For a stable development environment, it is necessary to find a way to resolve errors related to the Wi-Fi interface.

We wanted to use the **Transformation and Visualization Python module** which TA posted, but we couldn’t use it due to an error.

We will consult TA to figure out the error and extract visualized plot, graph as well as csv files.

6

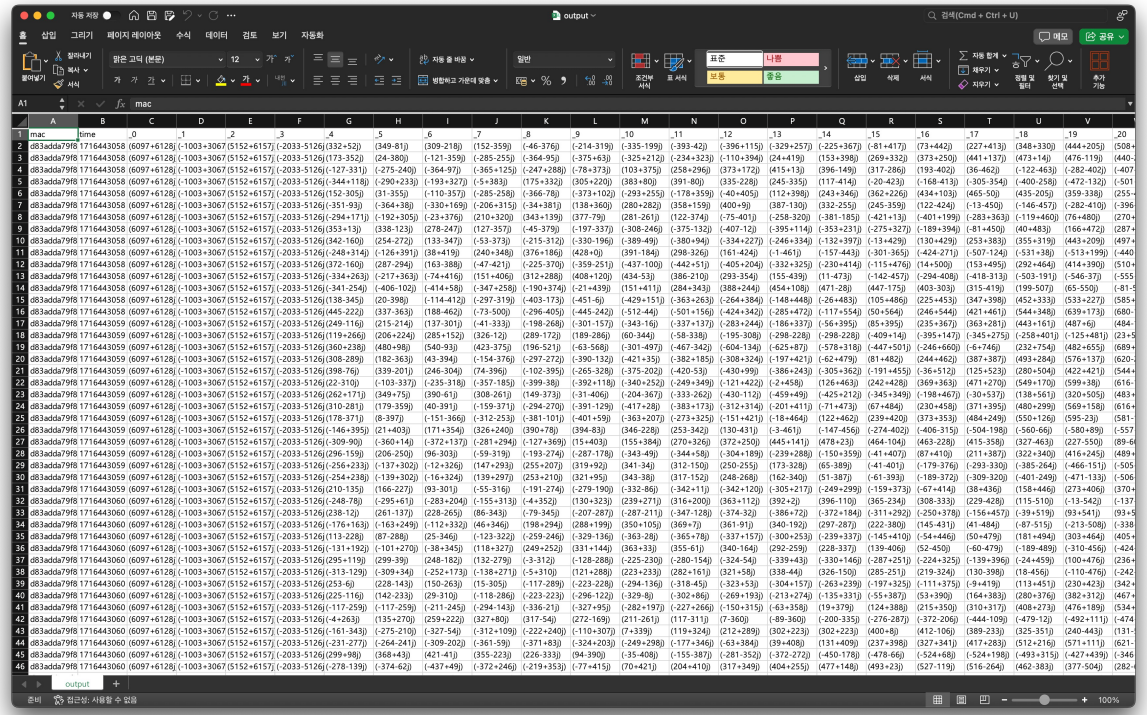
Data Collection and System Implementation

Part 6 >> Data Collection and System Implementation

pcap to CSV

```
~/Desktop/pcap-to-csv | main !1 ?1 ──────────── 19:25:18
❯ python create_dataset.py
WARNING: No IPv4 address found on anpi1 !
WARNING: No IPv4 address found on anpi0 !
WARNING: more No IPv4 address found on en3 !
Save output.csv
```

CSI.CSV



More detail about pcap to csv

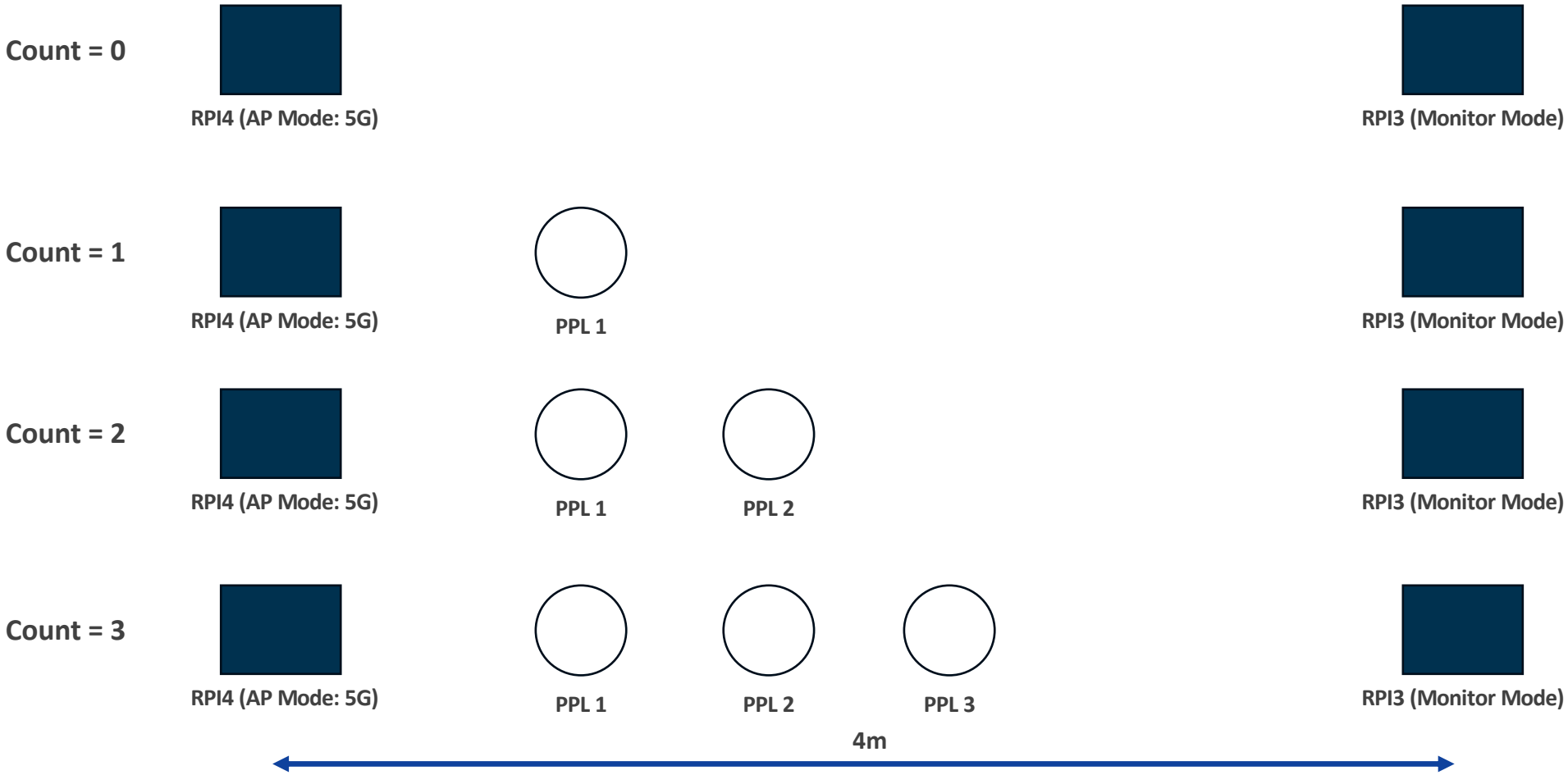
https://github.com/cheeseBG/pcap-to-csv

Part 6 >>

Data Collection and System Implementation

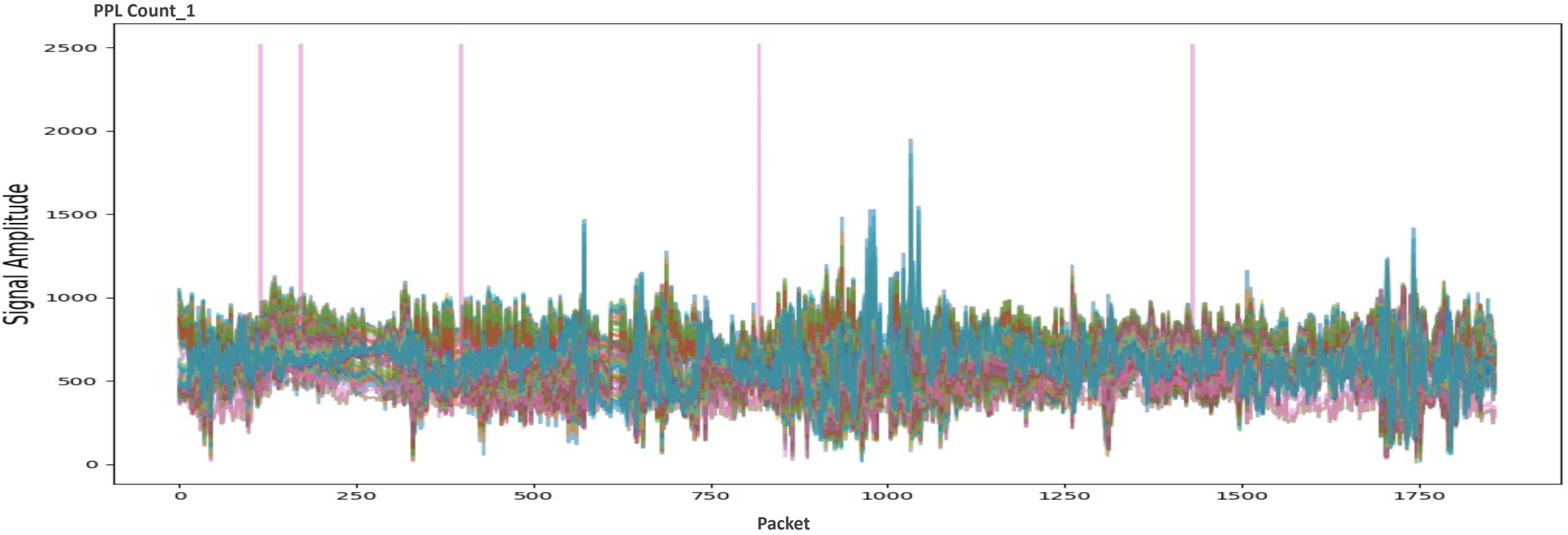
Data Collection: People Count 1 – Vertical Direction

