

Cloud and Peer-to-Peer Gaming

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What is P2P Gaming?

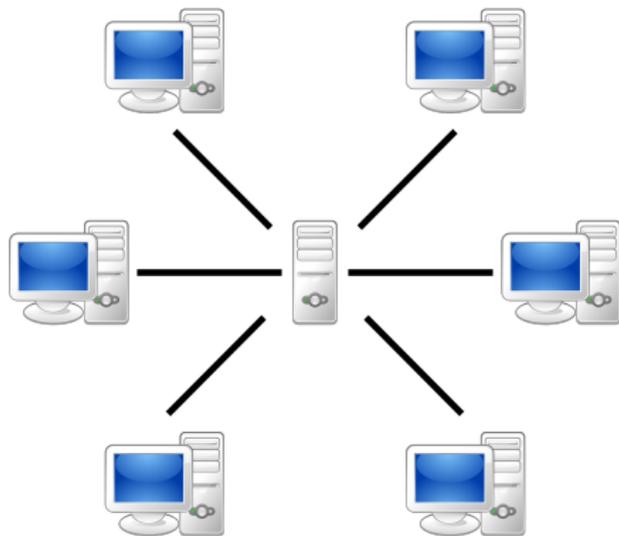


Figure 1: Client Server topology

What is P2P Gaming?

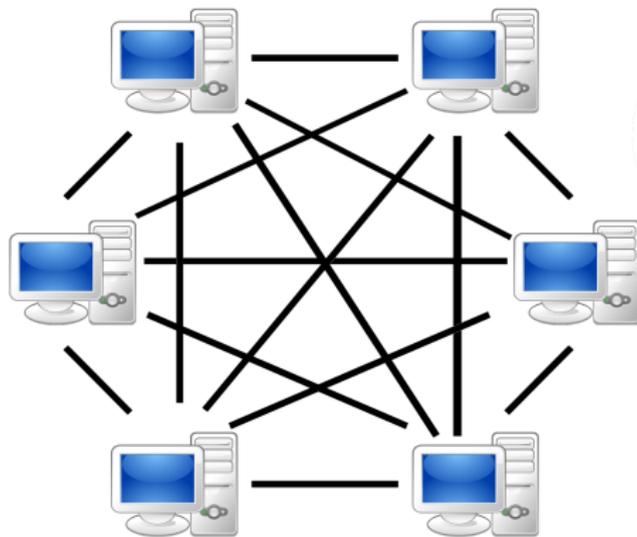


Figure 2: P2P topology

Donnybrook: P2P Gaming for FPS games



Figure 3: “Call of Duty: Black Ops 2”

How to reduce network traffic?



Figure 4: "Counter-Strike: Source"

Metrics

- ▶ Proximity: $I_{ij}^{(1)} = \max\{(1 - \text{dist}(i, j)/D_{\max})^{1.5}, 0\}$
- ▶ Aim: $I_{ij}^{(2)} = \max\{(1 - \hat{a}(i, j)/45^\circ)^{1.5 * \log(\text{dist}(i, j))}, 0\}$
- ▶ Interaction Recency: $I_{ij}^{(3)} = \begin{cases} e^{-t_{ij}/\text{sec}} & \text{if } t_{ij} \leq 3 \text{ sec} \\ 0 & \text{otherwise} \end{cases}$
- ▶ $A_{ij} = \sum_{k=1}^3 w_k I_{ij}^{(k)}$

Proximity



Figure 5: Metric: Proximity

Aim



Figure 6: Metric: Aim

Interaction Recency



Figure 7: Metric: Interaction Recency

Doppelgänger



Figure 8: Doppelgänger

Are we done?

