Tech Topic #5

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Gaming

- Lots of different kinds of games, but the most challenging are the interactive games
  - Typically racing or first person shooter (FPS) games

- The most interactive of the interactive games are
  - Online PC games (e.g., World of Warcraft)
  - Console games (e.g., Xbox, PS3, Wii)

- Most console games have a single player component and an interactive component
  - The interactive component is either a subscription model (Xbox) or free (PS3 and Wii)
Issues in Gaming

• Scale (Bandwidth)
  – The number of players and amount of bandwidth that can be supported
  – Limits are generally driven by minimum available bandwidth
  – With dial-up modems, hard to have any kind of scale
  – Xbox, for example, requires broadband connection

• Delay
  – Opinions on delay vary, but 50ms-100ms seems common
  – Some allowances go as high as 200ms

• Processing
  – Used to be an issue but not really anymore, or rather, is more of an issue for graphics quality but not networking
• Scale is not so hard to manage
  – Rather, requirements are limited based on strict limits on the number of players
  – Other techniques to reduce bandwidth requirements: reduce complexity, less frequent updates, aggregate updates, limited Areas of Interest, compression, etc.

• Consoles are often limited to 8, 16, or 32 players
  – Much beyond that and it is hard to have rich interactions

• PC games have unlimited players, but only a small number can co-exist in an area
  – For popular areas, replicated servers providing identical areas are used
Delay

• Games are even more sensitive to delay than real-time voice conversations
  – Even with minimal buffering and processing, physical distance propagation times are often too slow

• Consider for example, highly accurate first person shooter games

• Quite a few techniques to avoid dealing with delay
  – Fairly sophisticated efforts to measure delay between players (one of the components of matchmaking)
  – Other, in-game, techniques (e.g., dead reckoning)
Precision and Deadline

• Claypool papers talks about these two ways of describing how important delay is

• Precision: accuracy of action
  – Precise v. Imprecise

• Deadline: responsiveness
  – Tight v. Loose

• Game phases…

• But, we want to look at the really challenging parts
Architecture Types

- Two different types of architectures

- Peer-to-peer
- Distributed

- Client/server
- Centralized
Architecture Types

• Impacts of architecture type

• Where control decisions are made
  – Single point versus distributed fashion
  – Single point of control generally better for security
  – Single point is single point of failure (may be security issue)
  – Single point means server is likely a traffic hotspot
  – Single point may require more capability to handle updates

• Where data has to be sent
  – In single point, players only have to communicate with server
  – In single point, server has to communicate with all players
Client Capabilities

• Distributed architecture
  – All clients have to be able to perform data processing and game status updating

• Centralized architecture
  – A spectrum of possibilities
  – At one end: clients just pass actions to server and server responds with updated game state (player location, status, inventory, etc.)
  – At the other end: clients just pass game state (all of the processing was done locally)
    • Server still has to verify correctness of actions

• For either architecture, may need to re-sync periodically
Hybrid Architecture

• For some types of data, p2p distribution is used
  – Player-to-player voice communication
  – Non-critical game state

• For other types of data, central server is used
  – Game critical data is sent to the server and processed there (for correctness check)
Dealing with Delay

• Given the laws of Physics, how to overcome delay that must necessarily exist?

• Some reduction of the amount of data to send will help with delay, but these days, bandwidth constraints are well understood and can be managed

• Other technique is a combination of local processing and “dead reckoning”
Dead Reckoning

- Allow local player to estimate new position of remote player based on previous position and history

- Tradeoff between: delay and data consistency
  - The longer the time without an update, the more inconsistent the data becomes
  - Use one node (central server?) to deal with inconsistencies
One Possible Solution

- Use a centralized approach
  - Though each of the players has the potential to be the server

- Have some local processing
  - Can receive user inputs and display those on the screen
  - Can also do limited dead reckoning for remote player actions
    - Expecting only modest amounts of delay

- Send game state updates to the server
  - Server responds with whether action was allowed
    - Server runs “virtual world” to compare possibilities versus realities
  - If action is not possible (likely security hack), fix it
  - If conflict occurs (because of dead reckoning), fix it
  - Fixes may result in on-screen “hitch”

- An appearance of minimal delay and fairly good accuracy can be achieved
Server Also Checks for Cheats

- Packet and traffic tampering
  - reflex augmentation
    - proxy replaces human to produce superior results (aiming proxy)
    - e.g., aiming proxy
  - packet interception
    - proxy prevents packets from reaching the cheating player
    - e.g., suppressing the packets containing damage information
  - packet replay
    - the same packet is sent repeatedly (fire command)
      - e.g., the fire command packet

- Information exposure
  - gives information to player he/she is not supposed to have

- Design defects
  - can create loopholes which the cheaters are apt to exploit
Learning About How Games Work

• Traffic traces as a way of reverse-engineering what is happening
  – Typically hard to do because traffic is carefully encrypted

• Can also inject arbitrary delay and observe how game reacts

• And now… more on tracing traffic…