Date: 2024.05.27 (Mon) 11:00 ~ 13:00
@: AI Building Room 405



Part 6 >> Data Collection and System Implementation

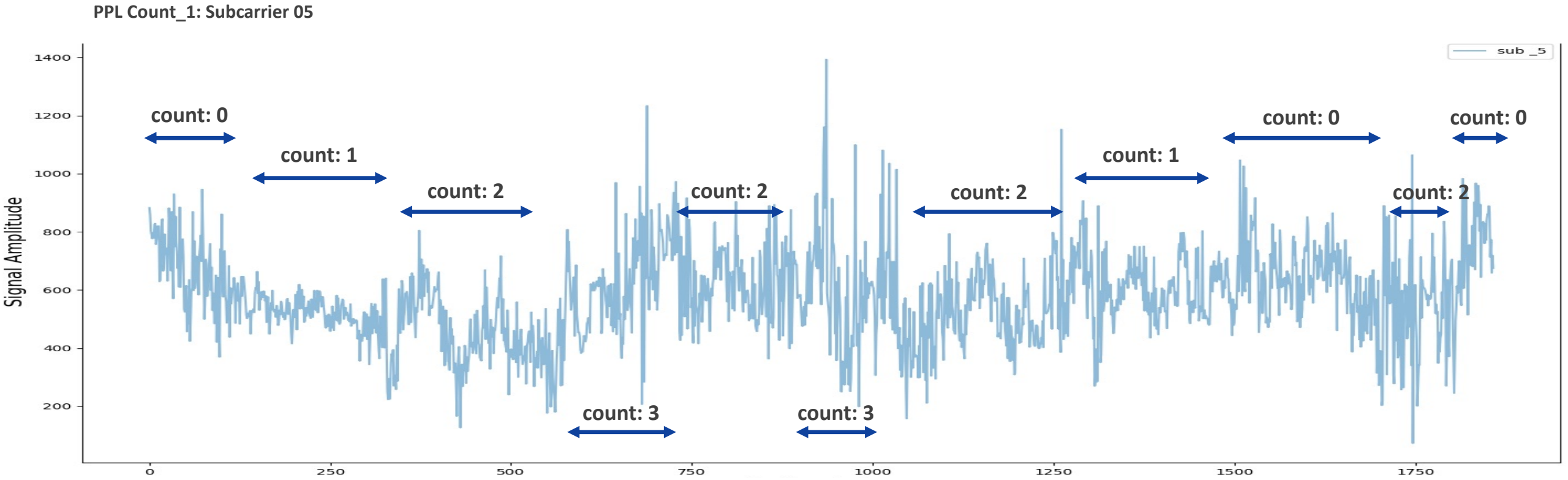
CSI visualization: People Count 1 – Vertical Direction



More detail about CSI visualization
https://github.com/cheeseBG/csi-visualization

Part 6 >> Data Collection and System Implementation

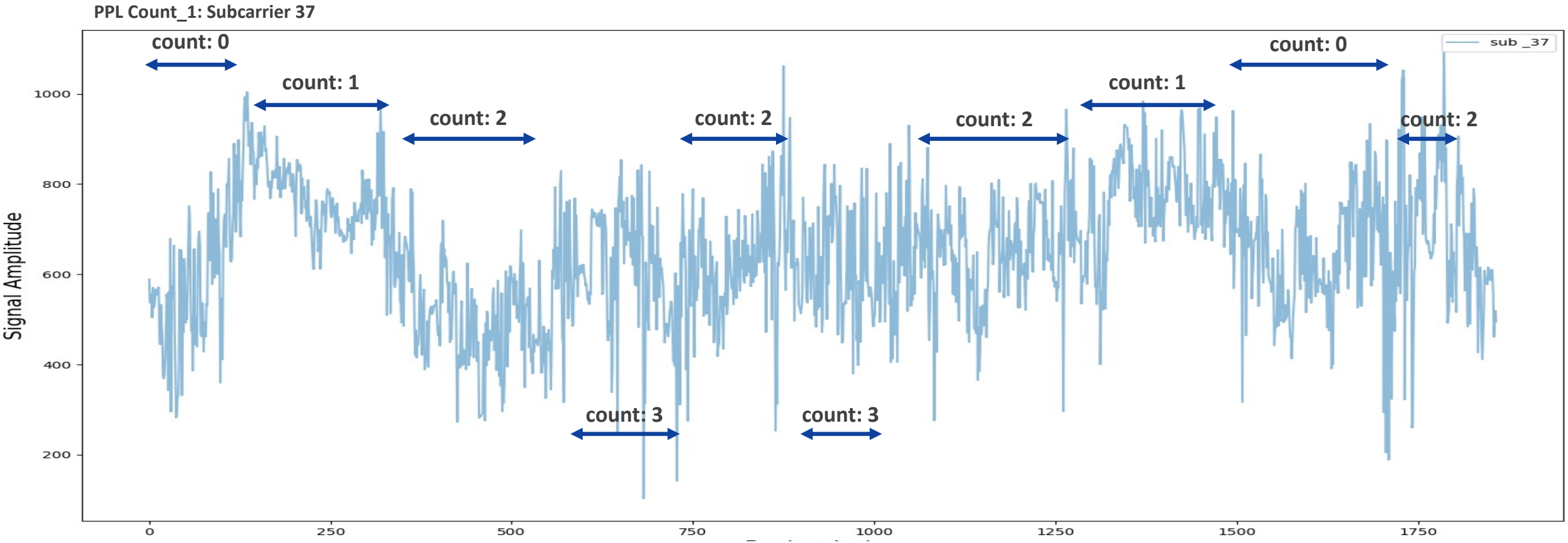
CSI visualization: People Count 1 – Vertical Direction



More detail about CSI visualization
https://github.com/cheeseBG/csi-visualization

