



# Cross Reality: The Convergence of AR and VR Technology

Dr. Uwe Gruenefeld ([uwe.gruenefeld@uni-due.de](mailto:uwe.gruenefeld@uni-due.de))

 [UweGruenefeld](#)

 [@UweGruenefeld](#)

 [Uwe-Gruenefeld](#)

**FALUNO**  
The Ruhr Institute for Software Technology





# Imagine you are exploring Venice ...





# So many options...





# Immersive view to check options...



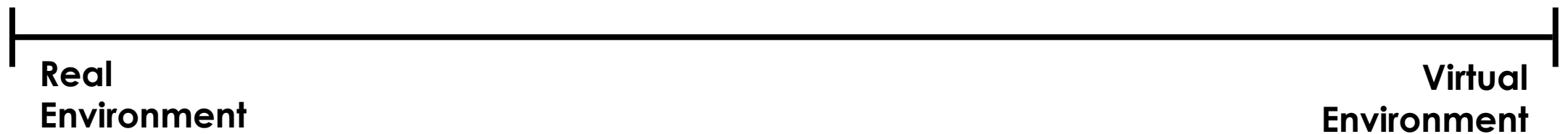


# Navigation to your favorite target...





# Reality-Virtuality Continuum



[Milgram and Kishino, 1994]

# Reality-Virtuality Continuum

Reality



Augmented Reality



Virtual Reality



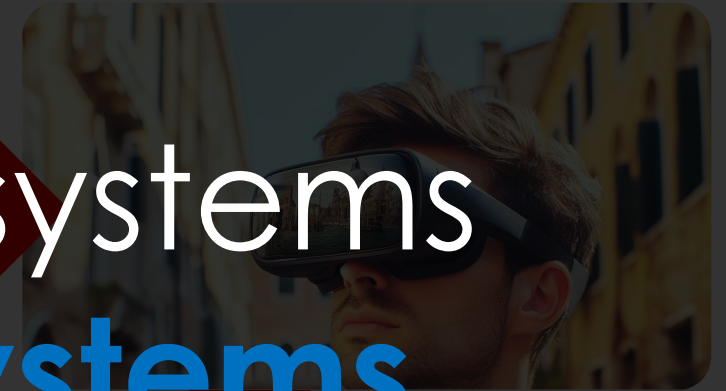
[Milgram and Kishino, 1994]

# Reality-Virtuality Continuum

Reality

Augmented Reality

Virtual Reality



We refer to these systems  
as **cross-reality systems**



[Milgram and Kishino, 1994]



# Definition



# Magic Book

Collaboration in ...



