University of Waterloo
Faculty of Engineering
Department of Electrical and Computer Engineering

StreamingOS: Low Cost Education System

Progress Report

Group 2020.15

Prepared by:
Matthew Milne – 20626854
Vidit Soni – 20627647
Vinayak Sharma – 20585279
Anurag Joshi – 20604210
Surag Sudesh – 20636861

Consultant:
Wojciech Golab

July 29th, 2019

Table of Contents

1.0 Overview of the project

1.1 Revised Project Abstract

As technology improves in the 21st century, using mobile devices for educational purposes is becoming more common in primary and secondary schools. In addition to the cost, this technology becomes quickly outdated and needs to be replaced, forcing schools to spend continuous amounts of money on maintenance. StreamingOS is a system that provides students and teachers with inexpensive thin endpoint devices, with the resource-heavy OS being streamed to these devices from a backend server using container virtualization. The objective of this project is to design a powerful, inexpensive device and streaming system that enhances the learning experience. StreamingOS uses an inexpensive endpoint device and container virtualization to visually render and stream the execution of applications from a server or the teacher's computer to these devices used by the students. The system design leverages concepts learned in distributed computing, operating systems, database theory, and networking courses. The advantage of this design over current alternatives is that it is scalable while enabling the teacher full control of what software each student views. The inexpensive hardware helps break down the barrier of the lack of technology in school settings and empowers teachers to incorporate more modern-day means of learning in their classrooms.

1.2 Original Project Timeline

Due to minimal dependencies between the different subcomponents, they can be developed in parallel if a virtual test environment has been setup. Figure 1 shows the project timeline.

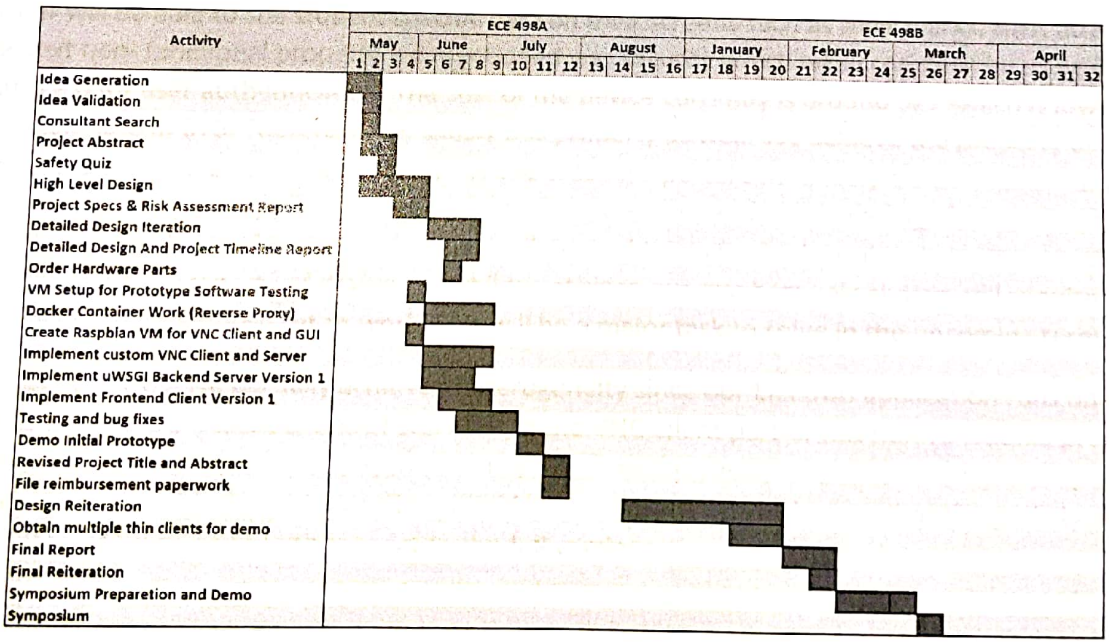

Figure 1 – Project Timeline

2.0 Current Status of Project

2.1 Prototype Completion

We estimate that our prototype model is roughly around 60% complete compared to the actual full model we envisioned. The first functional property we mentioned was latency and we had said that the end to end delay in our system should be less than 300ms. When we gathered data by running tests on our model, we found that the current end to end delay was roughly around 150ms. Therefore, we have met the requirements for this functional property. The next one was Authentication System. We believe we have completed this property as well since we use an OAuth 2.0 based authentication protocol for user authentication. The "Teacher Control" functionality is partially completed since we have the resources required to grant and revoke access to applications to students. However, we are currently missing on the functionality that allows the teacher to view live data from the student's screen on their screen. The next property was Multi User support. Currently, we have the feature where one teacher and around 5-6 students can be using our systems concurrently in a mini lecture room environment in an efficient manner. We believe we have partially completed this feature as well.

The next property was Network Connection. We are satisfying this property by making use of the HTTP methods for REST API calls between the client and server. Our next property was high performance and we believe we are already achieving this property since our system uses approximately 3.75 GB RAM and 11% CPU load for 3 OS containers, a reverse proxy and a database container which is quite reasonable compared to our initial estimates. We are currently missing the Students Bird Eye View functionality where the teacher will be able to see student specific data on their screens such as their marks, class attendance etc. The next non- functional property we mentioned was security which we accomplish by using Bcrypt and OAuth 2.0 for user authentication. The cost of the device currently is around $27 which is lower than our initial estimate of $75. Therefore, we satisfy this property as well. We achieve the property of reliability by making sure that the Electron application for the teacher's portal can reliably transmit commands to grant and revoke access of applications to each student. We also read database flags for containers before assigning them. We also perform some health check on endpoints for each container to ensure reliability. We have not met the property of device portability yet since our raspberry pi solution still requires a monitor, keyboard and mouse set to work. This will be a major task to solve in the upcoming term.