Part 6 >> Data Collection and System Implementation

CSI visualization: People Count 1 – Vertical Direction

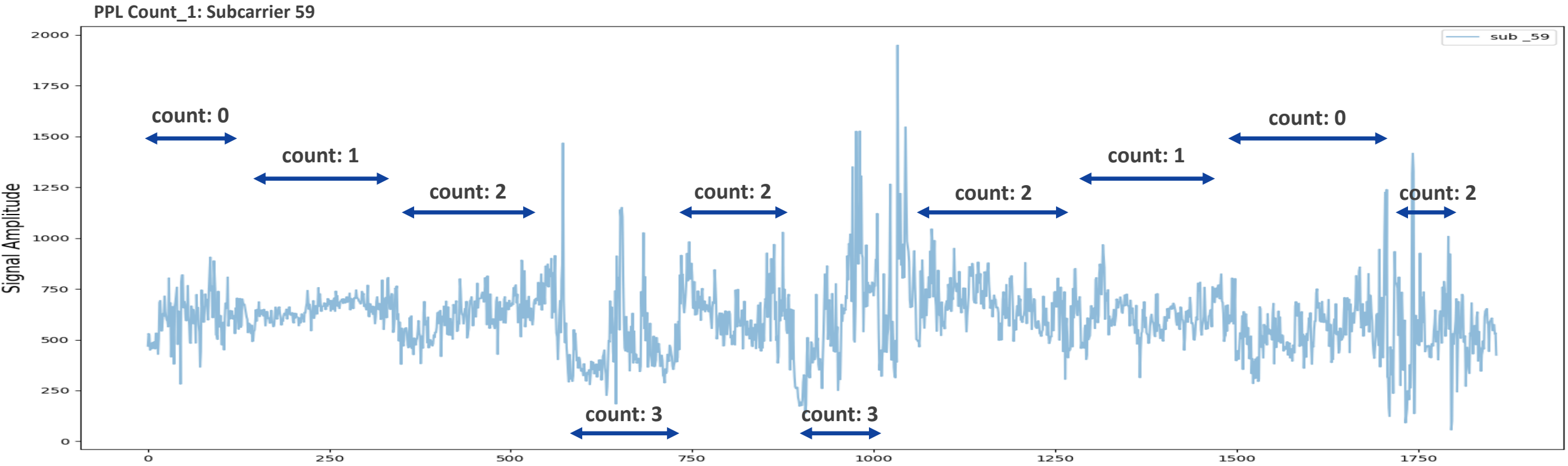


More detail about CSI visualization

https://github.com/cheeseBG/csi-visualization

Part 6 >> # Data Collection and System Implementation

CSI visualization: People Count 1 – Vertical Direction

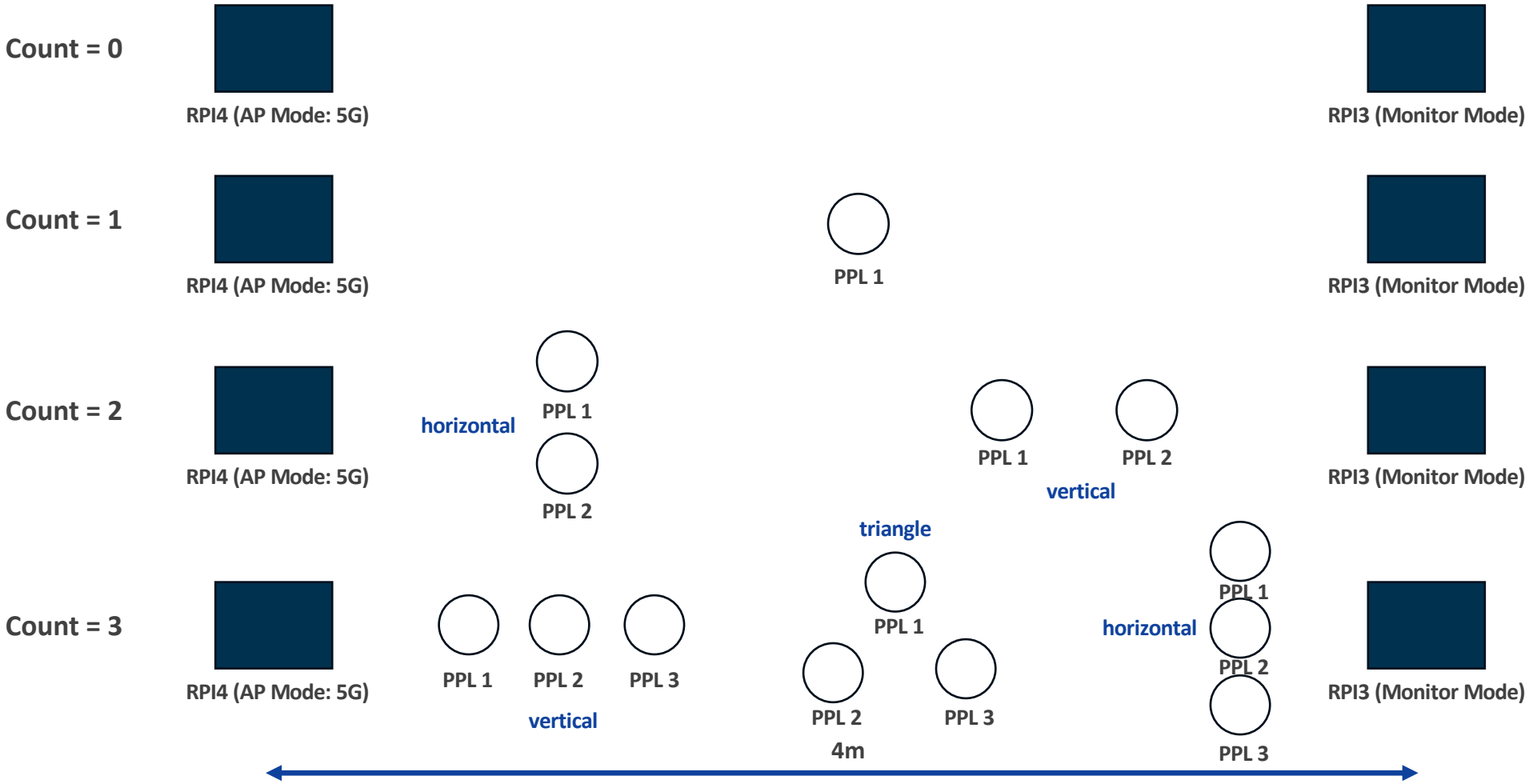


More detail about CSI visualization
https://github.com/cheeseBG/csi-visualization

Part 6 >> # Data Collection and System Implementation

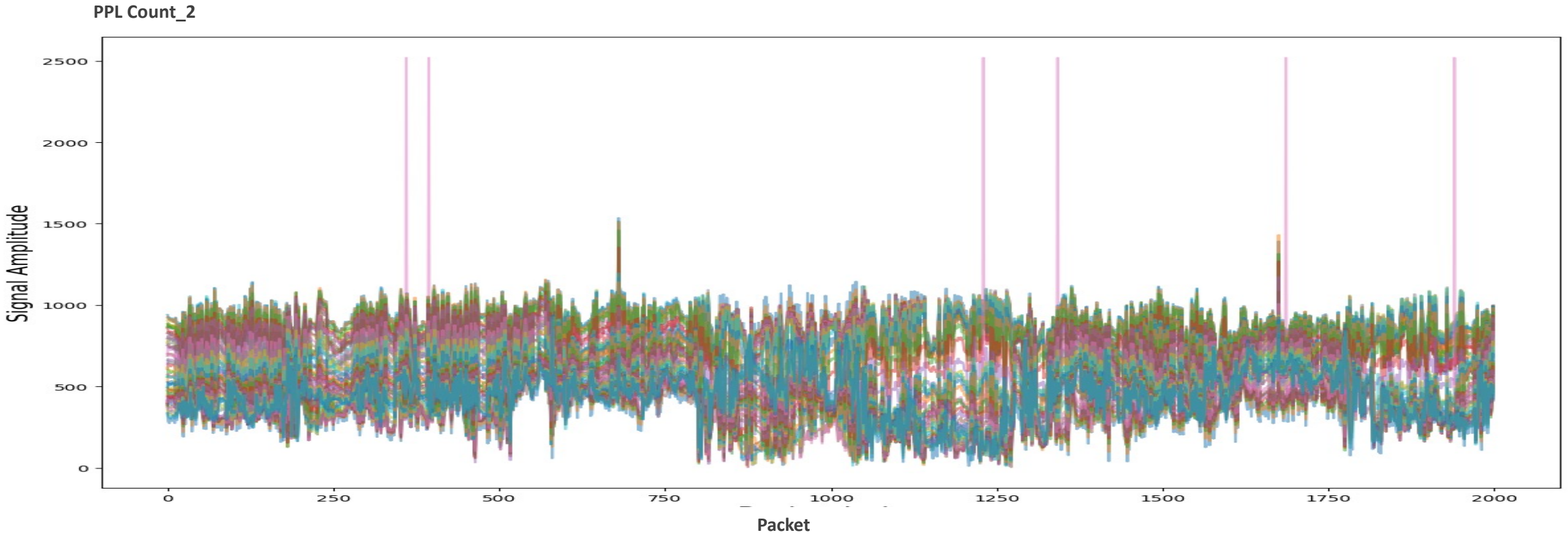
Data Collection: People Count 2 – Free Direction

