StreamingOS: Low Cost Education System

UNIVERSITY OF WATERLOO | FACULTY OF ENGINEERING
Department of Electrical and Computer Engineering

Group: 2020.15 **Consultant**: Wojciech Golab **Members**: Anurag Joshi, Matthew Milne, Surag Sudesh, Vidit Soni, Vinayak Sharma

MOTIVATION

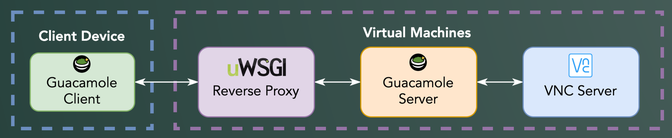
- Mobile devices for educational purposes is becoming increasingly more common in primary and secondary schools
- The cost of educational technologies range from $142 to $490 USD per student [1]
- Educational technologies become quickly outdated and need to be replaced, forcing schools to spend continuous amounts of money on maintenance

OBJECTIVE

- Provide students and teachers with inexpensive mobile devices
- Utilize the power of cloud computing to keep up with the increase in computer resource usage of modern applications over time

DESIGN ALTERNATIVES

- **Student Device:** Initially a Raspberry Pi Zero was used. However, this limited the device portability. To make the devices accessible in an everyday classroom, a 7-inch tablet was decided upon
- **Remote Desktop Software:** Only noVNC was initially used for connecting the student devices to the remote OS containers. Due to high latency when performing intensive tasks (especially in Windows), Guacamole was used which is a combination of noVNC and RDP



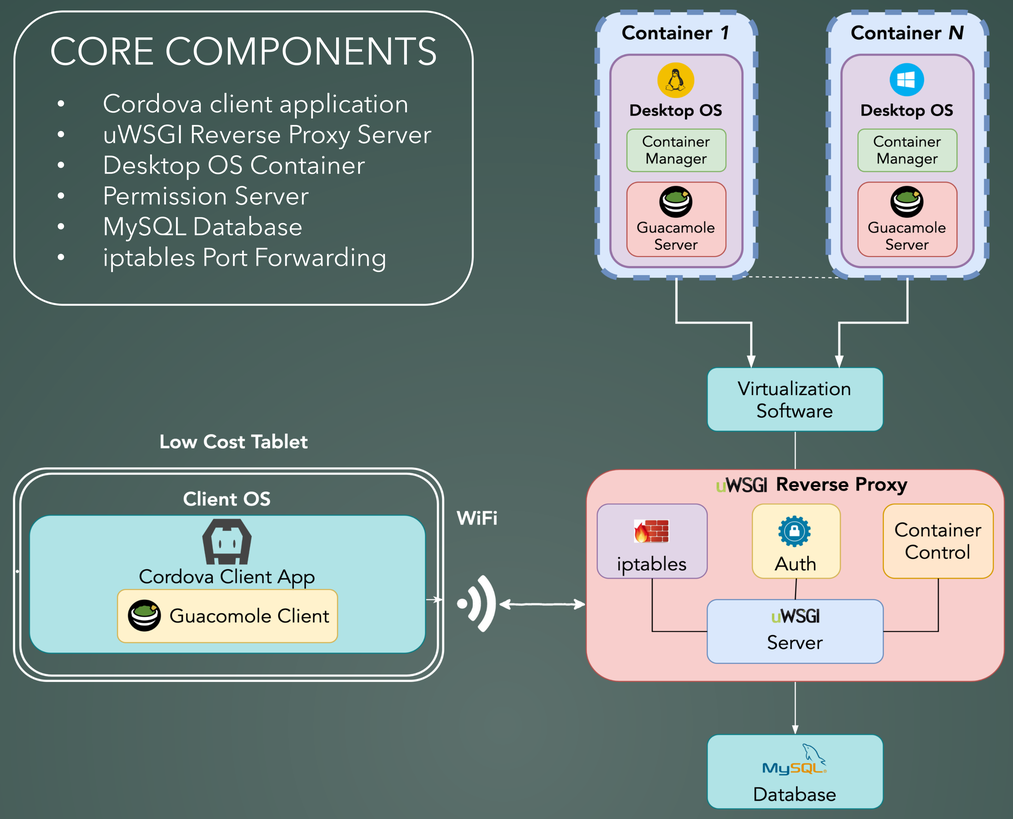
HOW IT WORKS

- **Container Request:** The Reverse Proxy finds a free OS container hosted on Azure, and sets up a network route with the client device using iptables
- **User Connects:** The client sets up a guacamole connection using the network port provided by the Reverse Proxy
- **Student Birds' Eye View:** OS containers periodically send screenshots of student sessions to the teacher's client via the Reverse Proxy
- **Broadcast:** When a teacher starts broadcasting, the Reverse Proxy obtains the teacher's current guacamole session and sends a view-only event ID to all clients
- **Messaging:** All clients have an event-stream backed by individual message queues in which the server places events for delivery

