



**MONTANA
STATE UNIVERSITY**

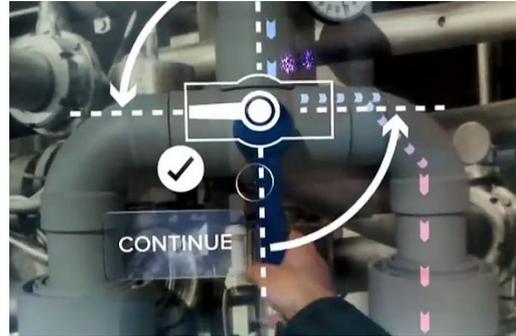
*Network performance requirements of
Augmented Reality Systems*

Mike P. Wittie

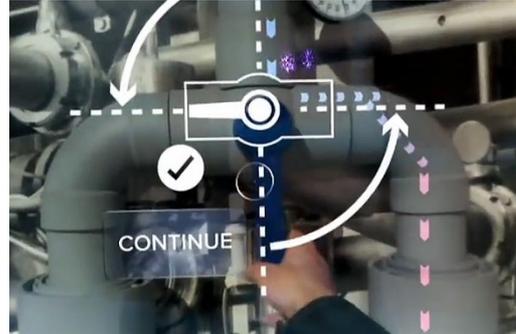
Augmented Reality (AR)



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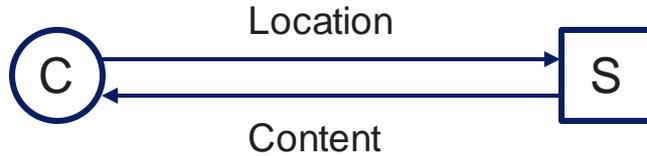


Augmented Reality (AR)



Traffic in AR applications

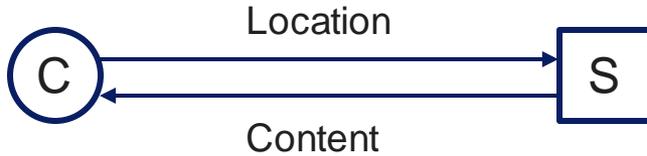
Augmented Reality Information Systems



- Static content queried and rendered by user position
- Google SkyMap, Augment, Zappar, Wikitude, Field Trip, Yelp Monocle, SpecTreck, Zombies, Run!, Layar

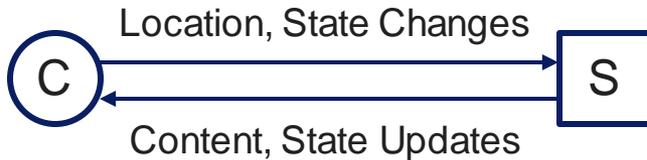
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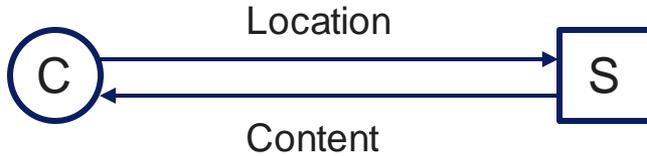
Siloed Augmented Reality



- Indirect user interactions through changes to application state
- Pokemon GO, Ingress

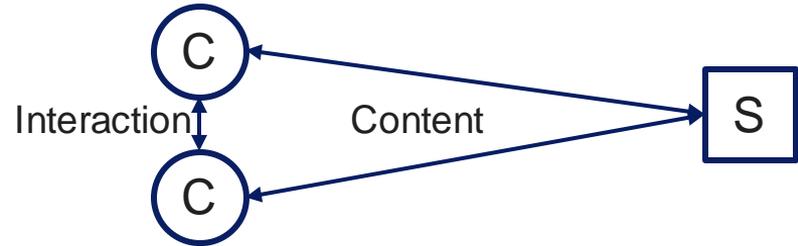
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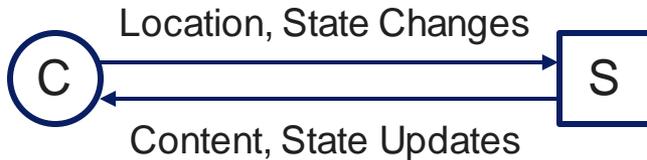
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Shared Augmented Reality



