History of 3D Video Games

- 3D computationally laborious
- SNES SuperFX Chip
  - Star Fox
- 3D accelerator cards for computers – later Graphics Processing Unit (GPU)
- 3dfx and Nvidia were the first GPU makers
- First games using GPU
  - Quake
  - Tomb Raider
  - Resident Evil
Video Games Today

• Modern games require strong hardware (fast CPU and GPU, more RAM)

• Console Manufacturers since 2001:
  ‾ Nintendo
  ‾ Sony
  ‾ Microsoft (Diffusion of Innovation)

• Gaming PCs

• COVID-19: difficult to buy new game consoles or GPUs
  ‾ Xbox Series X|S
  ‾ PlayStation 5
  ‾ Nvidia GeForce RTX 3000 series

• What can we do?
Cloud Gaming!
What is cloud gaming?

- Stream games from company server
- No downloads nor expensive hardware required
- Fast internet speed required
- First attempt: 2012
  - OnLive
  - Gaikai
- Today
  - Google Stadia
  - Xbox Cloud Gaming (xCloud)
  - PS Now
  - GeForce Now
A new foe has appeared!
DIY Cloud Gaming Solution

- Virtual Private Servers (VPS)
- Replicate computer environment in cloud
- Pay for what you use
- Connect with a basic computer/laptop
Testing the Services

• Network
  ▪ Download/Upload (in Mbps): 200/10
  ▪ Wireless: 802.11ac @ 5GHz
  ▪ Recorded latency: 26 ms

• Laptop:
  ▪ CPU: Intel Core i5-7360U
  ▪ RAM: 16 GBs
  ▪ Storage: 256 GB SSD
  ▪ GPU: Iris Plus Graphics 640 (integrated)
  ▪ O/S: Windows 10 64-bit

• Phone (for xCloud)
  ▪ Samsung Galaxy S7
  ▪ Android 8.0.0
Custom VPS Solution

- AWS – g4dn.xlarge instance
  - 4 virtual CPU cores
  - 16 GBs RAM
  - 125 GB NVMe SSD storage
  - Nvidia T4 GPU
  - Windows Server 2019 (functionally Win10 v1809)

- Parsec for remote connection
Games
Results

- Stadia and GeForce Now: buttery-smooth, minimal input-lag
- PS Now: graphical artifacting, moderate input-lag
- Xbox Cloud Gaming: very noticeable input lag
- Custom VPS Solution: noticeable compression artifacts, very smooth
  - Configuration moderately tedious
Costs

- Xbox Series X or PlayStation 5: $499.99
- Stadia: $9.99/month, $840 7-year cost (13 games)
- GeForce Now: $9.99/month, $840 7-year cost
- PlayStation Now: $9.99/month + $59.99 Controller, $900 7-year cost (6 games)
- VPS: $0.71/hour = $530 24/7 or $44.02 assuming 2-hour daily playtime
Cloud Gaming Future

• Stadia: not good outlook
• Xbox and PlayStation: server backend upgrade to 9th gen
• Amazon Luna and Nintendo enter the picture
• Improved networking infrastructure
  ▫ Data caps a problem
• Licensing is key!!!
• Supply improves?