3D Printer CyberSecurity Project

Team Members

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Faculty Advisor:

- ❖ Sid Bhattacharyya : sbhattacharyya@fit.edu

Client:

- ❖ Mike C Newton : Director - Strategic Technology Sciperio

Meeting Dates:

- ❖ Bi-Weekly Thursdays at 3:30 p.m.

- ❖ Additionally on Tuesdays when needed

Goal & Motivation:

- ❖ Our goal is to provide users with a secure method of remote 3D printing.

Approach:

1. Develop a website which allows users to register and submit gcode files to be remotely printed by an Ender 3. Requests will be handled as a queue and processed by selected administrators. Only approved accounts will be allowed to submit requests. Various security checks will be done on submitted files to ensure their authenticity.

2. Communication between the website, octoprint, and the printer is facilitated over a raspberry pi. Octoprint has a pre-existing api that will allow the website to communicate with the printer in real time and display relevant information to users. Some relevant information may include time until completion and potential errors. All applications will be deployed using docker.

3. Ensuring each print job is completed as expected we must prevent tampering during the execution. One way in which we will attempt to prevent tampering will be to install the GreatFET in order to listen to commands currently being executed by the printer and cross reference this with the expected commands in the given gcode file.

Novel Features/functionalities:

❖ Having the ability to see real time information to the user is important because feedback about how the print is doing remotely allows them to check progress without physically being by the 3D printer.

Technical Challenges:

1. Octoprint's api is fairly extensive and to utilize it to its full potential will require a lot of research as well as trial and error.

2. Using the GreatFET is new to the team so there will be a lot of trial and error as well as research into how the tool works. We want to ensure that we know how to use it otherwise something could break.