- Direct user interaction supported by global state
- Refresh, Tinder

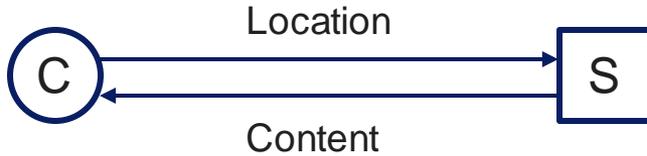
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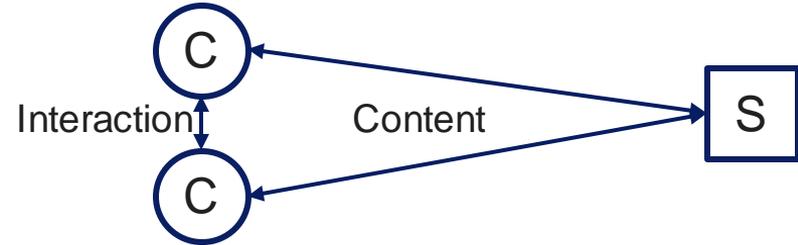
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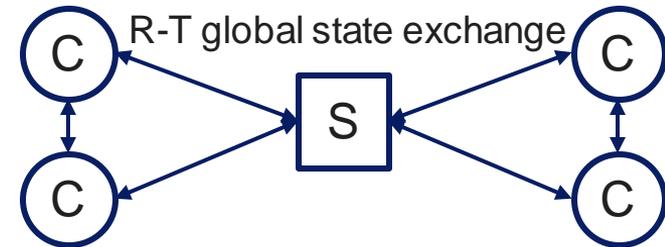
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Shared Augmented Reality



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Real-Time Augmented Reality



- Simultaneous experience and collaborative interaction
- Lyteshot, Holoportation

Holoportation



Impact of latency

Latency



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Cybersickness: 5-10 msec: <https://www.wearable.com/vr/vr-headset-motion-sickness-solution-777>

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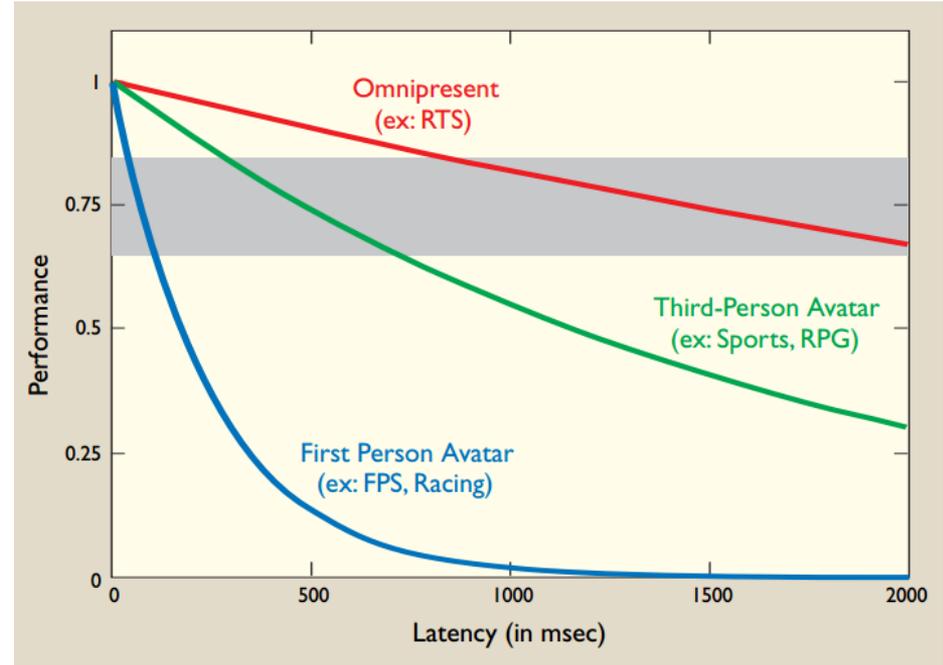
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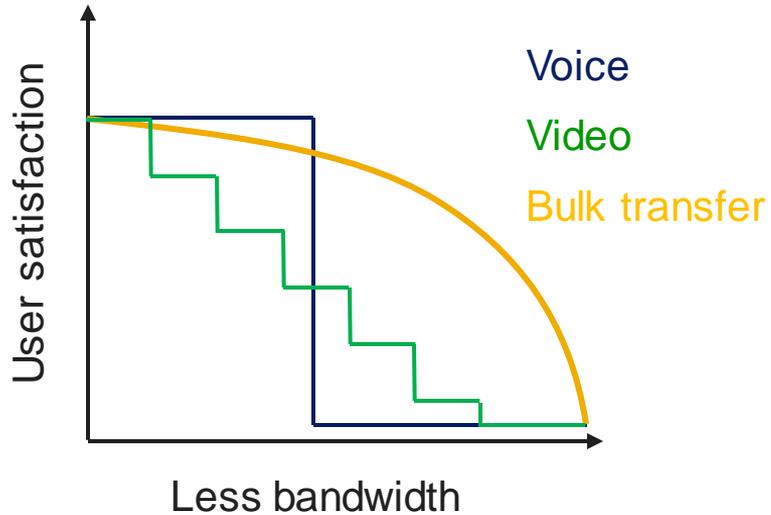
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Impact of Other Metrics