Date: 2024.05.27 (Mon) 11:00 ~ 13:00
@: AI Building Room 405



Part 6 >> Data Collection and System Implementation

CSI visualization: People Count 2 – Free Direction



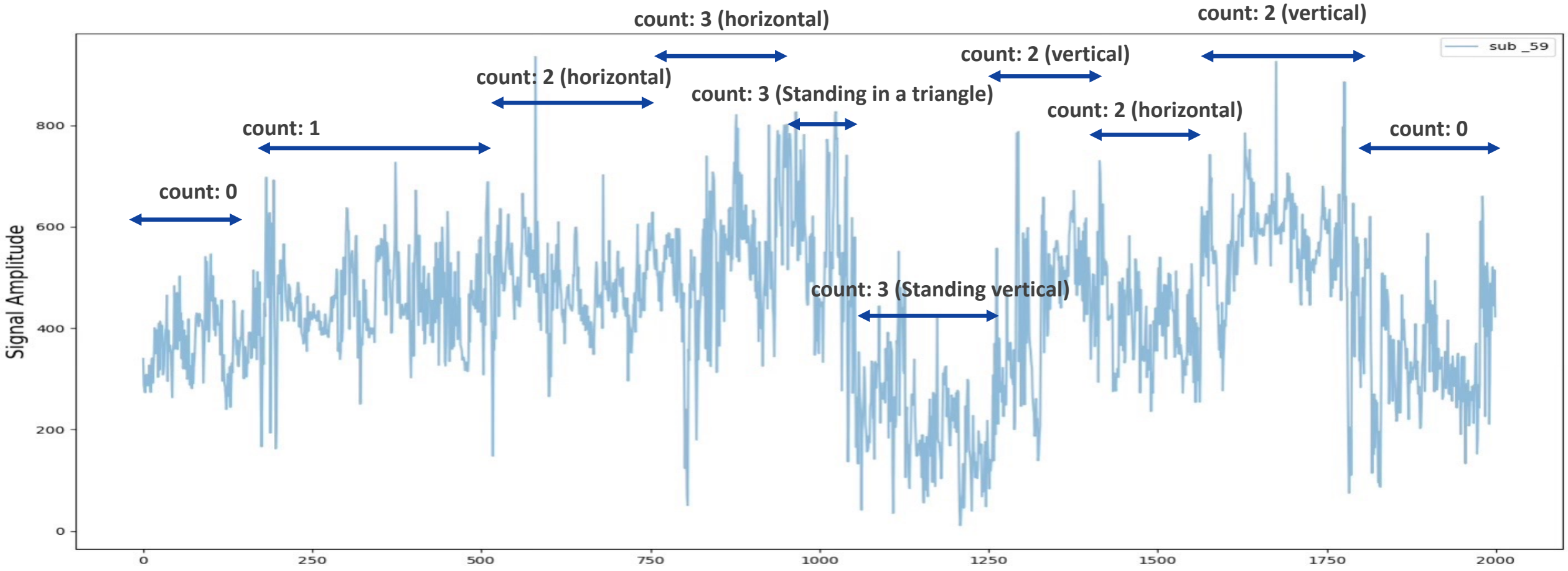
More detail about CSI visualization

https://github.com/cheeseBG/csi-visualization

Part 6 >> # Data Collection and System Implementation

CSI visualization: People Count 2 – Free Direction

PPL Count_2: Subcarrier 05



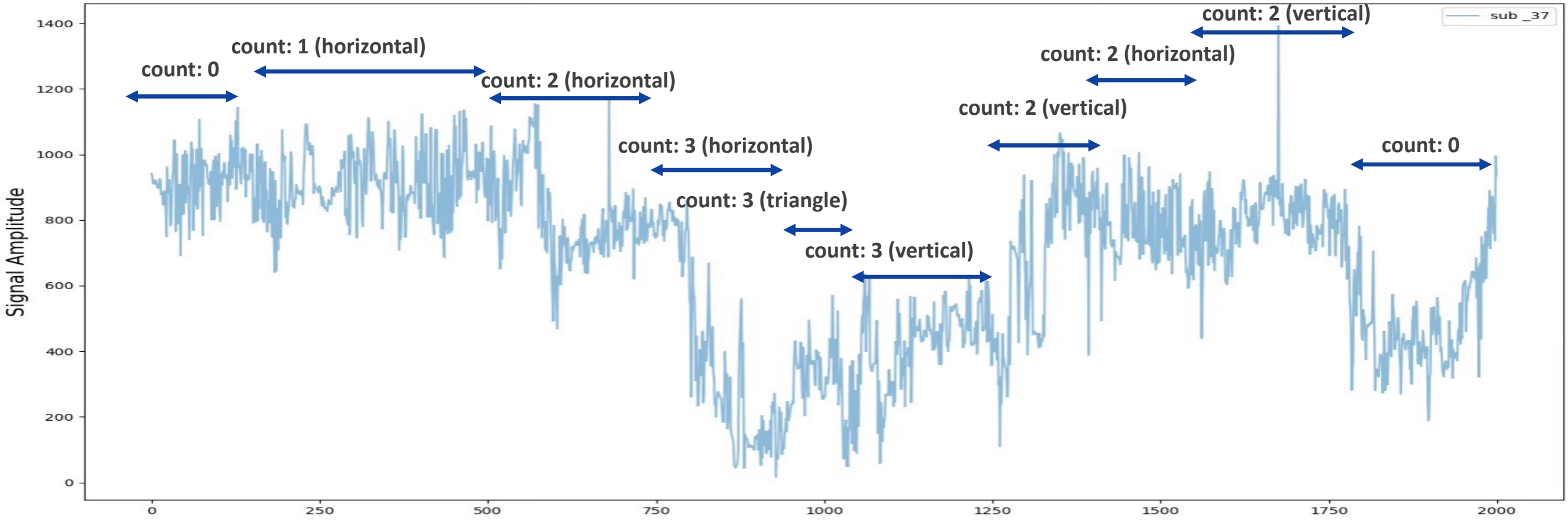
More detail about CSI visualization

https://github.com/cheeseBG/csi-visualization

Part 6 >> # Data Collection and System Implementation

CSI visualization: People Count 2 – Free Direction

PPL Count_2: Subcarrier 37



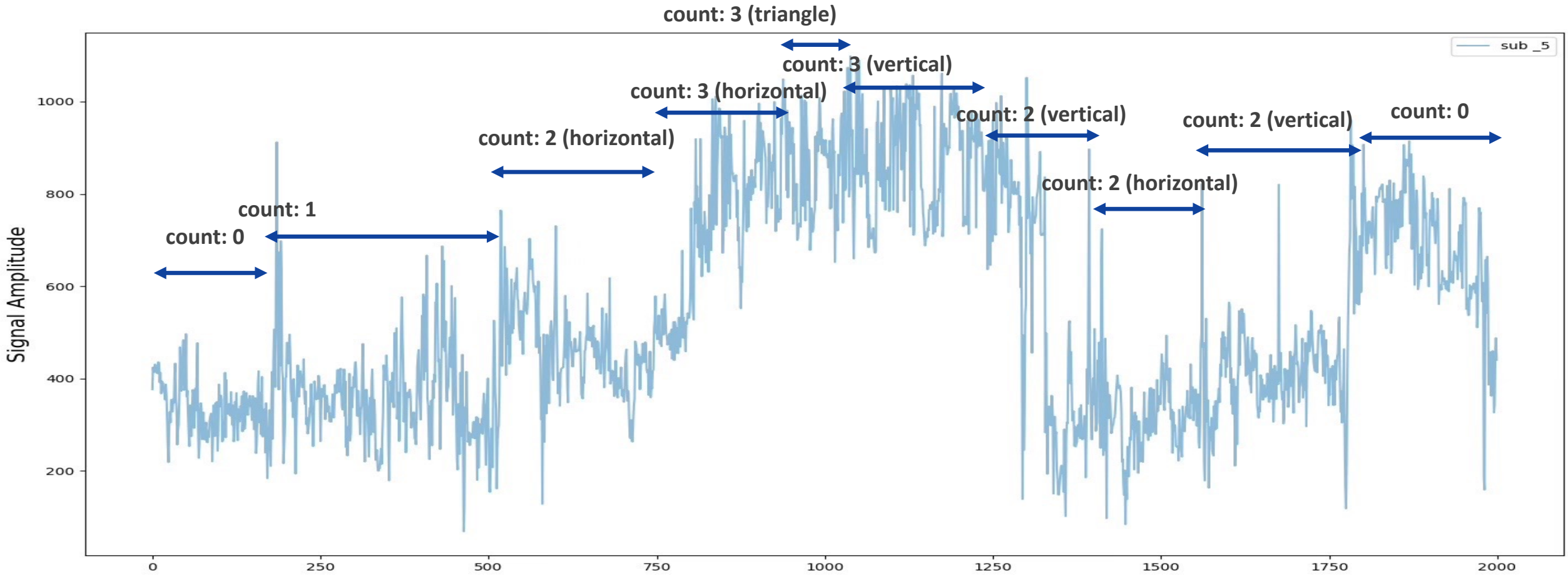
More detail about CSI visualization

https://github.com/cheeseBG/csi-visualization

Part 6 >> # Data Collection and System Implementation

CSI visualization: People Count 2 – Free Direction

PPL Count_2: Subcarrier 59



More detail about CSI visualization

https://github.com/cheeseBG/csi-visualization

7

Idea Proposal Exploiting Wi-Fi Sensing

Part 7 >> Idea Proposal Exploiting Wi-Fi Sensing

Treatment of insomnia using Wi-Fi sensing

Prevalence Among US Adults: Recent findings indicate that approximately 22% of adults in the United States experience insomnia every single night. Additionally, over half of US adults encounter insomnia at least once a month (Helsestart).

Korea's exponentially growing number of insomniacs: The number of insomnia patients has increased by 96 percent in the last 10 years, and at least 15 percent of the total population suffers from chronic insomnia.(BMJopen)

The number of insomniacs is constantly increasing, so we're trying to find a way to prevent and solve it through wifi-sensing.

Part 7 >> # Idea Proposal Exploiting Wi-Fi Sensing

Treatment of insomnia using Wi-Fi sensing

Function

- Notify to create a good sleep feedback or appropriate environment by diagnosing movement or sleep time that interferes with sleep when sleeping using wifi-sensing

Expectation Effectiveness

- Solving insomnia through a much better sleep

Part 7 >>

Idea Proposal Exploiting Wi-Fi Sensing

Target Marketing	Customer Experience Stories	Experience program	Partenership
• targeting office workers, students, and the elderly who often suffer from insomnia • our idea is a solution that can solve their lifestyles and sleep problems	• Increase credibility by promoting real user success stories. • Highlighting how much the quality of daily life has improved after improving insomnia.	• Run a free experience program so that we can directly experience the effects of the product. • Induce users who experience the effect of improving sleep during the experience period to purchase.	• Partnerships with sleep care hospitals, clinics, and wellness centers

Part 7 >> **Idea Proposal Exploiting Wi-Fi Sensing** - Expectation of Appearance

8

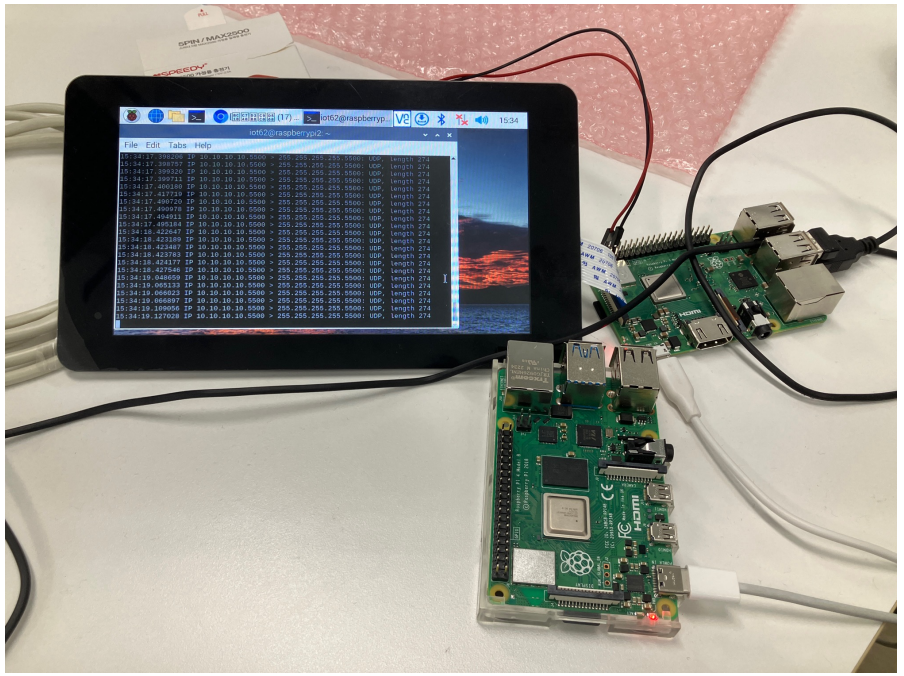
Documents & Contribution

Part 8 >> # Documents

IoT6 Teammates

Lab environment

Ai building, 405

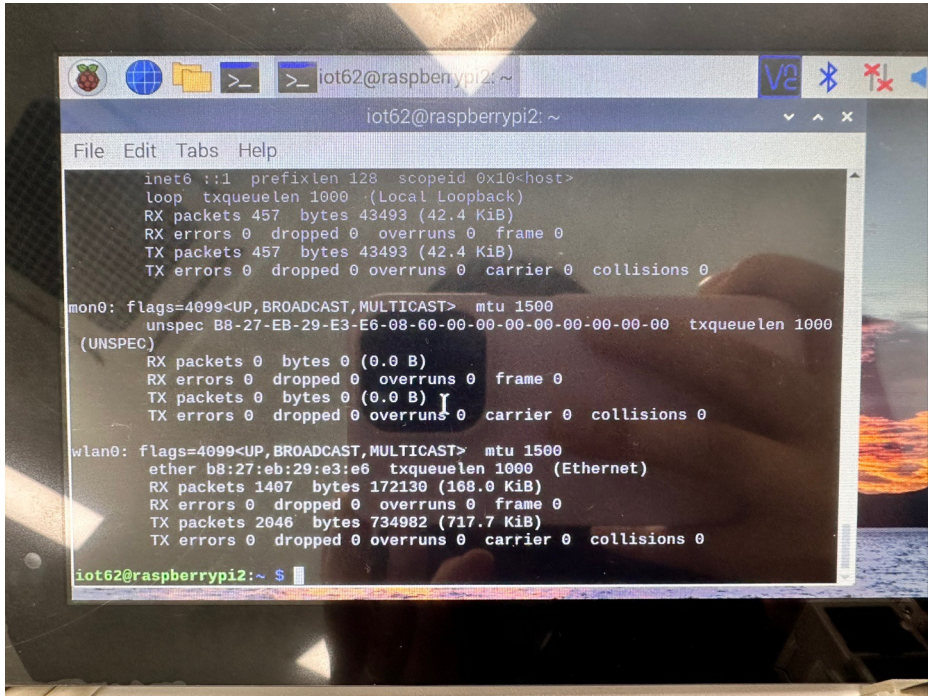


Part 8 >> **Documents**

AP Mode

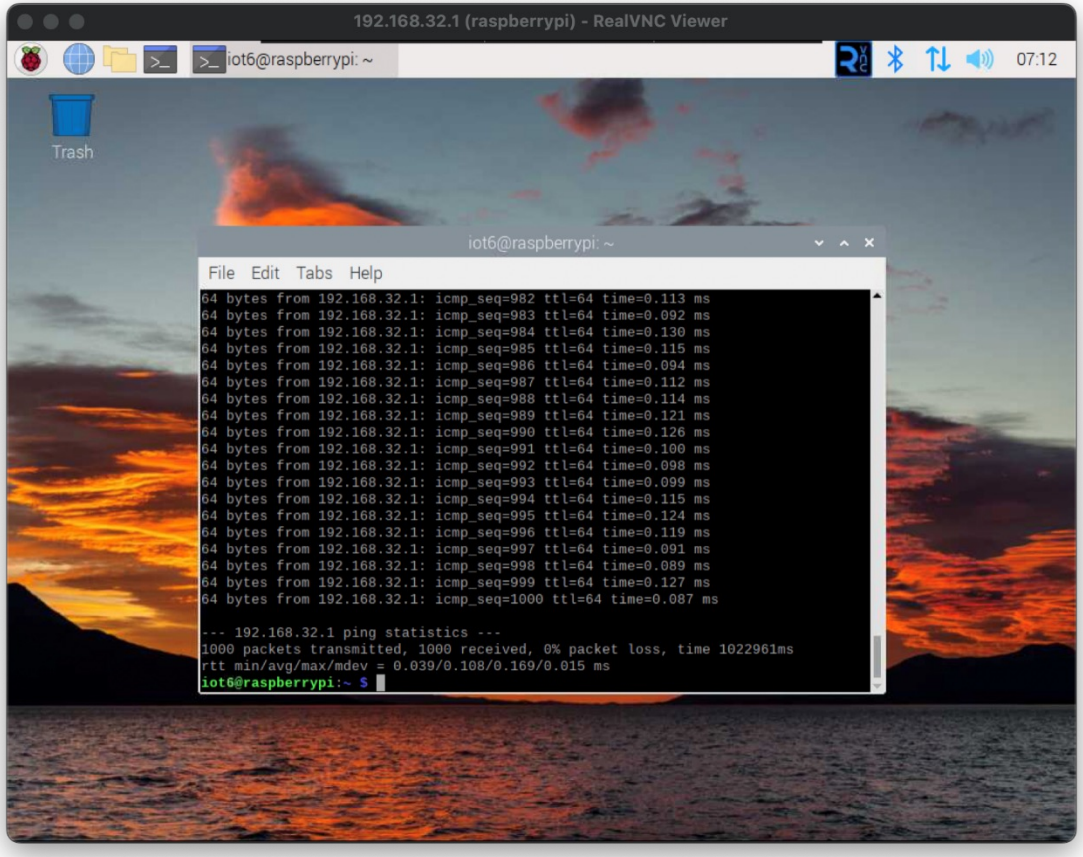
Iot-002-06

nexutil Monitor Mode activation

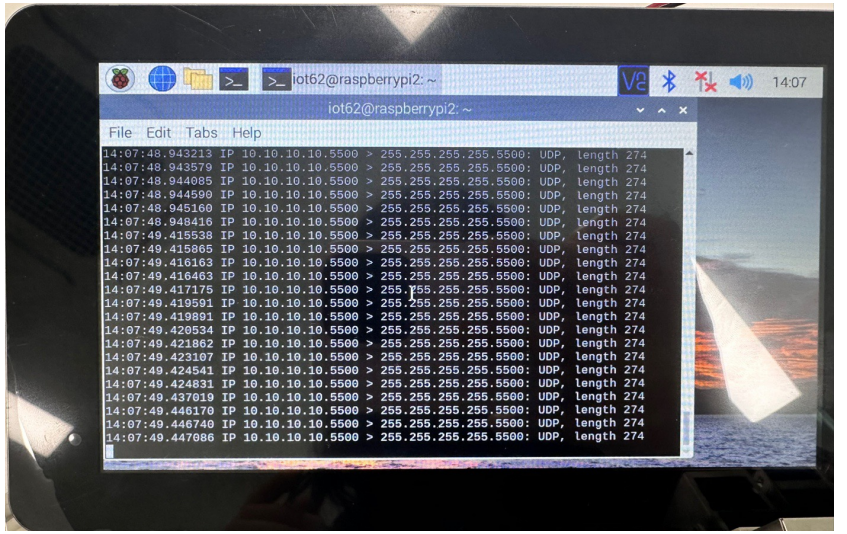


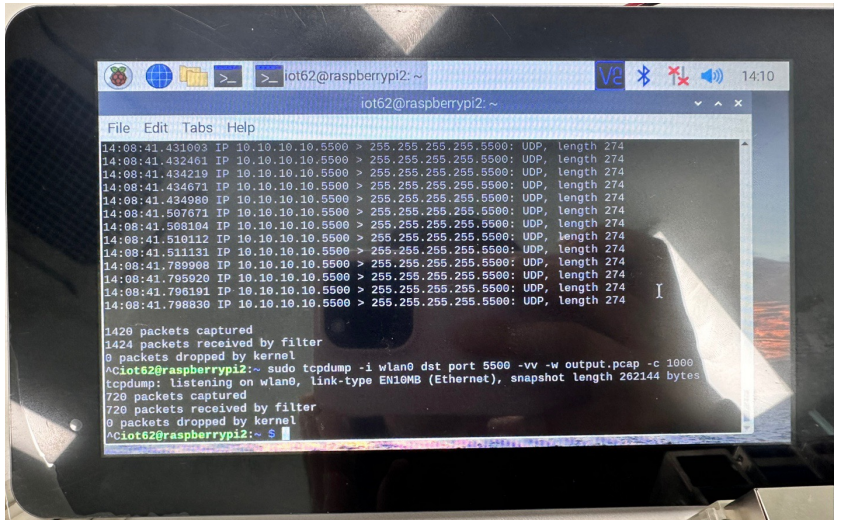
Part 8 >> # Documents

ping –c 1000



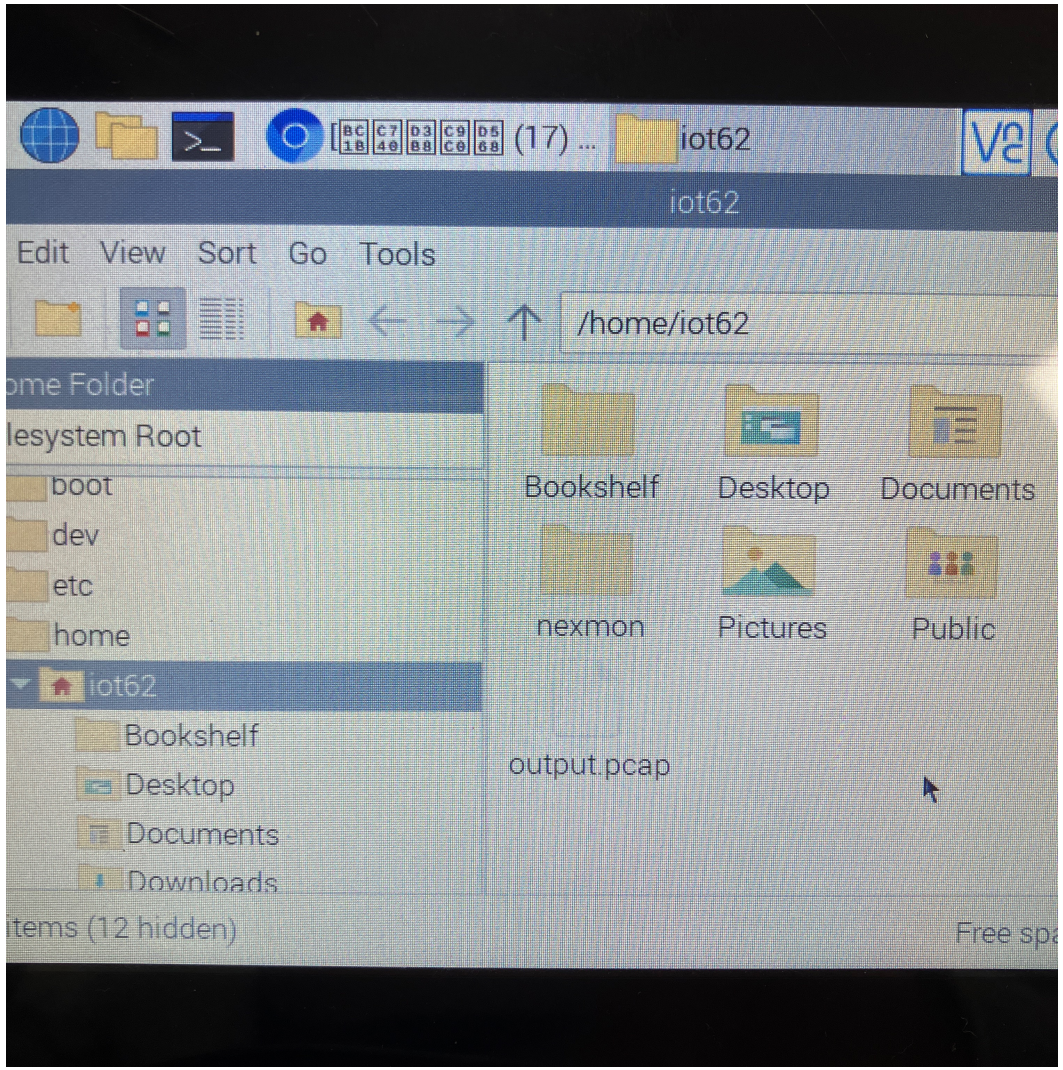
tcpdump Packet Store





Part 8 >> # Documents

pcap file store



pcap to CSV

	A	B	C	D	E	F	G
1	frame.time_epoch	ip.src	ip.dst	tcp.srcport	tcp.dstport	http.file_data	info
2	1715842409	10.10.10.10	255.255.255.255				5500 5500 Len=274
3	1715842409	10.10.10.10	255.255.255.255				5500 5500 Len=274
4	1715842409	10.10.10.10	255.255.255.255				5500 5500 Len=274
5	1715842409	10.10.10.10	255.255.255.255				5500 5500 Len=274
6	1715842409	10.10.10.10	255.255.255.255				5500 5500 Len=274
7	1715842410	10.10.10.10	255.255.255.255				5500 5500 Len=274
8	1715842410	10.10.10.10	255.255.255.255				5500 5500 Len=274
9	1715842410	10.10.10.10	255.255.255.255				5500 5500 Len=274
10	1715842410	10.10.10.10	255.255.255.255				5500 5500 Len=274
11	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
12	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
13	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
14	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
15	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
16	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
17	1715842411	10.10.10.10	255.255.255.255				5500 5500 Len=274
18	1715842413	10.10.10.10	255.255.255.255				5500 5500 Len=274
19	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
20	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
21	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
22	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
23	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
24	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
25	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
26	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
27	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
28	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
29	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
30	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
31	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
32	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
33	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
34	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274
35	1715842414	10.10.10.10	255.255.255.255				5500 5500 Len=274