Reality



Augmented Reality

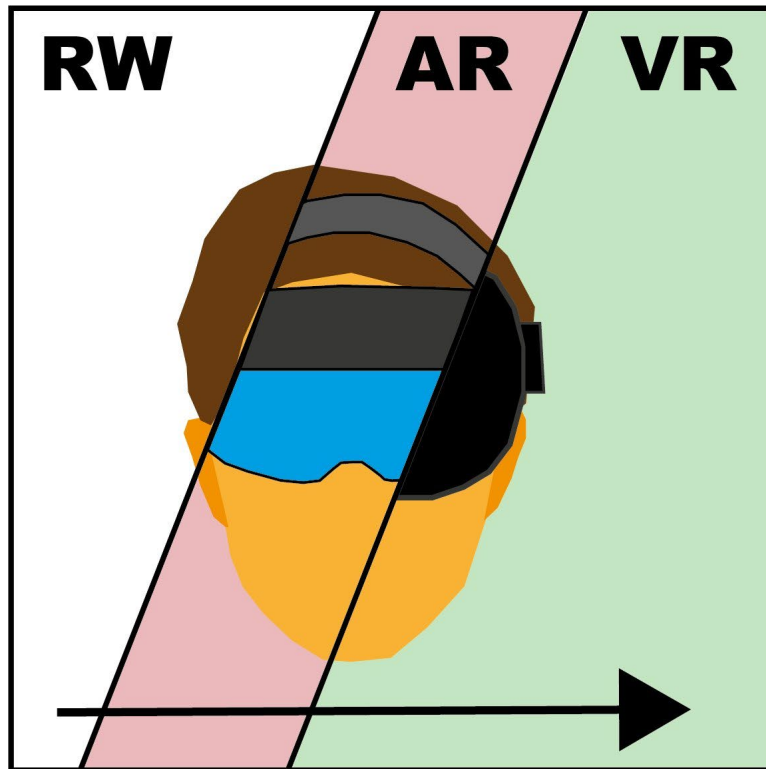


Virtual Reality

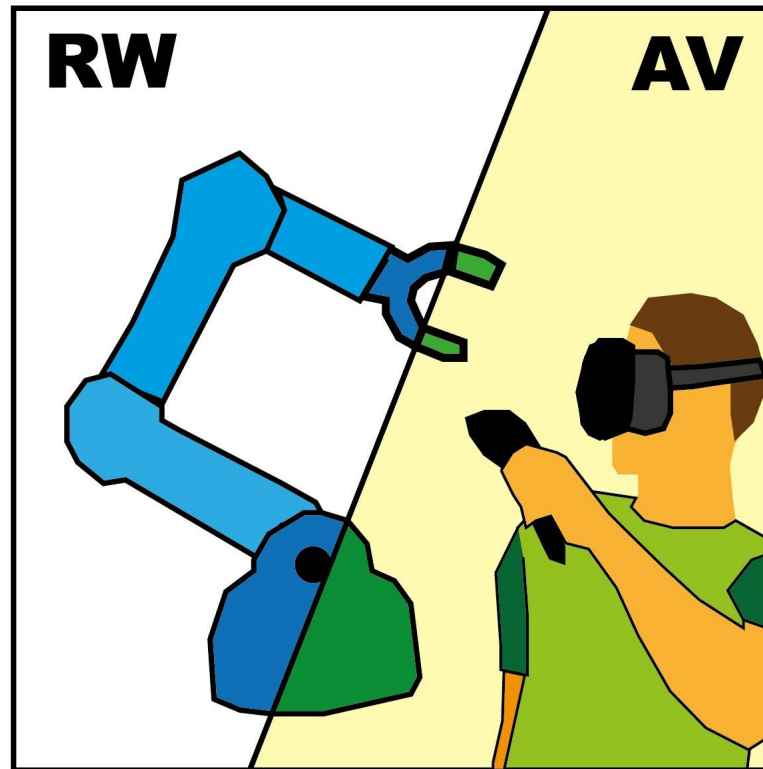
[Billinghurst et al., 2001]



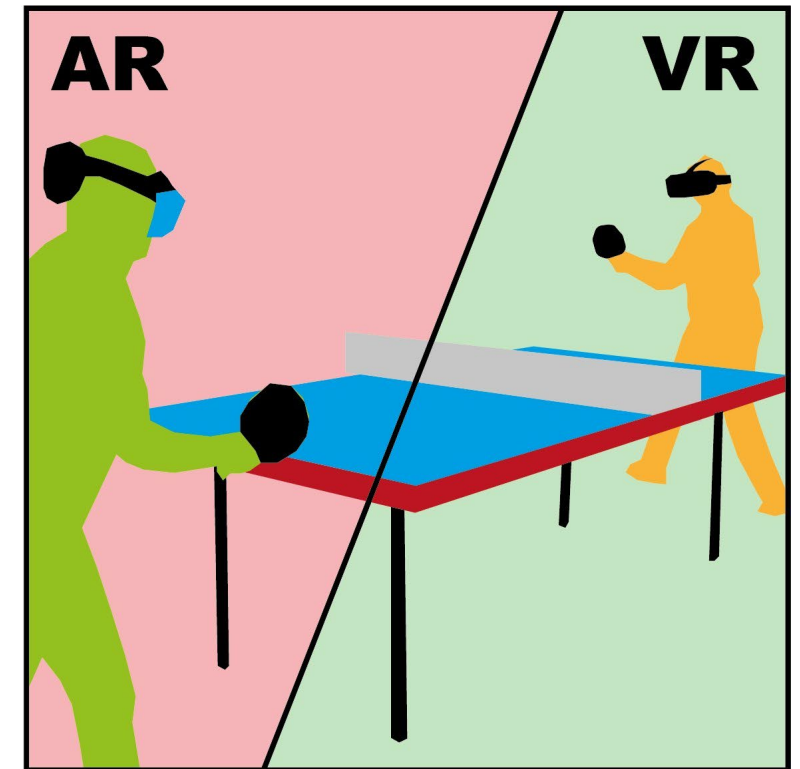
# A Scoping Survey on Cross-Reality Systems



