More on Latency and Game Playability

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Measuring Player Tolerance

- A non trivial task to measure a player's tolerance to network conditions
- Latency is BAD! But the question is how much latency actually results in a "unacceptable" playing environment??
- Surveying players and asking for their input on the quality of play they experienced is a very complex task. Not only do network factors affect playability, so does the emotional and physical state of the players. Are they not feeling well? Are they hungry? Has something upset them? These factors are very hard to capture, especially in anonymous settings.

How to Collect Data

- Closed controlled network gaming lab.
  - Cons: Limited in its scope – players have to agree to being subjects in an artificial environment and the numbers cannot be that large.
  - Pros: Easy to control networking environment and player moods. Collecting user experience is not an issue as all players are “specimens” in an experiment and comply by the rules of the experiment.
- Measurements from large public servers.
  - Requires collecting large quantities of network data (may not see all possible network states), and
  - convincing players to fill out “play quality” forms at the termination of their game time. Not a very viable option.
- Collect objective data (game statistics) on a game and correlate that to network conditions. I.e., higher number of hits when latency is X than when it is Y. More games played when packet losses are R as opposed to S. Etc.
  - Have to collect network measurements and game data.
  - Limited in scope as there is no control of networking environment.

Empirical Research

- Trials have been run on identical servers with different simulated networking conditions and data was collected to see the impact of latency. (We show some results at the end of the presentation.) Users are not queried, end game results are used to make "playability" assumptions.
  - No. of hits (FPS) vs latency
  - No. of games played by the players. It is assumed that the lower the latency, the more frequently the players will return to play as the play experience was good.

Sources of Error and Uncertainty

Public Server Measurements

- Public server studies lack any real knowledge about the players' environmental conditions and usually only display a limited range of networking conditions. They don't have much control over latency, jitter and loss conditions.
- The RTT estimates by the server are usually not very accurate either as was shown with some ping measurements and comparing them to the server estimates. Latter on average 5ms higher.

Sources of…. Contd.

Lab controlled Experiments

- Suffer from the difficulty of collecting statistically significant amounts of data. Need large numbers if reasonably accurate conclusions are to be drawn
- Number of players is usually limited and data points should be collected from independent samples, meaning that the same players can not be used over and over for repeat test scenarios.

Sources of ….. Contd.

Latency Compensation and other tricks

- To test a game with latency compensation algorithms in play or to test the game without any pre- and post-processing is an issue.

- Mimicking real world situation as closely as possible means…… ? Not clear. If a game gives a player no option to switch it off, then the measurements should be made with latency compensation, etc. in play. Some games it can be switched off by the player, in that case measurements can be made without the influence of the compensation algorithms.

Creating Artificial Network Conditions

Latency:

- Most systems used for network emulation are not real time.
- Packets are created following a distribution and queued for transmission based on when they were created.
- The system clock resolution can impact when the queues get polled. If small, e.g., 1ms, the error in the packet arrival process will not be very large.

Packet Loss:

- Simulating packet loss is not difficult. A random decision is made for each packet whether to transmit or drop. The probability of dropping is drawn from a loss distribution.

Jitter:

- Simulating jitter is not that straightforward as creating an arrival process with variable inter packet arrivals that experience jitter could result in packet mis-ordering. I.e., a packet that arrived later at sender could reach destination earlier than an earlier transmitted packet.

Player Experience and QoS

Typical Latencies

- Latencies differ over different networks and the type of last mile access a user has can add a significant amount to the overall delay of data transmission.
- LAN latencies are low – typically 10ms or less
- Dial up modems – hundreds of msecs
- Cable and DSL –typically tens of msecs but can vary to 100msecs
- Backbone latencies within a continent are around 50msecs and cross continent can easily reach hundreds of msecs.

Impact of Latency

- Depends very much on the "game type"
- Player interactions can be very sensitive to latency – e.g., shooting an enemy with a rifle.
- Some game scenarios, such as amassing an army or moving troops over a terrain will not be affected as much by latency.
- Some latencies can be visually masked – e.g., large explosions, multiple shots/strikes (e.g., machine gun), a lot of activity such as a group attack on a monster.

Categorizing Player Actions

- Precision
- Deadline

The precision and deadline requirements for a player action determine the effects of latency on that action.

Precision

- Precision is the accuracy required to complete an action successfully.
- Precision is the size of a distant opponent and the player's weapon/tool and its target range. E.g., Call of Duty and sniper carrying a rifle vs a machine gun and an attack on a tank.

Deadline

- Deadline is the time required to achieve the final outcome of the action.
- Deadline is the time to target an opponent with a weapon or spell before the opponent moves out of range.

Further understanding of requirements

- The precision and deadline requirements are determined not only by the action itself but also
  - by the interaction model,

  and
  - by the player's game perspective.

Interaction Model

The interaction model defines how a player interacts with the game world and is typically classified as either:

- the avatar model
- the omnipresent model

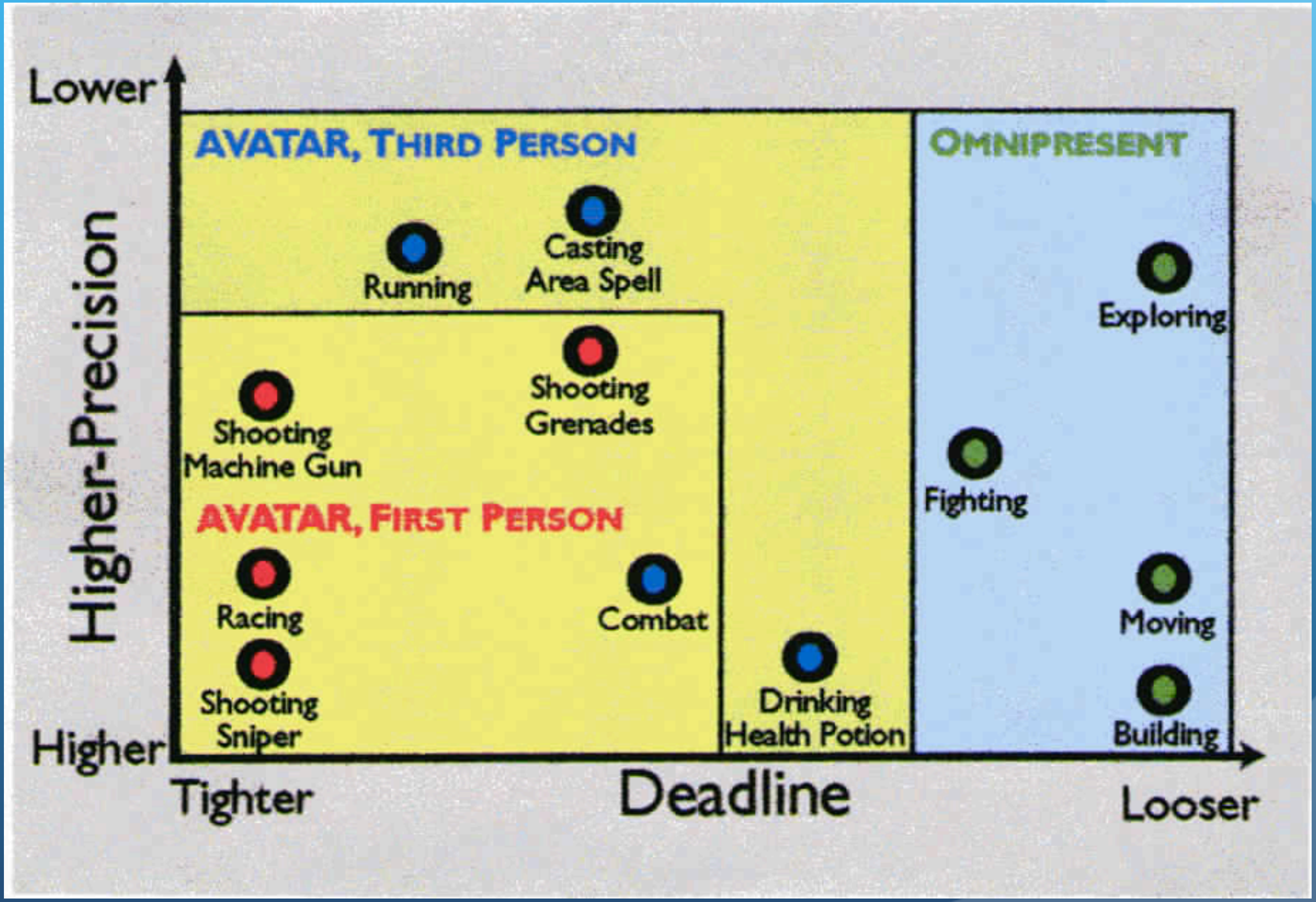
Interaction Models contd.

- In the avatar model, the player interacts with the game through a single representative character, and player actions are defined in terms of commanding it.
  - The avatar exists at a particular location in the virtual world and can influence only the immediate locality.
  - First-person shooter games, role-playing games, action games, sports games, and racing games are all examples of game genres with an avatar-interaction model.
- In the omnipresent model, players view and simultaneously influence the entire set of resources under their control. Real-time strategy games such as Rise of Nations and construction and simulation games are genres of this model.