output

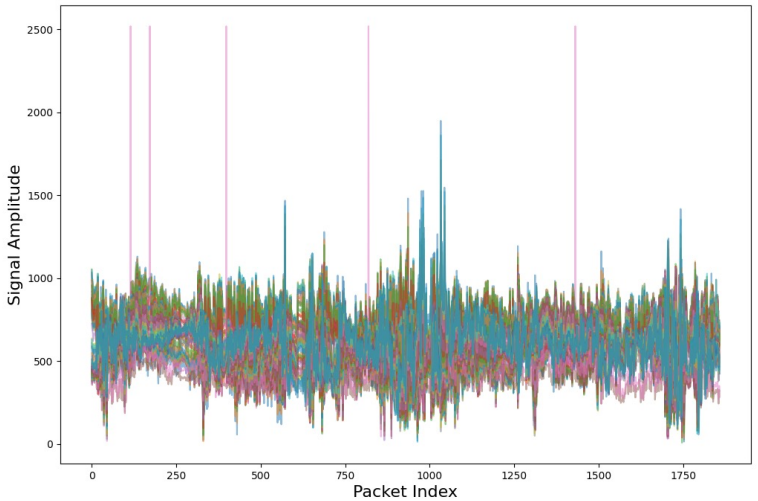
준비 접근성: 사용할 수 없음 개수: 1001 125%

Part 8 >> Documents

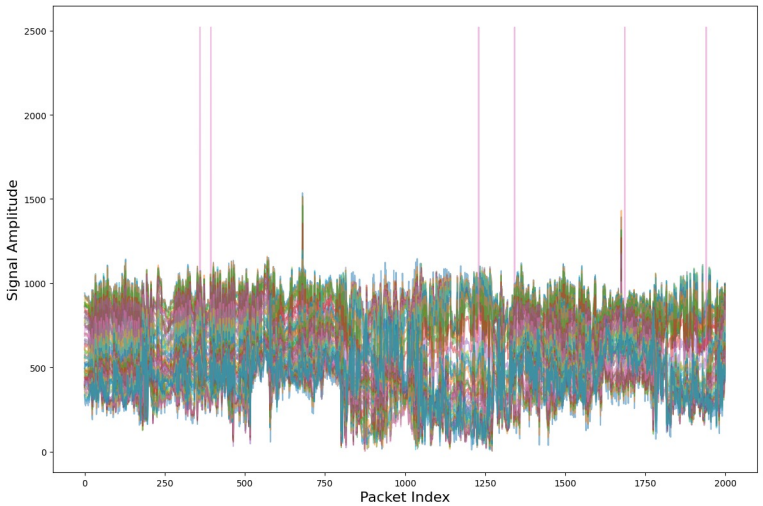
pcap to CSV

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	mac	time	_0	_1	_2	_3	_4	_5	_6	_7	_8	_9	_10
2	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(332+52j)	(349-81j)	(309-218j)	(152-359j)	(-46-376j)	(-214-319j)	(-335-199j)
3	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(173-352j)	(24-380j)	(-121-359j)	(-285-255j)	(-364-95j)	(-375+63j)	(-325+212j)
4	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-127-331j)	(-275-240j)	(-364-97j)	(-365+125j)	(-247+288j)	(-78+373j)	(103+375j)
5	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-344+118j)	(-290+233j)	(-193+327j)	(-5+383j)	(175+332j)	(305+220j)	(383+80j)
6	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(152-305j)	(31-355j)	(-110-357j)	(-285-258j)	(-366-78j)	(-373+102j)	(-293+255j)
7	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-351-93j)	(-364+38j)	(-330+169j)	(-206+315j)	(-34+381j)	(138+360j)	(280+282j)
8	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-294+171j)	(-192+305j)	(-23+376j)	(210+320j)	(343+139j)	(377-79j)	(281-261j)
9	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(353+13j)	(338-123j)	(278-247j)	(127-357j)	(-45-379j)	(-197-337j)	(-308-246j)
10	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(342-160j)	(254-272j)	(133-347j)	(-53-373j)	(-215-312j)	(-330-196j)	(-389-49j)
11	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-248+314j)	(-126+391j)	(38+419j)	(240+348j)	(376+186j)	(428+0j)	(391-184j)
12	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(372-160j)	(287-294j)	(163-388j)	(-47-421j)	(-225-370j)	(-359-251j)	(-437-100j)
13	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-334+263j)	(-217+363j)	(-74+416j)	(151+406j)	(312+288j)	(408+120j)	(434-53j)
14	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-341-254j)	(-406-102j)	(-414+58j)	(-347+258j)	(-190+374j)	(-21+439j)	(151+411j)
15	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(138-345j)	(20-398j)	(-114-412j)	(-297-319j)	(-403-173j)	(-451-6j)	(-429+151j)
16	d83adda79f8	1716443058	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(445-222j)	(337-363j)	(188-462j)	(-73-500j)	(-296-405j)	(-445-242j)	(-512-44j)
17	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(249-116j)	(215-214j)	(137-301j)	(-41-333j)	(-198-268j)	(-301-157j)	(-343-16j)
18	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(119+266j)	(206+224j)	(285+152j)	(326-12j)	(289-172j)	(189-286j)	(60-344j)
19	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(360+238j)	(480+98j)	(540-93j)	(423-375j)	(196-521j)	(-63-568j)	(-301-497j)
20	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(308-289j)	(182-363j)	(43-394j)	(-154-376j)	(-297-272j)	(-390-132j)	(-421+35j)
21	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(398-76j)	(339-201j)	(246-304j)	(74-396j)	(-102-395j)	(-265-328j)	(-375-202j)
22	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(22-310j)	(-103-337j)	(-235-318j)	(-357-185j)	(-399-38j)	(-392+118j)	(-340+252j)
23	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(262+171j)	(349+75j)	(390-61j)	(308-261j)	(149-373j)	(-31-406j)	(-204-367j)
24	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(310-281j)	(179-359j)	(40-391j)	(-159-371j)	(-294-270j)	(-391-129j)	(-417+28j)
25	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(178-371j)	(8-397j)	(-151-366j)	(-312-253j)	(-381-101j)	(-401+59j)	(-363+207j)
26	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-146+395j)	(21+403j)	(171+354j)	(326+240j)	(390+78j)	(394-83j)	(346-228j)
27	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-309-90j)	(-360+14j)	(-372+137j)	(-281+294j)	(-127+369j)	(15+403j)	(155+384j)
28	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(296-159j)	(206-250j)	(96-303j)	(-59-319j)	(-193-274j)	(-287-178j)	(-343-49j)
29	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-256+233j)	(-137+302j)	(-12+326j)	(147+293j)	(255+207j)	(319+92j)	(341-34j)
30	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-254+238j)	(-139+302j)	(-16+324j)	(139+297j)	(253+210j)	(321+95j)	(343-38j)
31	d83adda79f8	1716443059	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(210-135j)	(166-227j)	(93-301j)	(-55-316j)	(-191-274j)	(-279-190j)	(-332-86j)
32	d83adda79f8	1716443060	(6097+6128j	(-1003+3067	(5152+6157j	(-2033-5126j	(-248-78j)	(-295+61j)	(-283+204j)	(-155+313j)	(-4+352j)	(130+323j)	(239+271j)