Type I: Transitional



Type II: Substitutional

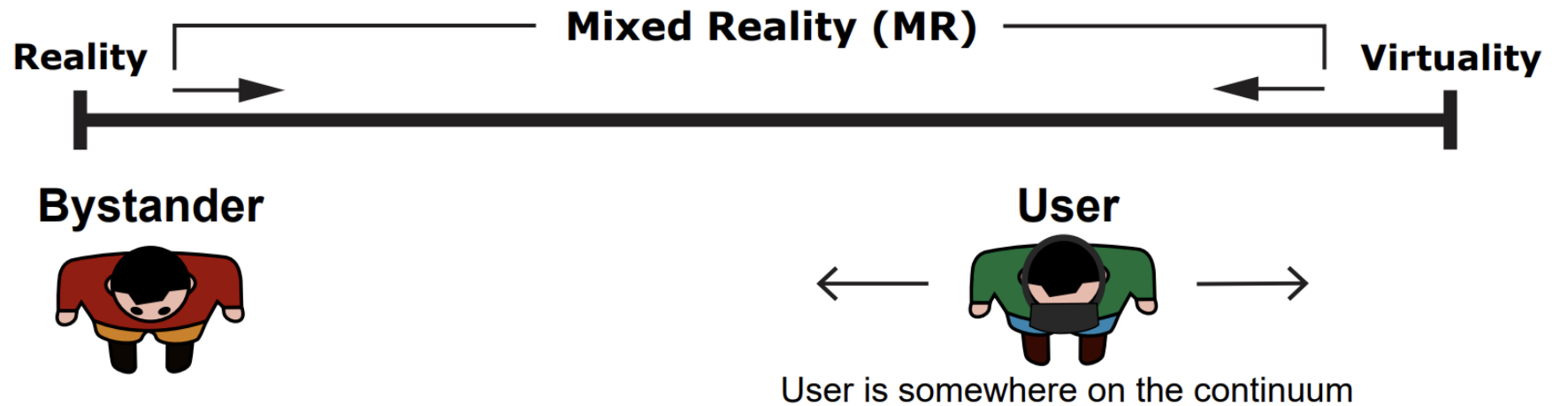


Type III: Multi-User

Auda, J., Gruenefeld, U., Faltaous, S., Mayer, S., & Schneegass, S. (2023).  
A Scoping Survey on Cross-Reality Systems. ACM Computing Surveys.



# It Takes Two To Tango



<b>Isolated Experiences</b>	●	far away, no transition	●
<b>Bystander Inclusion</b>	● → ●	uni-directional transition	●
<b>Collaboration</b>	● → ●	bi-directional transition	● ← ●

Auda, Jonas, Gruenefeld, Uwe, & Mayer, Sven (2020). It Takes Two To Tango: Conflicts Between Users on the Reality-Virtuality Continuum and Their Bystanders. In XR@ ISS.