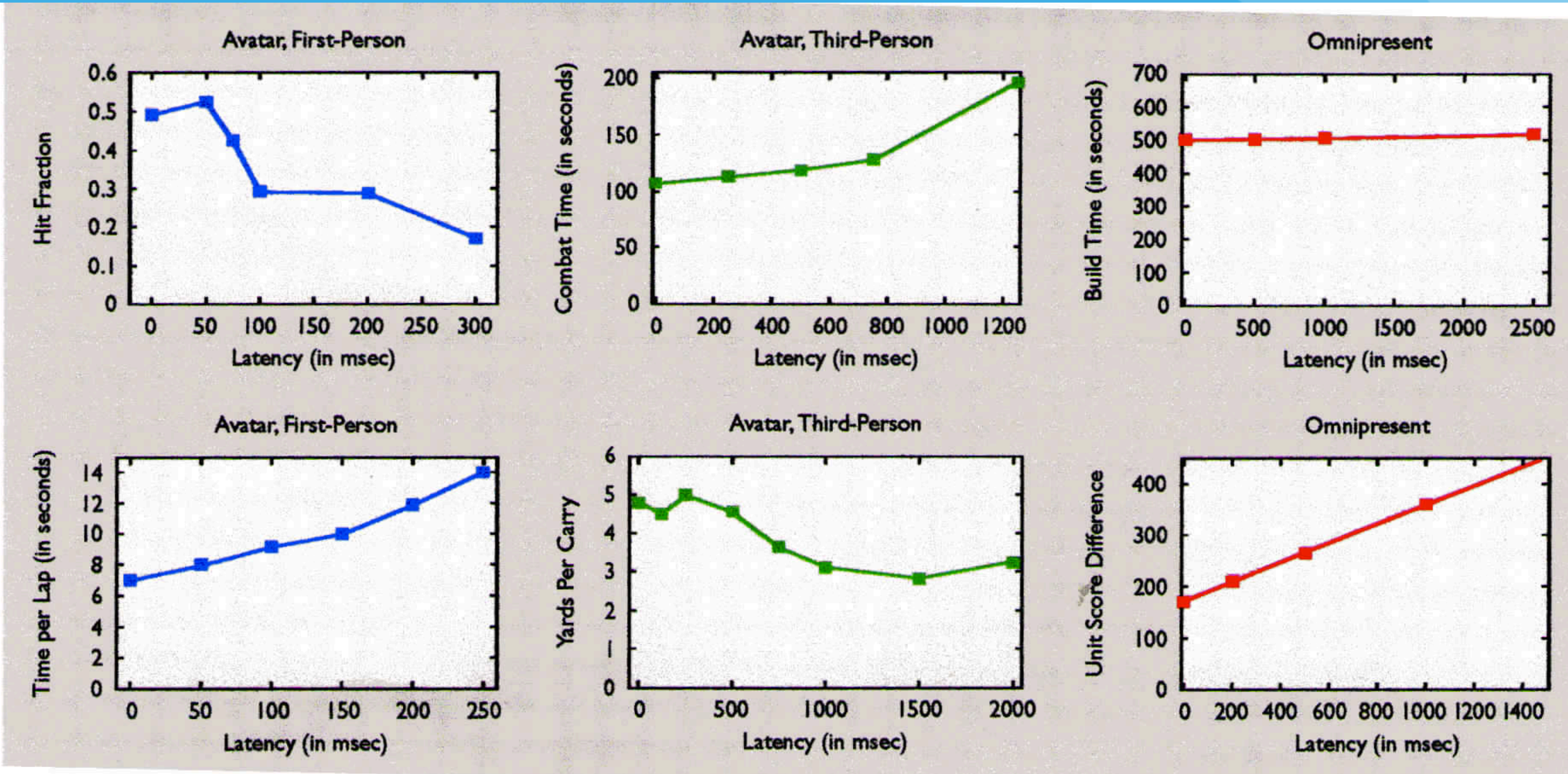
Game Perspective

- Defines how a player views the game world on a screen.
- Games with the avatar interaction model typically have either a first-person perspective where the player sees through the eyes of the avatar or a third-person perspective where the player follows an avatar in the virtual world.
- The perspective used by games with the omnipresent-interaction model is often variable, giving players an aerial perspective or bird's-eye view of the virtual world while also allowing them to zoom in to a third-person or even a first-person perspective for finer granularity of control over individual resources.

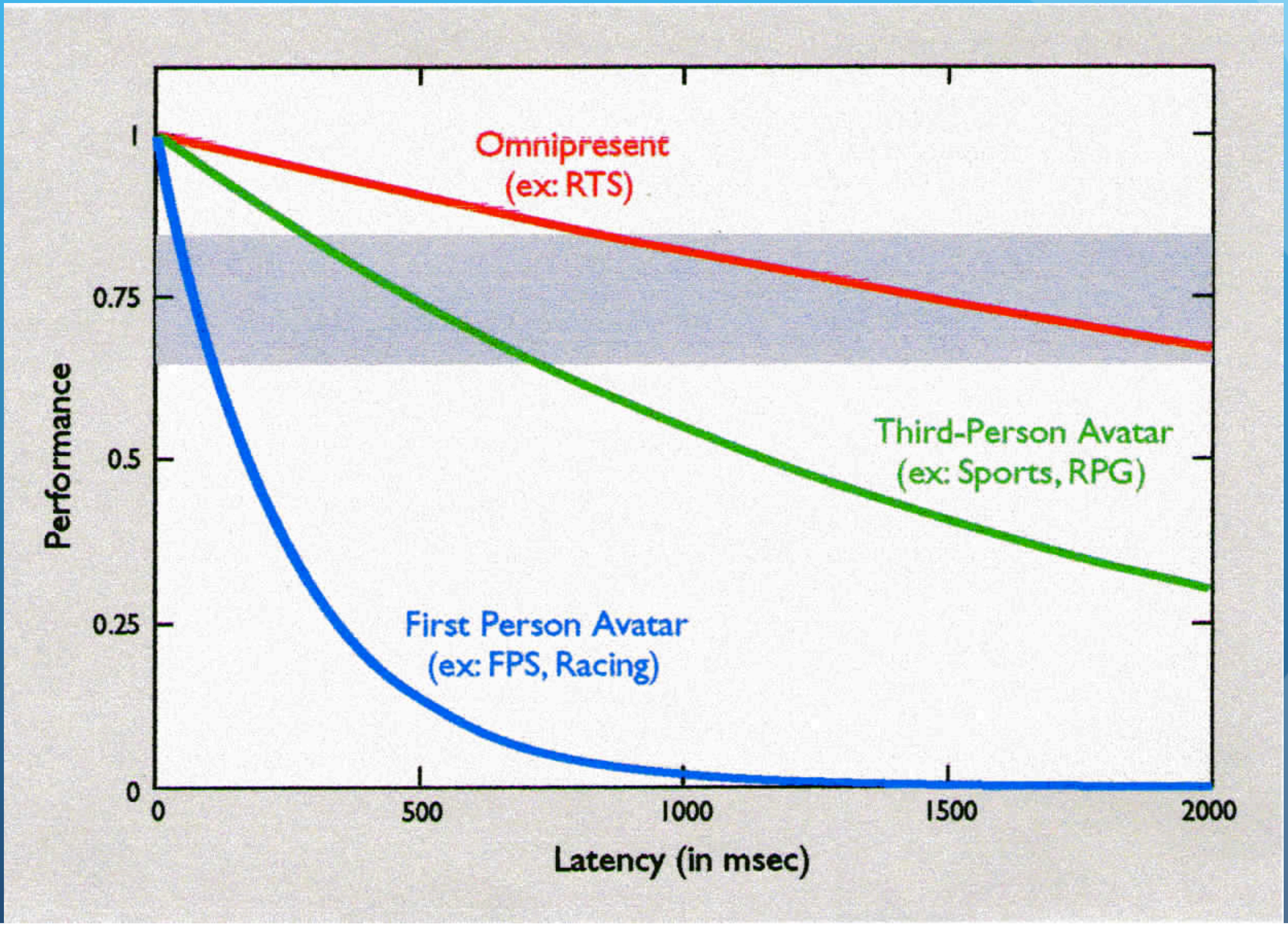
Precision – Deadline Game Requirements



Playability vs Latency for Different Interaction Models



Performance vs latency for different classes of online games



Ball Park Numbers for Designers

Model	Perspective	Example Genres	Sensitivity	Thresholds
Avatar	First person	FPS, racing	High	100msec
	Third person	Sports, RPG	Medium	500msec
Omnipresent	Several	RTS, Sim	Low	1,000msec

Why do we need numbers??

For:

- *Game designers*. So they know the latency tolerances of different player actions, helping them apply latency compensation techniques, as needed
- *Network designers*. So they are able to create infrastructures providing quality of service (QoS) for online games and other interactive applications
- *Game players*. So they are able to make informed choices about their Internet connections and QoS purchases affecting latency and hence gameplay.

Reference

***Latency and Player Actions in Online Games*. Mark Claypool and Kajal Claypool. COMMUNICATIONS OF THE ACM,** November 2006/Vol. 49, No. 11