3. 3D printers can fail at any point during the printing process, we need to figure out how to handle a failed print and have the queue not skip over a "completed" print. We also need to note that the printer has failed, but octoprint does not have a check for that so we need to implement how to determine if it has failed.
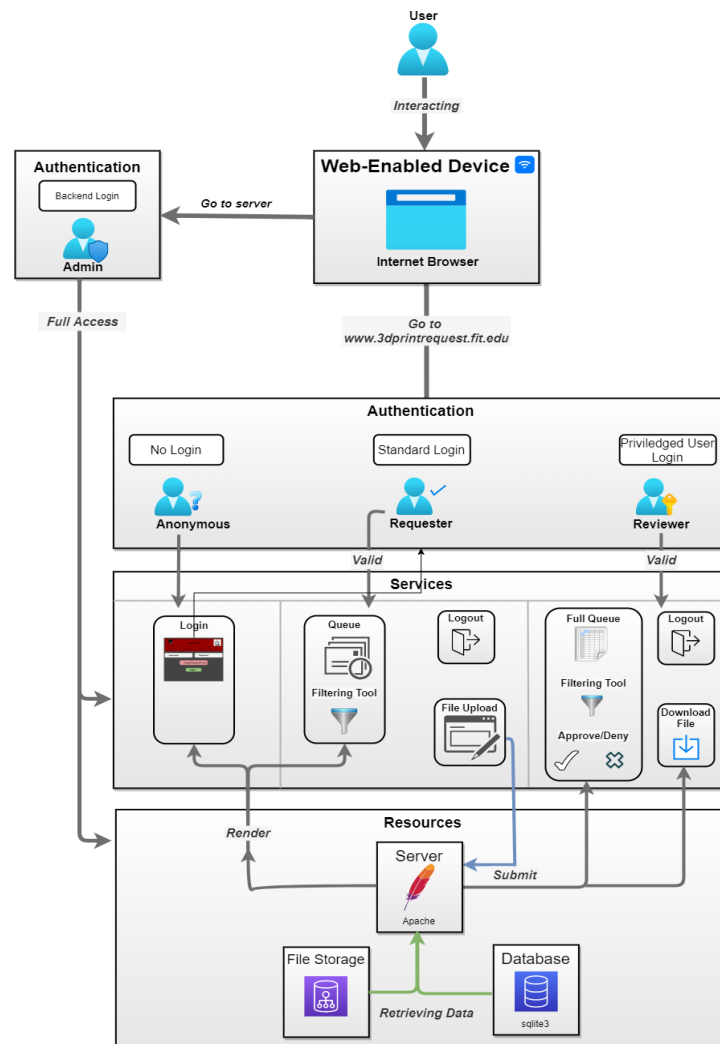
Design: system architecture diagram
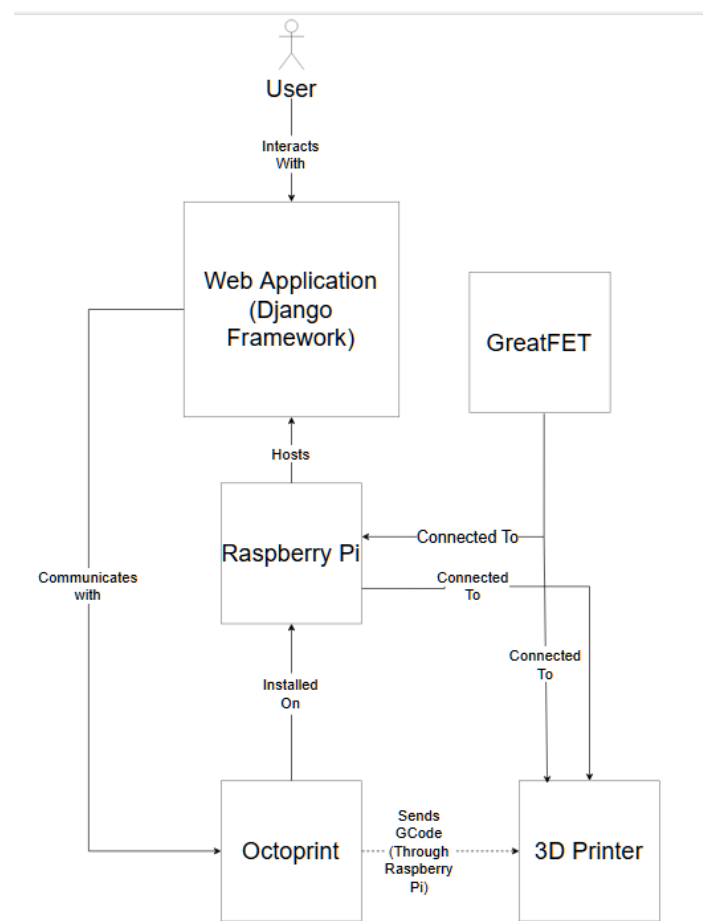
● components/modules of the software system
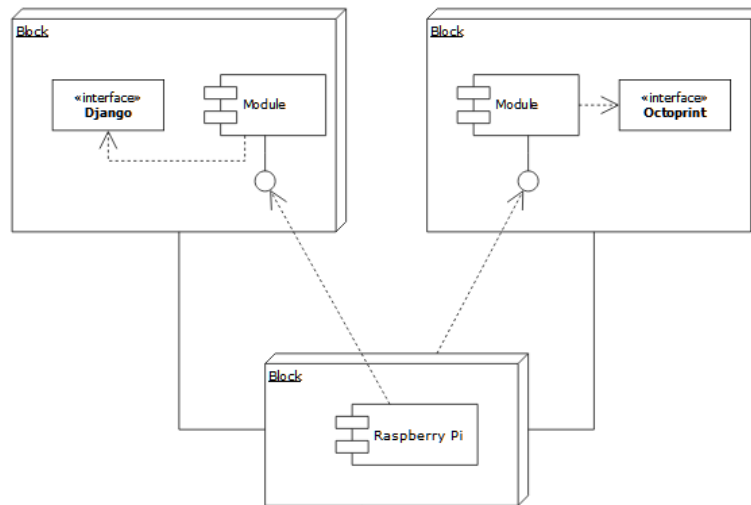
● interfacing with different types of users (if any)

Evaluation: how to measure success? Some ideas:

- speed
    - How fast does the printer move through the queue?
    - How long does it take to infiltrate the system?
- accuracy (e.g. how accurate is the system?)
    - Does the 3D printer misprint?
    - Does the 3D printer waste filament?
- reliability
    - How often does the 3D printer fail a print from the queue?
- user survey
    - Rating of how easy the website is to navigate.

Progress Summary:

Module/feature	Completion %	To do
GUI	50%	Allowing drop down menus, mouse-over help messages...
Docker Container	50%	Upload to the new raspberry pi
Networking on Raspberry pie	25%	Setup website communication with octoprint's api
Pen Testing Tools (GreatFET)	25%	Install the new software onto the raspberry pi and begin testing

Milestone 4 (Feb 14): itemized tasks:

- ❖ Implement, test & demo use of the raspberry pie to print

- ❖ Implement, test & demo the website interfacing with octoprint's api

- ❖ Utilize the GreatFET to intercept and inject traffic

- ❖ Investigate potential vectors for attack in the Ender 3 firmware

Milestone 5 (Mar 21): itemized tasks:

- ❖ Implement, test, and demo which features/modules

- ❖ Evaluation results

- ❖ Create poster for Senior Design Showcase

Milestone 6 (Apr 18): itemized tasks:

- ❖ Implement, test, and demo which features/modules

- ❖ Test/demo of the entire system

- ❖ Evaluation results

- ❖ Create user/developer manual

- ❖ Create demo video

Task matrix for Milestone 4 (teams with more than one person)

Task	Tiffanie	Carl	Isaiah	Nick
1. Implement, test & demo use of the raspberry pie to print	100%	0%	0%	0%
2. Implement, test & demo the website interfacing with octoprint's api	0%	100%	0%	0%
3. Utilize the GreatFET to	0%	50%	0%	50%

intercept and inject traffic				
4. Investigate potential vectors for attack in the Ender 3 firmware	0%	0%	100%	0%
5. Update the Dockerfile to include Octoprint & Web application	0%	0%	0%	100%

❖ Description (at least a few sentences) of each planned task for Milestone 4:

➢ Task 1: Implement, test & demo use of the raspberry pie to print

■ To be able to test and demo the remote 3D printing, the web application needs to be on the raspberry pi as well as octoprint. From there the admin should be able to tell the printer to select the first option from the queue and begin printing.

➢ Task 2: Implement, test & demo the website interfacing with octoprint's api

■ To test and demo the interface, while printing the web app should work with octoprint to give the user an idea of when the print will be completed. It should have the capability to state how far in progress the print is as well as if it fails at any point.

➢ Task 3: Utilize the GreatFET to intercept and inject traffic

■ Place GreatFET in between the printer and the Raspberry and set it to listen to & forward traffic between the endpoints. Design functionality for the GreatFET to select and modify packet fields being transmitted as a man-in-the-middle attack.

■ Connect GreatFET as an endpoint to the Ender 3 printer and configure it to operate as a fuzzer. Using a template G-Code file, the GreatFET will autonomously change values in normal traffic and record the responses from the printer.

➢ Task 4: Investigate potential vectors for attack in the Ender 3 firmware

- Given that the Ender 3 is open source, it will make it easier to look through the firmware for vulnerabilities. These vulnerabilities would give insight to see the best possible path to exploit the printer.

- Analyze the fuzzing traffic from Task 3 to determine any attack vectors.

- Utilize automated analysis tools such as centrifuge.

➤ Task 5: Update the Dockerfile to include Octoprint & Web application

- Including all three software applications into the dockerfile will allow the team to easily pull changes together and stay up to date. This is the most efficient way to keep all of our tools together which will allow us to monitor what is installed on the raspberry pi.

Approval from Faculty Advisor

❖ "I have discussed with the team and approve this project plan. I will evaluate the progress and assign a grade for each of the three milestones."

❖ Signature: _____ Date: _____