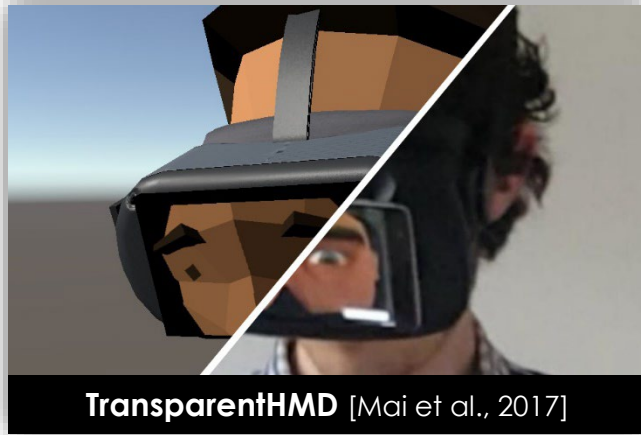
# Challenge: Prototyping





# VRception: Showcases

**XR → Real World**



**Real World → XR**



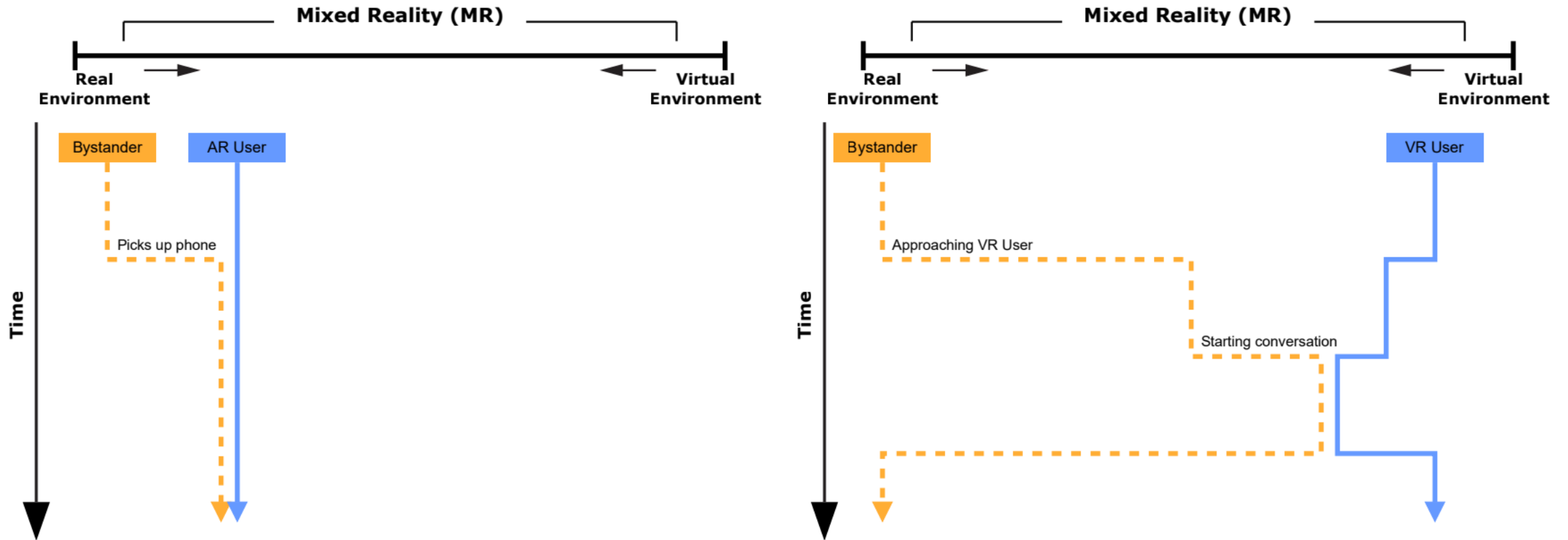
**Real World ↔ XR**





# Challenge: Understanding

# The Actuality-Time Continuum



Auda, Jonas, Faltaous, Sarah, Gruenefeld, Uwe, Mayer, Sven & Schneegass, Stefan (2023).  
The Actuality-Time Continuum: Visualizing Interactions and Transitions Taking Place in  
Cross-Reality Systems. In JWCR @ ISMAR.

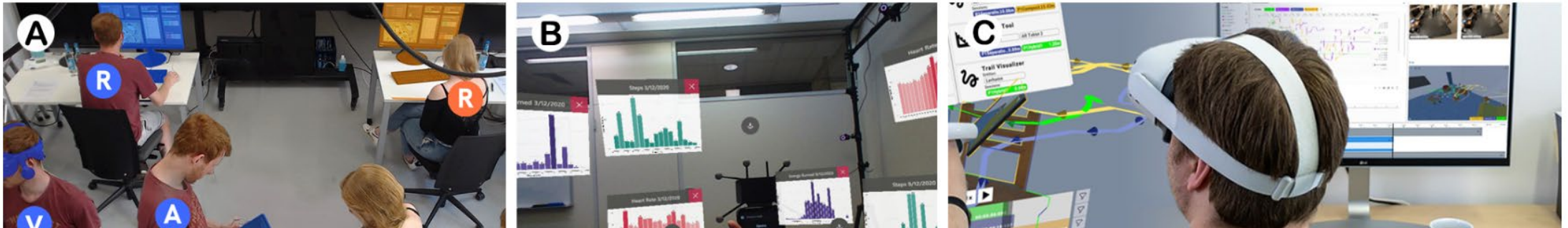


# 1st Joint Workshop on Cross Reality

to be held in conjunction with the IEEE International Symposium on Mixed and Augmented Reality (ISMAR 2023)

## Scope of the Workshop

Cross Reality (CR) is an emerging technology that focuses on the concurrent usage of or the transition between multiple systems at different points on the reality-virtuality continuum (RVC), including Virtual Reality (VR), Augmented Virtuality (AV), and Augmented Reality (AR). CR has gained significant attention in recent years due to its potential for revolutionizing various research and industry areas where users need to comprehend and explore spatial data and its relevant information in different forms. It is expected that in the near future, more CR applications will arise to allow users to transition along the individual stages of the RVC or to collaborate in-between these stages to use their distinct advantages and mitigate their potential problems.



<https://cross-realities.org>

Taking place on the 16th of October

# Take-Away Message

# Take-Away Message

- AR and VR perceived as distinct technologies
- They will merge to form cross-reality systems
- Many low-hanging fruits (open challenges)
  
- What **challenges** remain unsolved? Will **cross reality** replace **mixed reality**?

  
All materials



---

## Cross Reality: The Convergence of AR and VR Technology

Dr. Uwe Gruenefeld ([uwe.gruenefeld@uni-due.de](mailto:uwe.gruenefeld@uni-due.de))

 [UweGruenefeld](#)  [@UweGruenefeld](#)  [Uwe-Gruenefeld](#)

**FALUNO**  
The Ruhr Institute for Software Technology