CSI Visualization



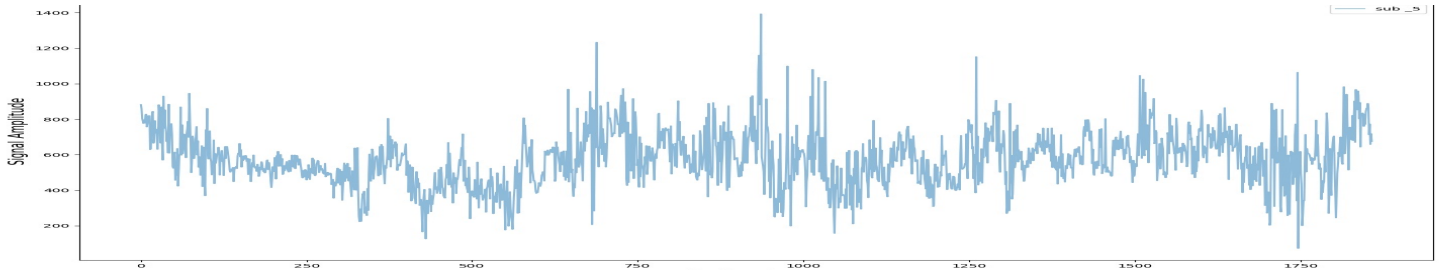
People Count 1: Vertical Direction



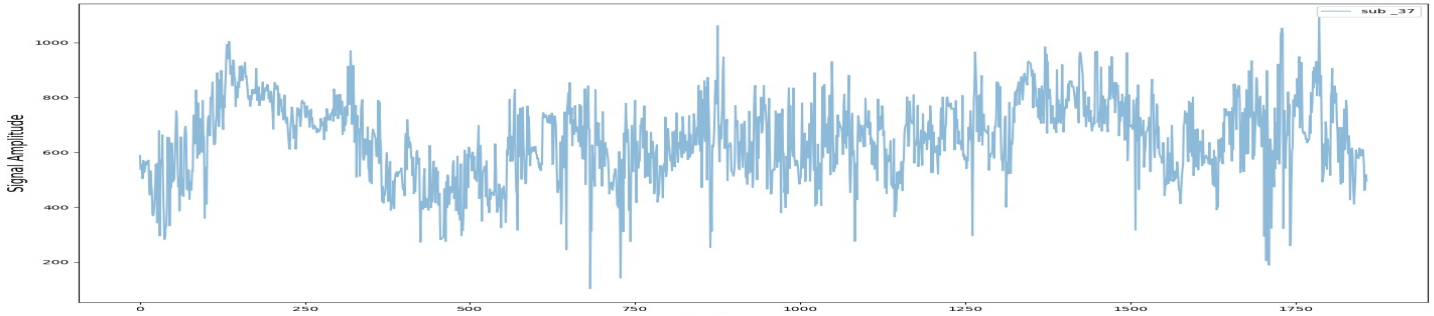
People Count 2: Free Direction

Part 8 >> # Documents

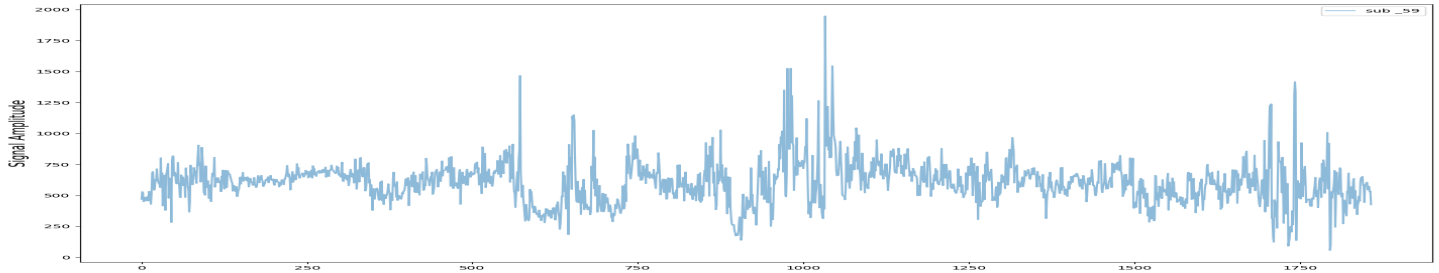
People Count 1 Subcarriers



People Count 1: Sub carrier 05



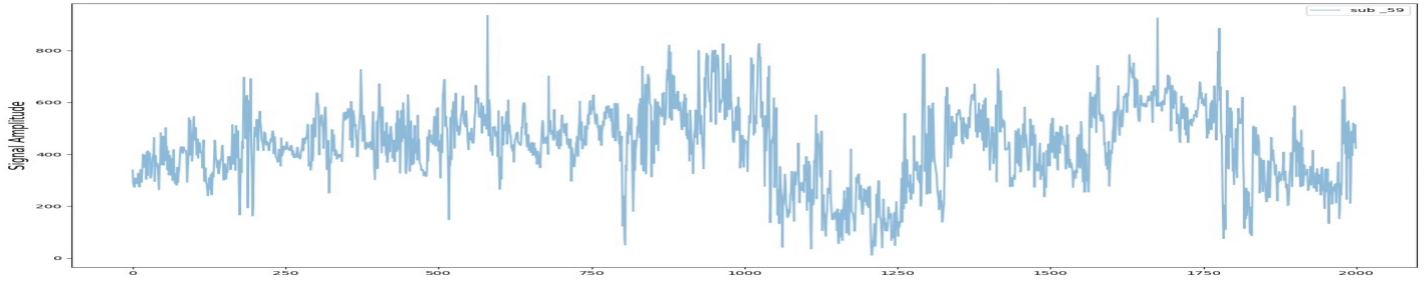
People Count 1: Sub carrier 37



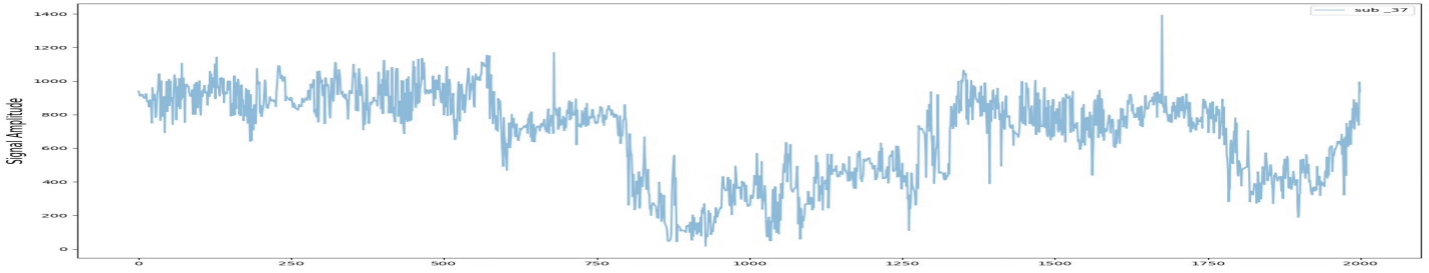
People Count 1: Sub carrier 59

Part 8 >> Documents

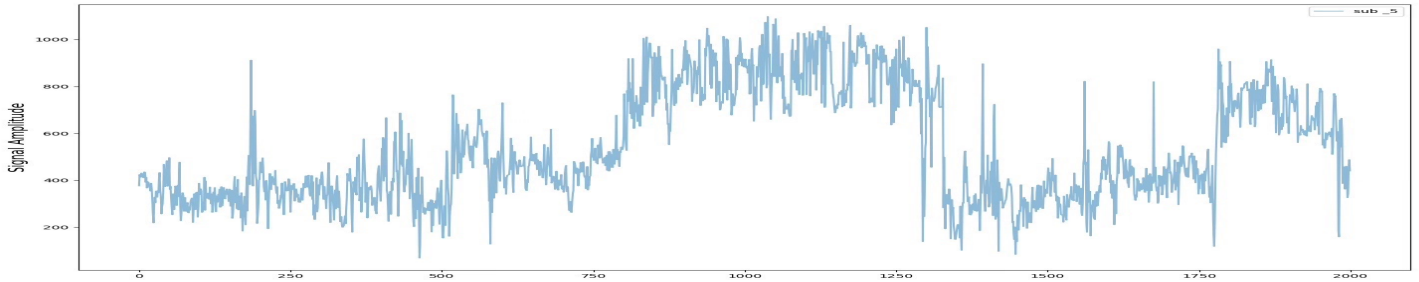
People Count 2 Subcarriers



People Count 2: Sub carrier 05

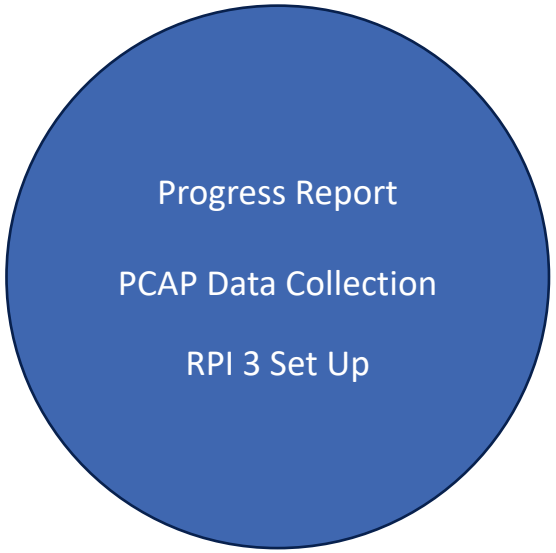


People Count 2: Sub carrier 37

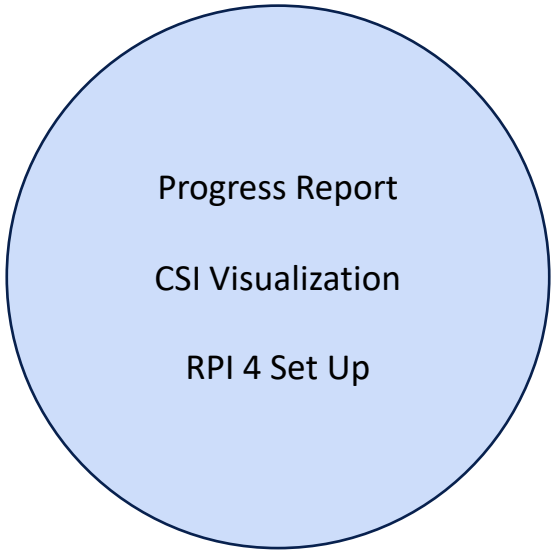


People Count 3: Sub carrier 59

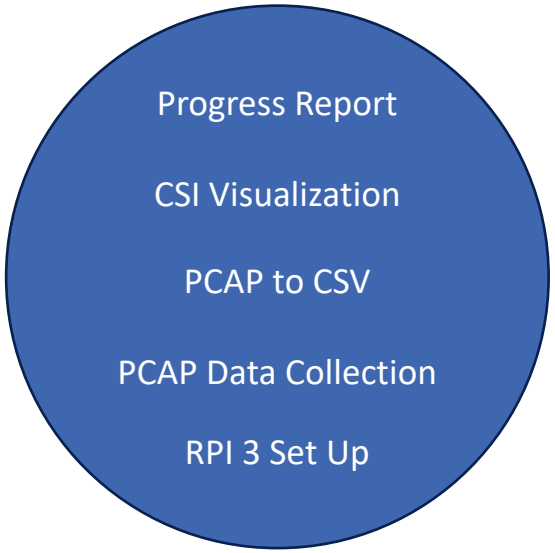
Part 8 >> # Contribution



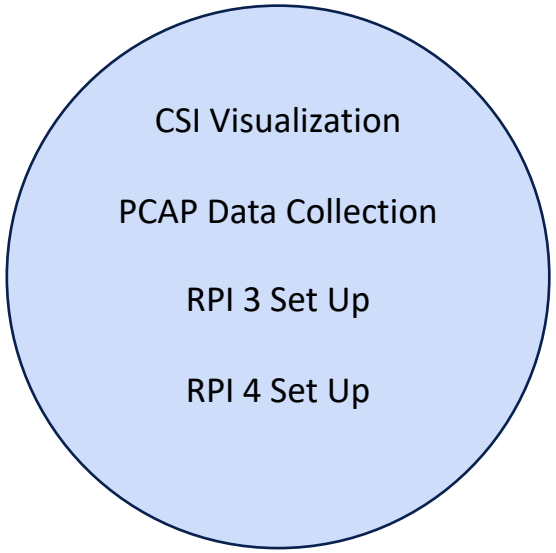
201931322 KimJaeyoung



202031415 LimHyungsub



202033502 KangHyunjoon



202034909 KimJuhye

9

References

Part 9 >> # References

Nexmon CSI

https://github.com/seemoo-lab/nexmon_csi

Nexmon Install Manual

https://pio-ji.notion.site/Wi-Fi-Sensing-3c03bfbaa99c4cb8a7a40333278efff3

Raspberry pi AP Mode

https://limjunho.github.io/2020/08/25/Raspberry-Pi-AP%EB%A7%8C%EB%93%A4%EA%B8%B0.html

PPT template

https://yusaebyeol.blogspot.com/2022/07/powerpoint-template-free-download-ppt.html

CSI Extraction

https://pio-ji.notion.site/CSI-3ddf719f41934575bddda406732b2ccf

What is Nexmon

https://github.com/seemoo-lab/bcm-rpi3

What is Raspberry Pi

https://opensource.com/resources/raspberry-pi

gigasheet, Convert PCAP to CSV

https://www.gigasheet.com/popular-tools/convert-pcap-to-csv

Convert PCAP to CSV

https://github.com/cheeseBG/pcap-to-csv

CSI real time Visualization

https://github.com/cheeseBG/csi-visualization