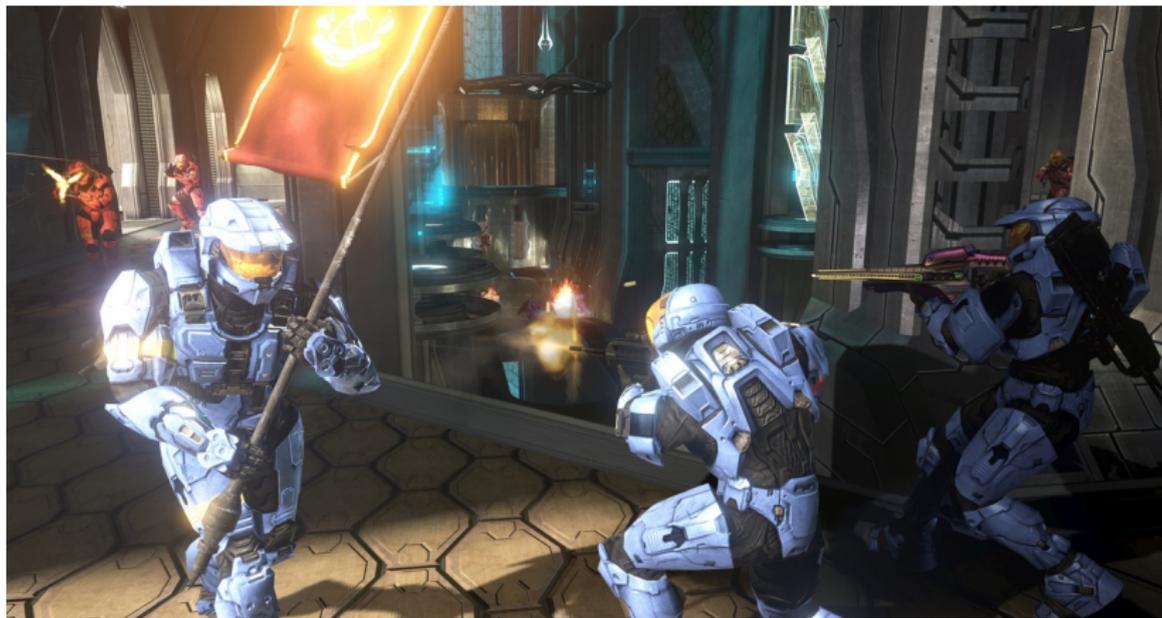


Figure 9: Halo 3

Concrete numbers for Quake III

- ▶ 20 interest set updates per second
- ▶ 1 guidance update per second
- ▶ Reduction of bandwidth requirement: $\frac{20n}{20*5+n}$
 - ▶ 1000 player game of Quake III: 12 Mb/s -> 670Kb/s

Does it work?

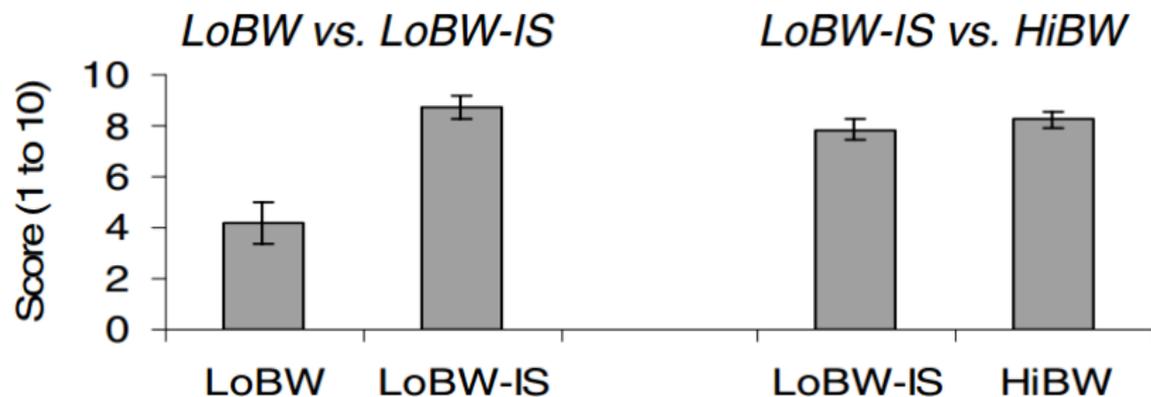


Figure 10: User evaluation

Cloud Gaming

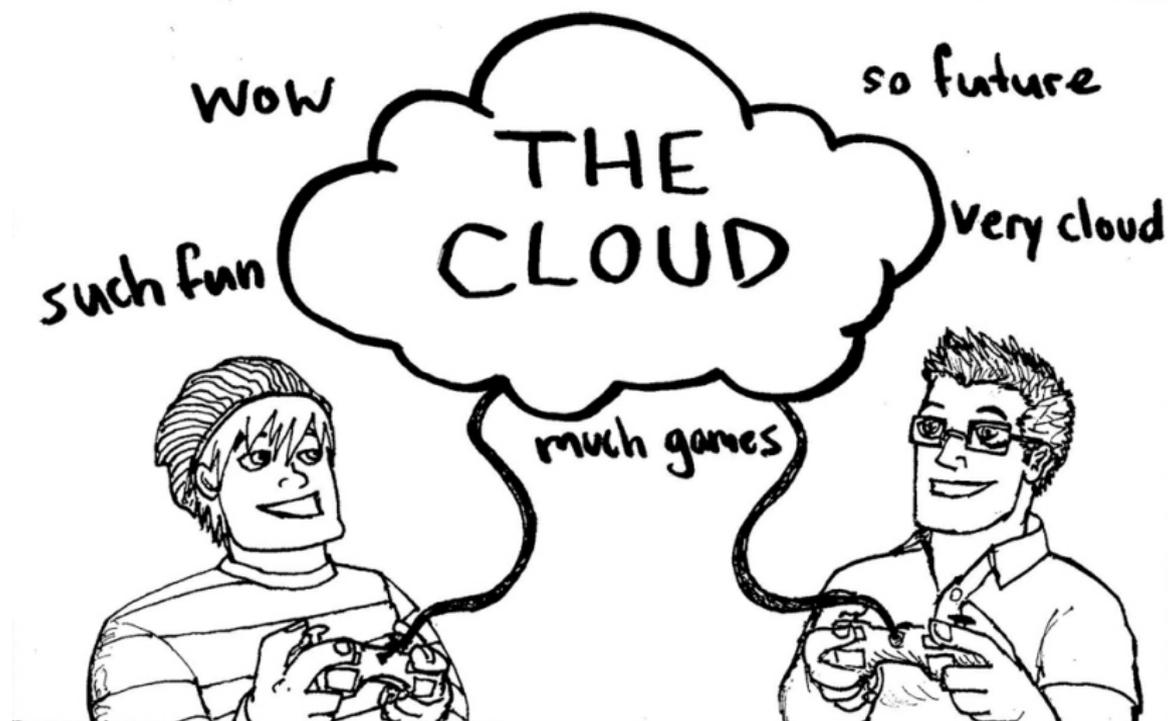


Figure 11: Cloud Gaming

Standard cloud gaming

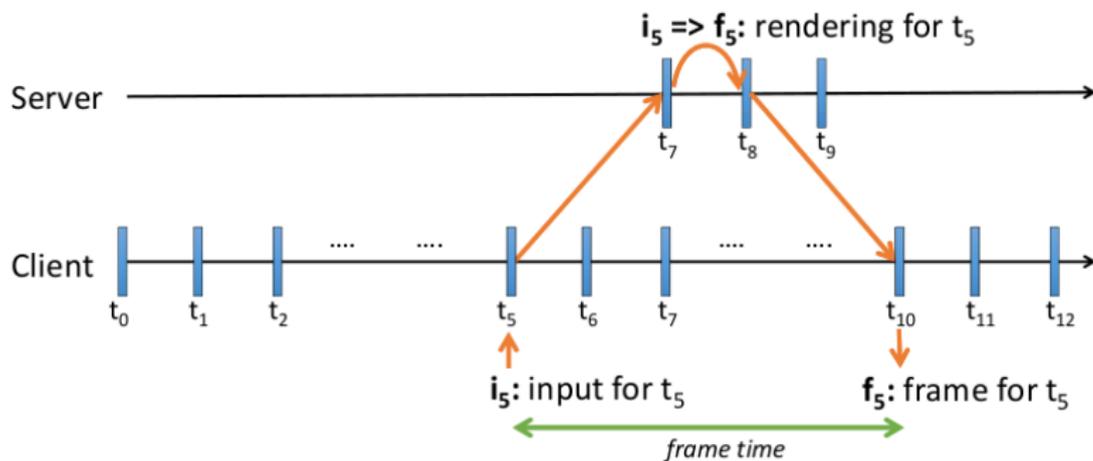


Figure 12: Standard cloud gaming

Navigation events

Navigation vector: $N_t = \{\delta_{x,t}, \delta_{y,t}, \delta_{z,t}, \theta_{x,t}, \theta_{y,t}, \theta_{z,t}\}$

Future input prediction

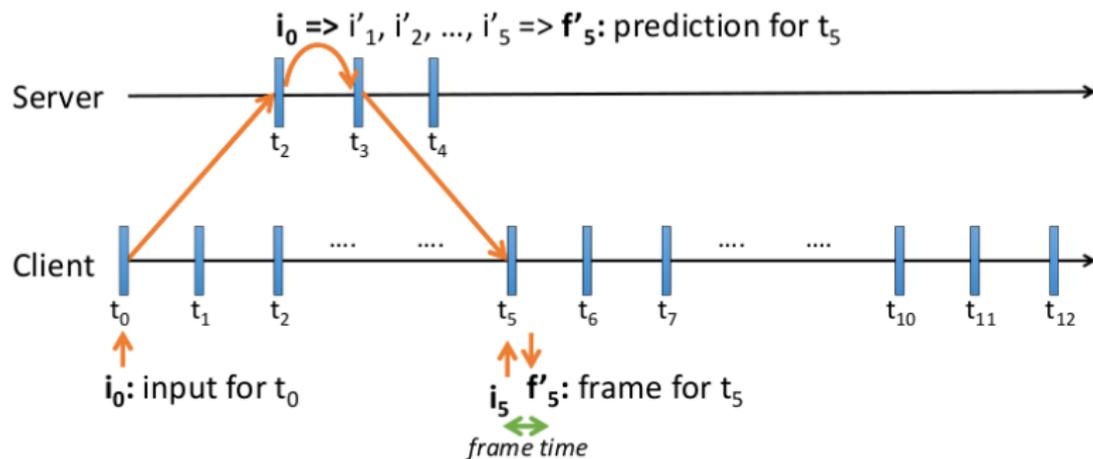


Figure 13: Outatime

Viewpoint interpolation



Figure 14: Example of viewpoint interpolation

Cube map

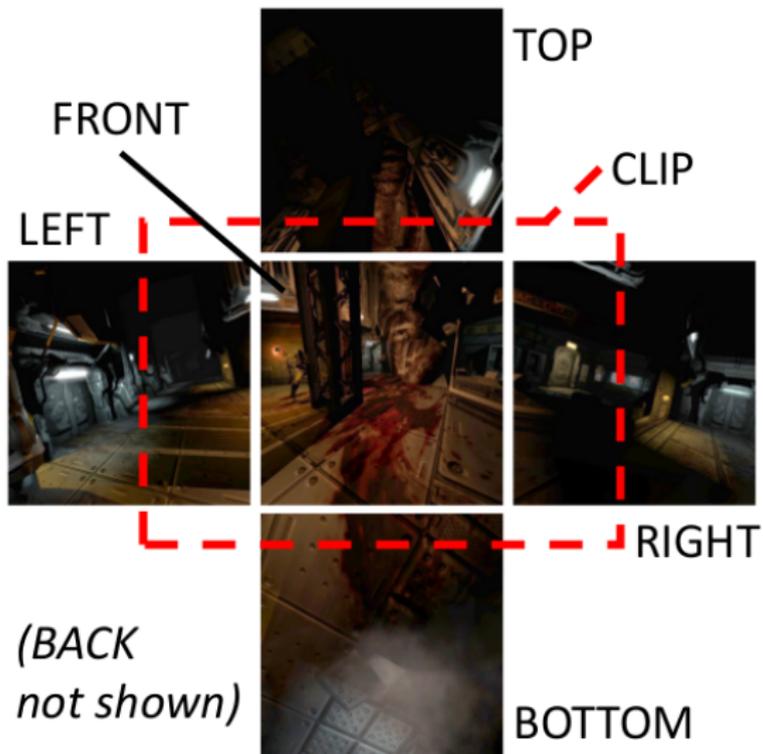


Figure 15: Cube map

Speculative Rendering

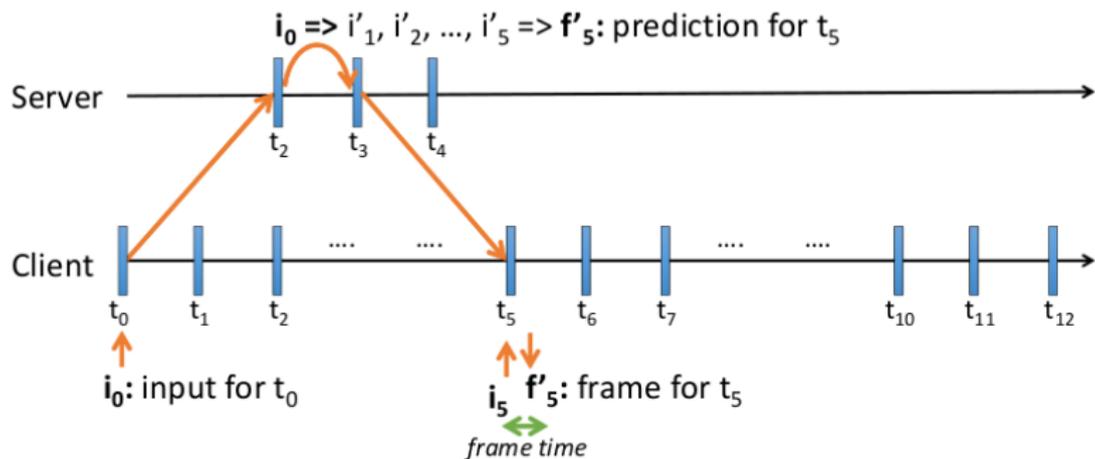


Figure 16: Speculative Rendering I

Impulse Events

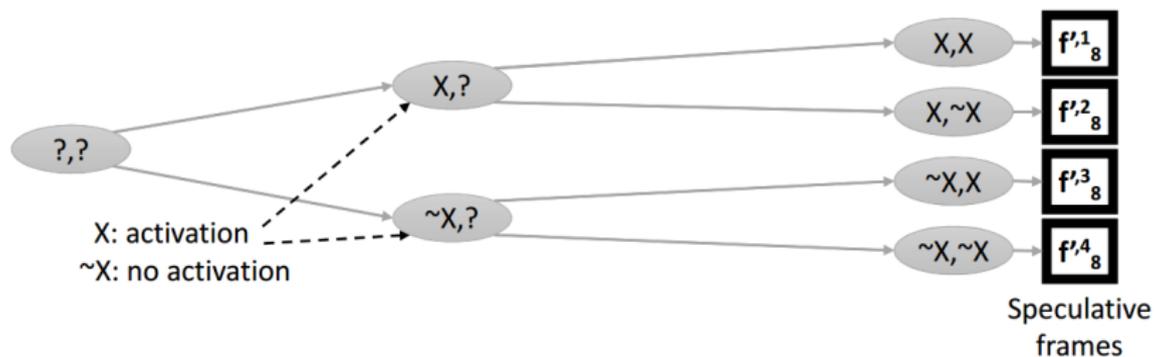


Figure 17: Speculative Rendering II

Subsampling and timeshifting

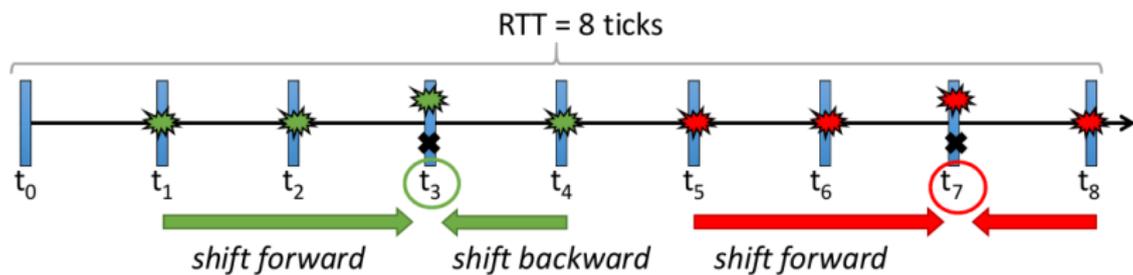


Figure 18: Subsampling example

Joint encoding



$\sim X, \sim X$



$\sim X, X$



$X, \sim X$



X, X

Figure 19: Joint encoding

Does it work?

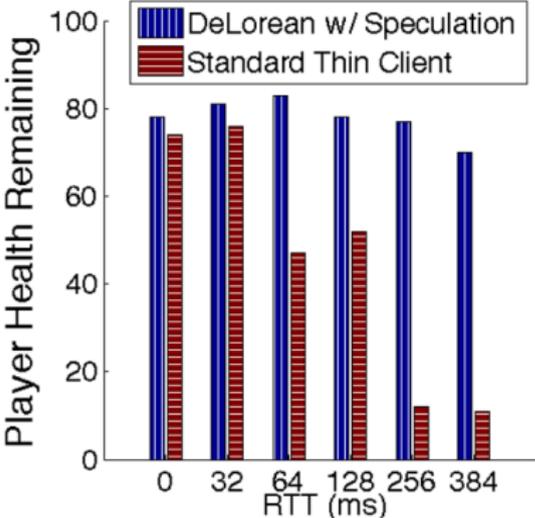
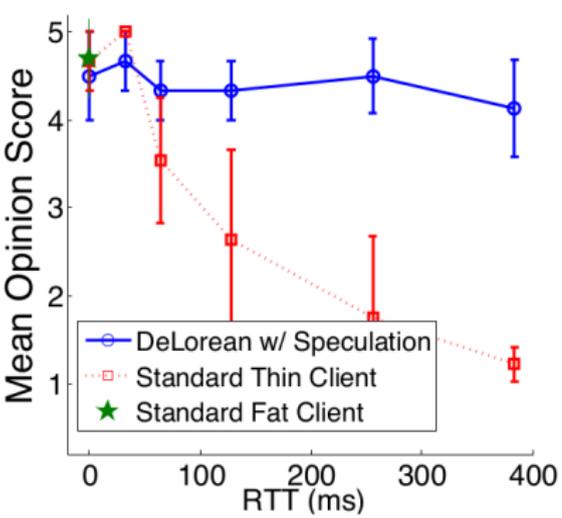


Figure 20: Evaluation results

Similarities between Donnybrook and Outatime

- ▶ Obstacle: Network limitations
- ▶ Exploitation of human cognition limitations
- ▶ Exploitation of temporal and spatial locality
- ▶ Future prediction

Current state



Figure 21: Cloud gaming companies

Discussion



Metrics:

1. Proximity
2. Aim
3. Interaction recency

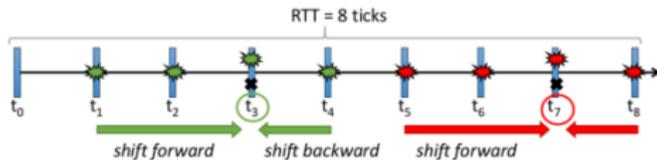
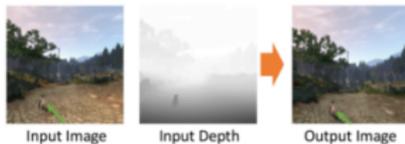
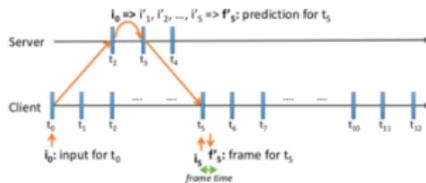


Figure 22: Reminders