Abertay University

Raspberry Pi Speedtester

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CMP408

Introduction

Background:

- Monitoring networks is crucial as reliance on them grows in the modern age
- Businesses need stable, low latency networks to function and changes can result in significant revenue losses
- Implementing a monitoring system may help alleviate issues as they're happening

Project:

- Hardware network speed tester with a web server on AWS to display results
- Consist of a Raspberry Pi Zero W, button to start the test using LKM, and an LED to indicate that the speedtest is running

Relevance to System Internals and Cybersecurity:

System Internals:

- Usage of GPIO pins and specific input and output devices interfacing with the device at a low level
- Interfacing with Linux OS through LKMs
- LKM developed by the author to enable the button, which in turn will run the test

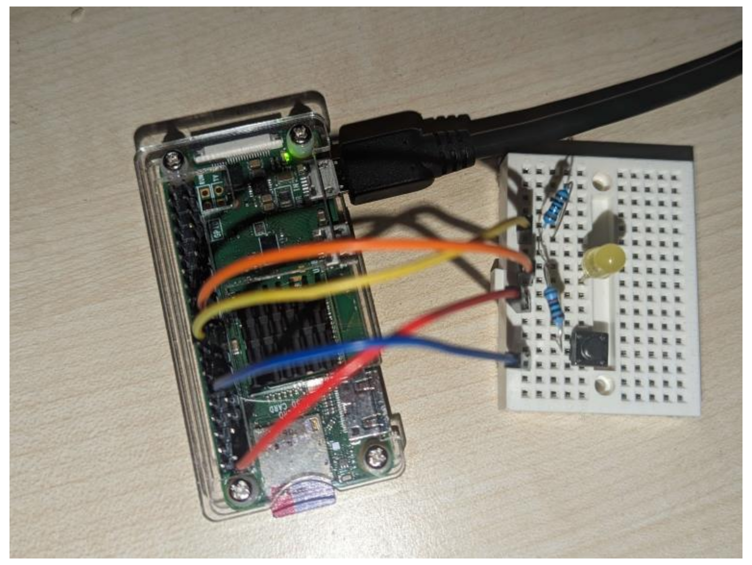
Cybersecurity:

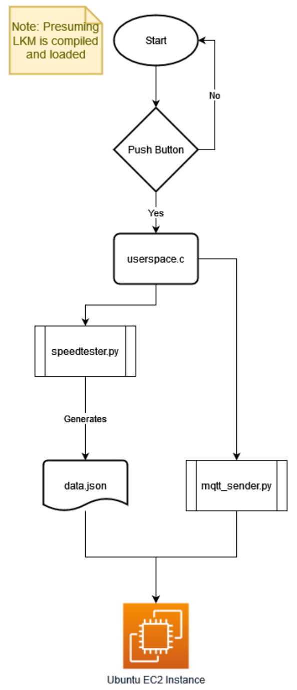
- AWS web server set up correctly and securely
- Users' IP addresses can be potentially identifying features of their network if the website is not set up securely then the security of the user of the device could be compromised
- Site's integrity must be maintained to prevent results of the test from being tampered with

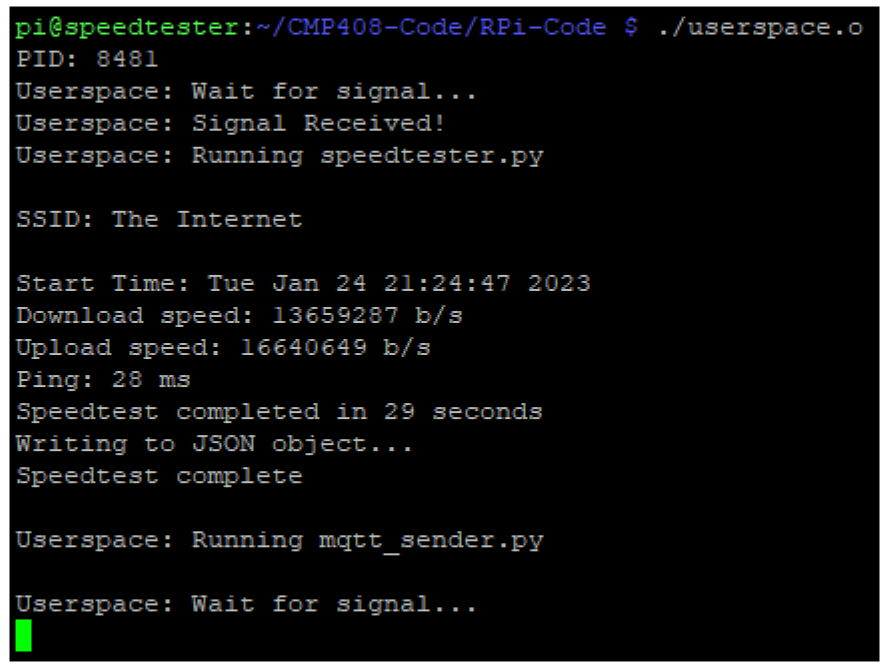
Methodology

Raspberry Pi:

- Project work began on a Linux-based laptop, but was later transferred to a Raspberry Pi
- The first program created was "speedtester.py", which uses the "speedtest-cli" Python module to record network information and writes it to a JSON file for later use in a web server. It also turns on the LED.
- The main piece of work for the Pi was a button Linux Kernel Module (LKM) to run "speedtest.py" on button press using an intermediary userspace program
- An intermediary program (userspace.c) registers itself with the LKM, sends a signal to run "speedtester.py" and interacts with a device file for the button
- "The intermediary program also triggers "mqtt_sender.py" which sends the JSON data to a server using MQTT by creating an MQTT client, setting authentication and topic, connecting to a broker, and sending the data.







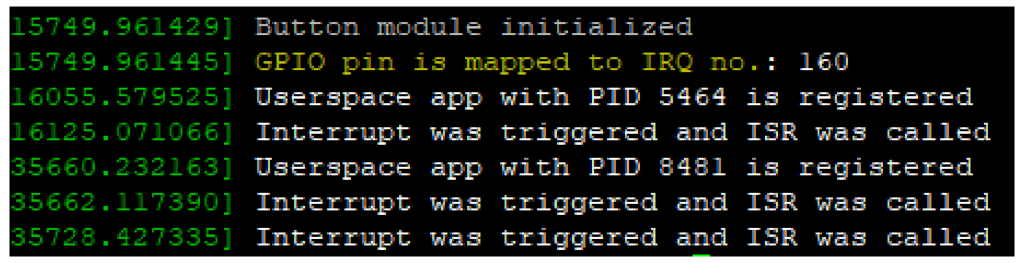
```
pi@speedtester:~/CMP408-Code/RPi-Code $ ./userspace.o
PID: 8481
Userspace: Wait for signal...
Userspace: Signal Received!
Userspace: Running speedtester.py

SSID: The Internet

Start Time: Tue Jan 24 21:24:47 2023
Download speed: 13659287 b/s
Upload speed: 16640649 b/s
Ping: 28 ms
Speedtest completed in 29 seconds
Writing to JSON object...
Speedtest complete

Userspace: Running mqtt_sender.py

Userspace: Wait for signal...
```

Cloud:

- The developer used the Flask web framework due to its lightweight approach, ease of use and the fact it uses Python
- The webpage uses an endpoint called "data" that displays the JSON data in a table
- The project uses an AWS EC2 instance running Ubuntu to serve the app
- The developer used MQTT to send the JSON object from the Pi to the EC2
- mqtt_sender.py on the Pi sends the data and mqtt_receiver.py on the EC2 receives it, saves it to "data.json" and subscribes to the same topic
- SSL/HTTPS is set up using a domain and Certbot tool to ensure a secure connection
- Security group configuration of the EC2 shows that SSH is only accessible via the developer's IP address.

Project Highlights

This project uses various Python libraries to conduct network speed tests on a Raspberry Pi, store the data in a JSON file and transmit it to an AWS EC2 instance using MQTT. A button-triggered Linux Kernel Module was implemented to initiate the speed testing script and send it to the server. A custom GUI was created to display the results securely, and an LED indicator is used to notify the user that the speed test is in progress.



```
15749.961429] Button module initialized
15749.961445] GPIO pin is mapped to IRQ no.: 160
16055.579525] Userspace app with PID 5464 is registered
16125.071066] Interrupt was triggered and ISR was called
35660.232163] Userspace app with PID 8481 is registered
35662.117390] Interrupt was triggered and ISR was called
35728.427335] Interrupt was triggered and ISR was called
```

Future Work

- Developer wanted two LEDs, but only one was available due to lack of resistors, developer did not want to burn pi out
- Web interface can be improved (graphs, filtering, etc.)

References

Huiyeon, K. (2020) 'Step-by-step visual guide on deploying a Flask application on AWS EC2', *Tech Front*, 9 June. Available at: https://medium.com/techfront/step-by-step-visual-guide-on-deploying-a-flask-application-on-aws-ec2-8e3e8b82c4f7 (Accessed: 22 January 2023).

Let's code a Linux Driver - 15: Sending a signal from Kernel to Userspace (2022). Available at: https://www.youtube.com/watch?v=nt_z07t7qMc (Accessed: 23 January 2023).

Martz, M. (2021) 'speedtest-cli: Command line interface for testing internet bandwidth using speedtest.net'. Available at: https://github.com/sivel/speedtest-cli (Accessed: 16 December 2022).