Bandwidth

- 5Mbps - HD streaming
- 25Mbps – 4K



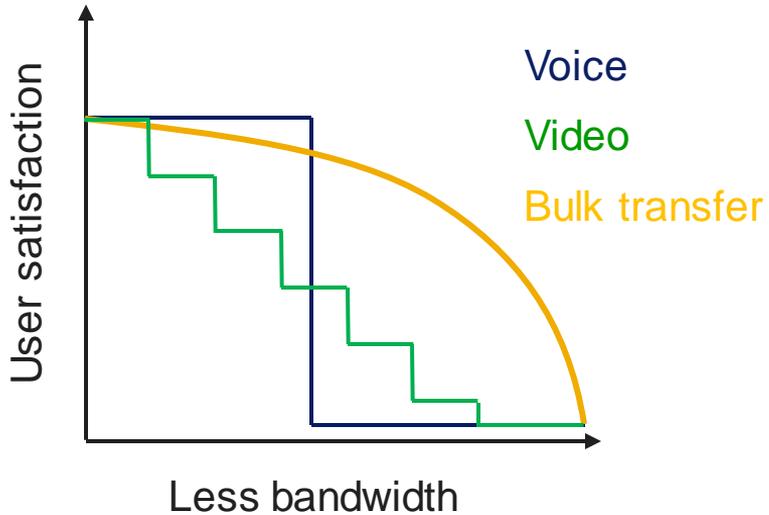
Impact of Other Metrics

Loss

Bandwidth

- 5Mbps - HD streaming
- 25Mbps – 4K

- Critical in smart manufacturing



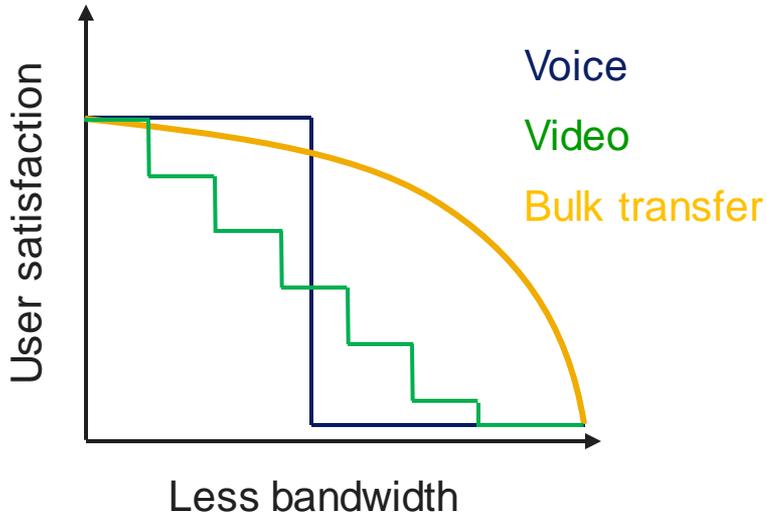
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- Critical in smart manufacturing
- Not much effect on game scores

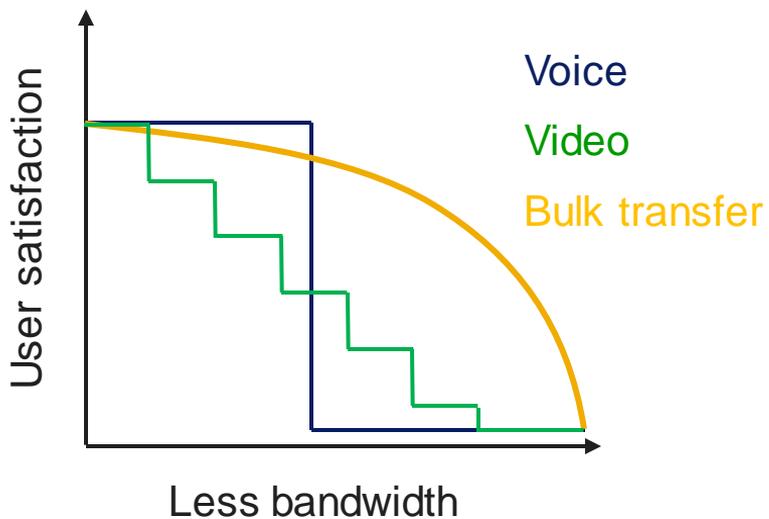


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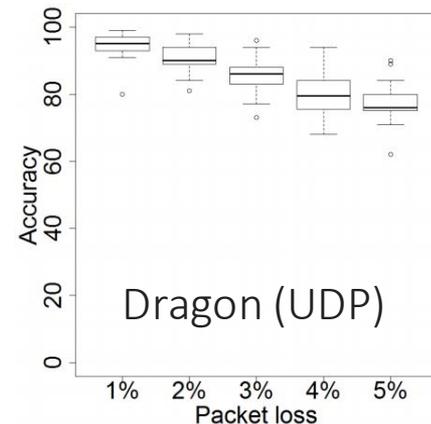
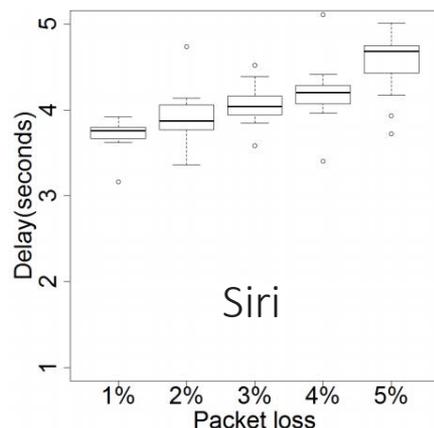
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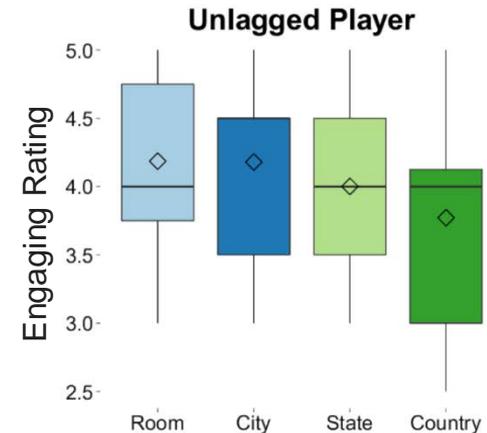
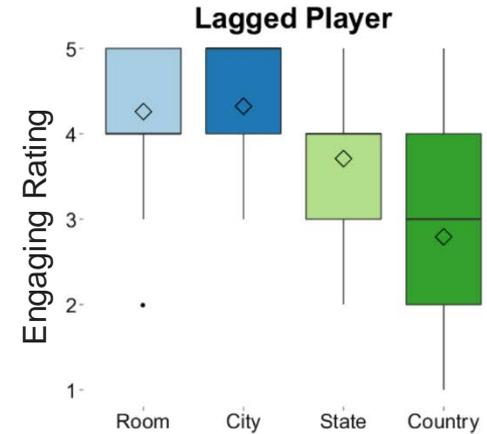
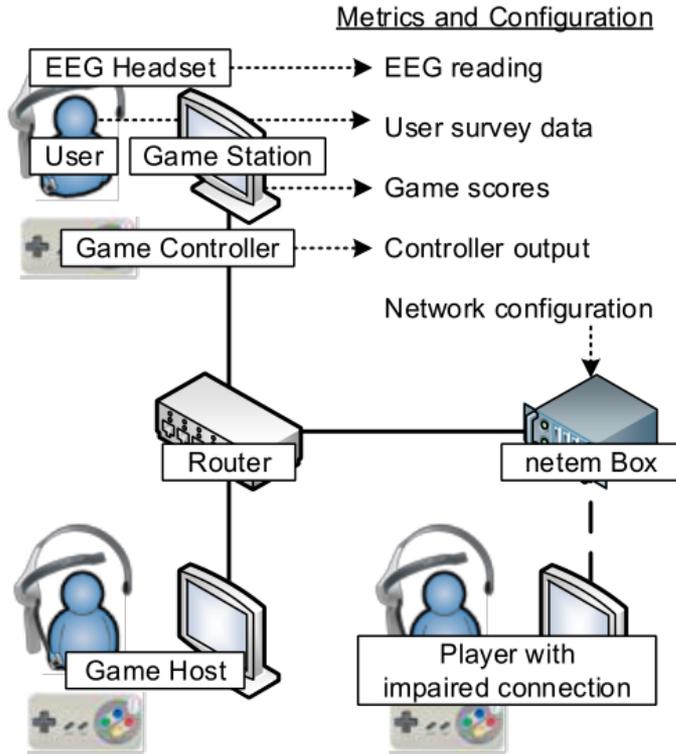
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- Critical in smart manufacturing
- Not much effect on game scores
- Affects speech recognition systems



Lag in group Applications



Eben Howard, Clint Cooper, Mike P. Wittie, Steven Swinford, Qing Yang. "Cascading Impact of Lag on User Experience in Multiplayer Games," in *ACM NetGames*, December 2014

Overcoming Tracker-to-Display Lag