OVERVIEW

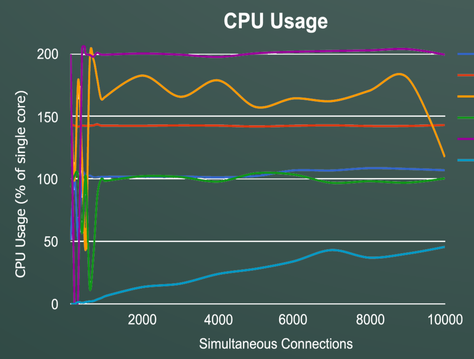
CORE COMPONENTS

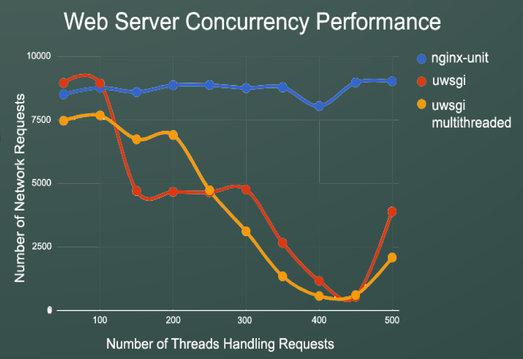
- Cordova client application
- uWSGI Reverse Proxy Server
- Desktop OS Container
- Permission Server
- MySQL Database
- iptables Port Forwarding



ANALYSIS

- **Student Birds' Eye View:** The refresh time for the student screenshots is 4.98s on average
- **OS Container Cleanup:** The average time for cleaning up a student's session on Linux is 44.00s, and Windows is 35.69s
- **Server Performance:** uWSGI is a lightweight web server that excels in relation to low CPU usage and simultaneous connections compared to existing alternatives [2] as shown in the graph (CPU Usage) below
- **Web Server Concurrency:** uWSGI served the highest number of concurrent requests with the lowest amount of threads, allowing for lighter server [3] as shown in the graph (Web Server Concurrency Performance) below





FEATURES

- **Student Birds' Eye View:** Teachers can view the screens of all students in one convenient location
- **Broadcast:** Teachers can seamlessly share their screen with all students
- **Application Permissions:** Teachers can permit and revoke access to specific applications for each student
- **Messaging:** Teachers can broadcast personalized messages to send to their students' devices
- **Heterogeneity:** The application can be run on multiple platforms such as Windows, Linux, Android and iOS
- **Portability:** The education devices can fit in a standard backpack and weighs approximately 300g (3 apples)

COMPETITIVE ADVANTAGE

- **Cost:** The cost of the full system, including the mobile device and backend system, does not exceed $75 USD per year per student (full calculations in table below) [4]
- **Teacher Features:** Wide array of teacher functionalities including bird's eye view, broadcast, app permissions, messaging, etc. which enhances the education experience
- **Future Proof:** As the computational needs for students increase, the cloud system can scale

Parameters	Windows	Linux
Type of Azure VM	B2S	B1S
Number of Cores	2	1
RAM	4 GB	1 GB
Temporary Storage	8 GB	4 GB
VM Cost (USD) Per Month	$19.48	$3.42
Disk Type	Standard SSD	Standard SSD
Disk Storage	32 GB	32 GB
Storage Cost (USD) Per Month	$2.40 + $0.20 (for transactions)	$2.40
Subtotal (USD) Per Month	$22.08	$6.02

REFERENCES

[1] B. B. a. R. L. Ross, "The Cost of School-Based Educational Technology Programs", 3 March 2013. [Online]. Available: https://www.rand.org/pubs/monograph_reports/MR634/index2.html. [Accessed 1 June 2019]

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