Lastly, we believe we have partially achieved heterogeneity since our Electron application runs on all platforms but there is a decent chunk of work left in the VNC Client part of this non-functional property. Overall, we believe that we have achieved around 60% of the functional and non-functional properties. This is also in conjunction with the estimates provided by our consultant which state that the prototype model is around 50 to 74% complete with respect to the full version.

2.2 Student Hours

Table 1 below shows the number of hours spent each student has worked on so far for the project.

Table 1 - Number of hours invested by each team member in 4A

Student	# of Hours Invested
Anurag Joshi	123
Matthew Milne	123
Surag Sudesh	124
Vidit Soni	125
Vinayak Sharma	123
Total	618

3.0 Discussion

Based on the list of functional and non-functional specifications listed in the detailed design document, the prototype is ~60% complete. The group is highly confident in the ability to finish the project before March 2020.

This is a list of tasks that need to be performed before the project can be considered complete along with expected time required.

- ➔ Improvements to latency by implementing quic protocol for VNC client server communication (~2 weeks)
- ➔ Investigate webRTC (~ 1 week)
- ➔ Implement Student Bird's Eye view using noVNC (~ 3 weeks)
- ➔ Implement software stack on a low-cost tablet (potentially Fire 7 HD) to make the solution portable (~ 5 weeks)
- ➔ Improvements to the UI/UX of the Teacher and Student Electron apps (~ 2-3 weeks)
- ➔ Implement user specific storage (~ 2 weeks)

The time estimates are calculated based on the amount of time spent during ECE 498A to perform similar tasks. Since the prototype is 60% done, most of the above-mentioned tasks can be performed in parallel with 1-2 members taking the lead for each.

During the coop term, the team plans to conduct a 1-hour meeting using Skype (or similar video conferencing software) every Sunday at 1PM EST to discuss current status, blocking issues and triage any work that needs to be done. All issues are tracked on our Trello Kanban board. Each member will spend approximately 3-5 hours per week on project work.

Any work that is not completed in the coop term, and the final end-to-end system test will be completed in the first few weeks of ECE 498B.

Appendix B: Initial Prototype Demonstration Feedback Sheet

ECE498A: Initial Prototype Demonstration Feedback Sheet

Group number (e.g., 2018.083): 2020115

Instructions for consultant: By checking the most appropriate boxes below, please provide frank feedback to the student group about how you think their project is progressing. At this point in the term, students should have finalized their designs and their prototypes should be at least 50% (preferably 75%) complete. Students will respond to this feedback in their Progress Report. In March next year, the students will approach you again to schedule a Final Prototype Demonstration, in which you formally assess (and assign grades) on their project and prototype.

Assessment of the level of challenge and upper-year knowledge used in the project

- [x] Project is significantly challenging, clearly requiring substantial 3rd or 4th year engineering knowledge
- [ ] Project is challenging, arguably requiring substantial 3rd or 4th year engineering knowledge
- [ ] Project is fairly straightforward, requiring substantial 2nd year university-level engineering knowledge
- [ ] Project is simple, requiring little or no university-level engineering knowledge beyond 1st year

Assessment of how complete the prototype construction is

- [ ] More than 90% done
- [ ] 75% to 90% done
- [x] 50% to 74% done
- [ ] 25% to 49% done
- [ ] Less than 25% done
- [ ] Impossible to judge

Your confidence that, by next March, the prototype will be 100% complete and satisfy all essential design specs

- [ ] Very high
- [x] High
- [ ] Unsure
- [ ] Low
- [ ] Very low

Your confidence that the group is working well as a team

- [x] Very high
- [ ] High
- [ ] Unsure
- [ ] Low
- [ ] Very low

Your confidence that the group has put appropriate effort and time (ideally 120 hours per student) into the project

- [ ] Very high
- [x] High
- [ ] Unsure
- [ ] Low
- [ ] Very low

Other feedback to the students:

- GOOD TEAM WORK
- GOOD PRESENTATION
- REQUIREMENTS NEED A MINOR CLEANUP
- THE TARGET USE CASE REMAINS A LITTLE FUZZY

Consultant's signature: [signature] Date: July 25, 2019

ECE498A: Marking Sheet for the Progress Report

Group number: 2020. 15

			Marks
Presentation and layout	Follows required formatting, layout, structure, page limit; correct spelling, grammar, captioning, units; readability, professionalism of language, flow; persuasiveness of justifications:	up to 3 marks	3 / 03
Level of challenge and upper year knowledge (based on consultant feedback)	Level (4): ✓ 10 marks Level (3): 6 marks Level (2): 3 marks Level (1): 0 marks		10 / 10
Prototype completion (based on consultant feedback and student comments)	Prototype is likely at least 75% complete: 20 marks (10) Prototype is likely between 50% and 74% complete: ✓ 14 marks (7) Prototype is likely between 25% and 49% complete: 6 marks (3) Prototype is likely less than 25% complete: 2 marks (0)		14 / 20
Student hours (based on consultant feedback and student comments)	Detailed logs kept, signed, and included in Appendix A; total hours put in by students is consistent with 120 hours per student, and each student is contributing a fair share:	up to 2 marks	2 / 02
Discussion	Prototype is likely less than 50% complete but students have a serious and convincing plan to get back on schedule:	up to 3 marks	/ 03 (extra marks)
	Deduction for late submission: (-4 marks if miss deadline, and -4 marks off for every additional 24 hours) **Note:** This deliverable is not considered submitted unless Appendices A and B are included.		
		Final Mark:	29 / 35

Additional comments from course instructor: