

PROGRAMMING ABSTRACTIONS for AUGMENTED WORLDS

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ABOUT AUGMENTED WORLDS

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- Augmented/Mixed Reality
 - merging real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real-time
 - recent technology boost
 - Microsoft Hololens, Magic Leap, Google Project Tango, Meta systems, ...

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(Microsoft Hololens)



(Meta)





(Microsoft Hololens demo - Project X-ray, October 2015)



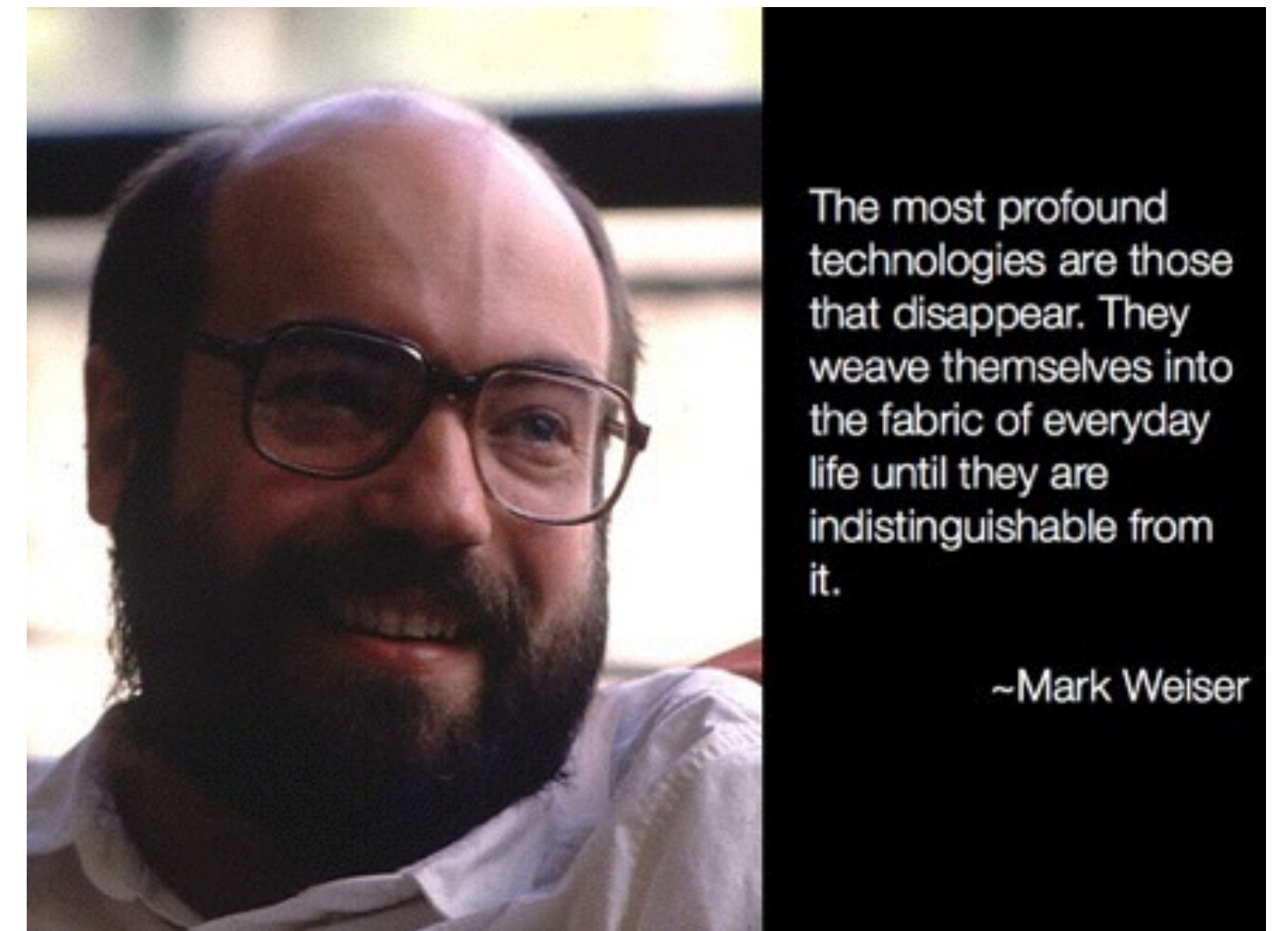
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DIFFERENT FORMS OF AUGMENTATION

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- pervasive/ubiquitous computing and IoT
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The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.

~Mark Weiser

DIFFERENT FORMS OF AUGMENTATION

- Integrating further forms of augmentation besides AR/MAR
- pervasive/ubiquitous computing and IoT
 - *augmentation of the environment*
- wearable/mobile computing
 - *human augmentation*



(Thad Starner)



“COMPUTATION AS AUGMENTATION” PERSPECTIVE

Back to Engelbart's work (1962)
- framework for human intellect augmentation

MAIN IDEA & OBJECTIVE

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 - novel and interesting issues
 - blueprint for developing new kinds of software systems & applications
 - e.g. hands-free systems, collaborative environments

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 - blueprint for developing new kinds of software systems & applications
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- Focus
 - looking for *high-level computation and programming abstractions* and frameworks for designing and programming augmented worlds
 - interesting context for applying concurrent objs, actors, agents...

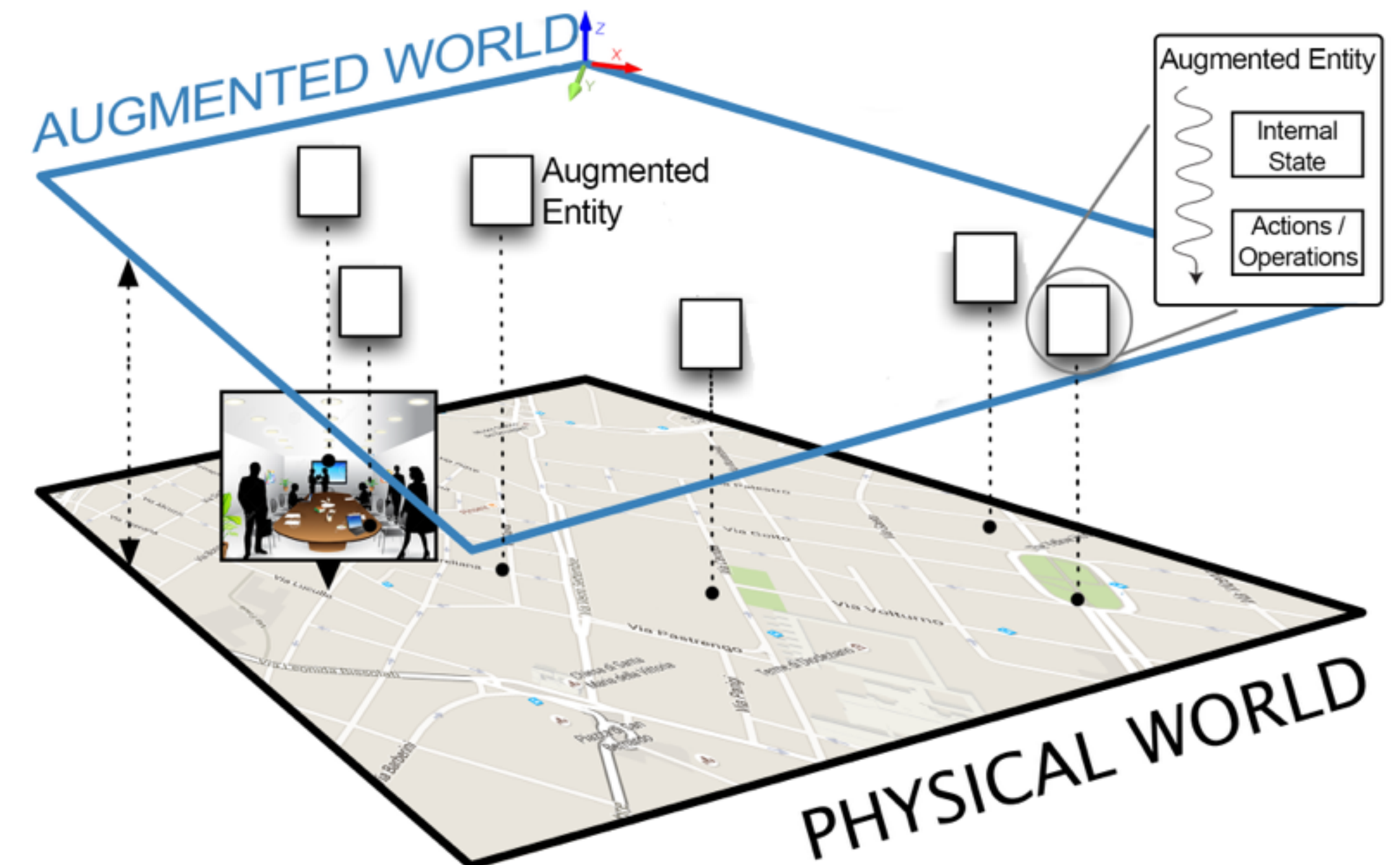
RELATED WORKS

- Location-based applications and Context-Aware computing
- Online multi-user distributed collaborative environments
 - e.g. Croquet
- Spatial Computing
 - physical space as first-order concept of the computational layer

AUGMENTED ENTITY ABSTRACTION

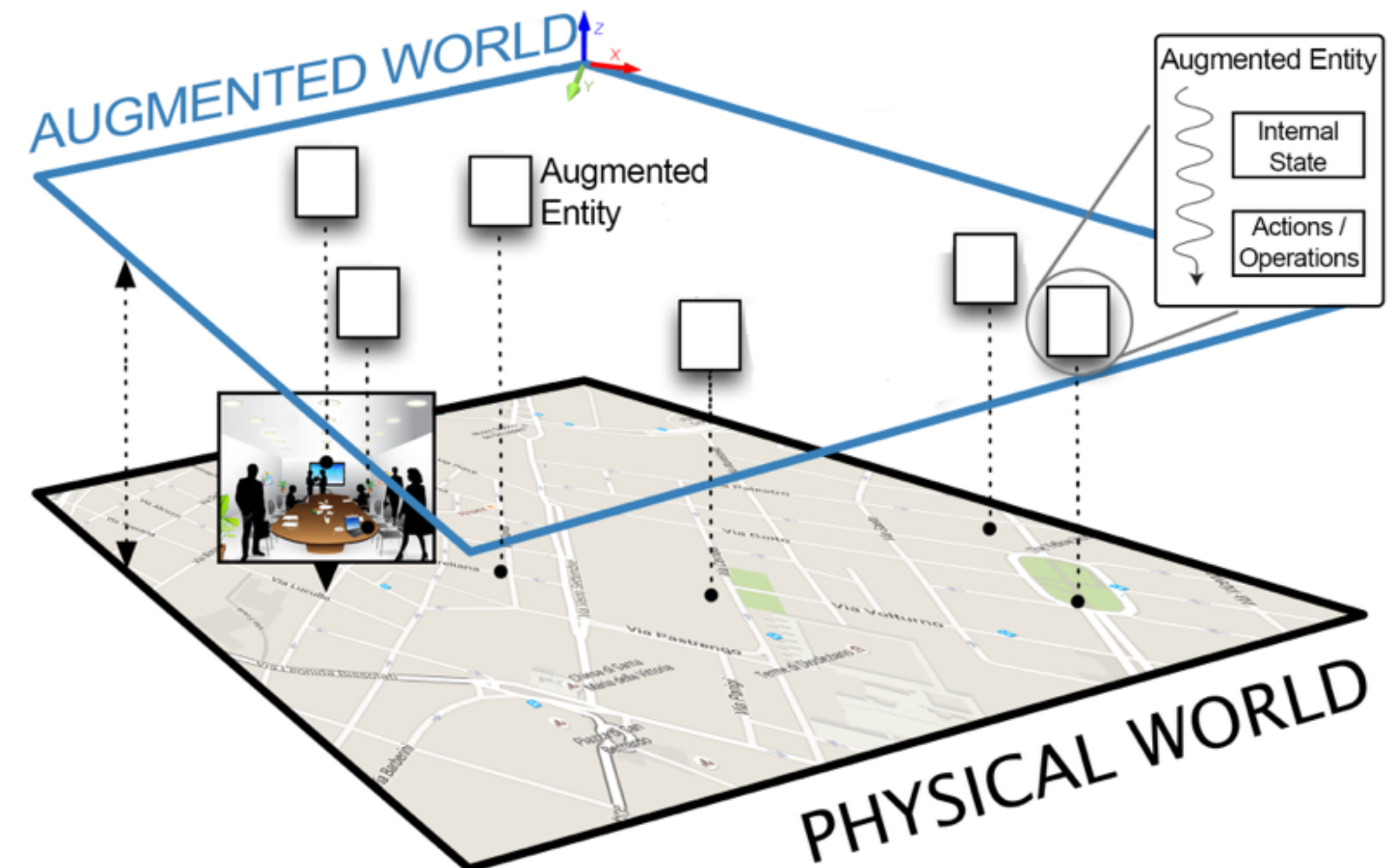
AUGMENTED ENTITY ABSTRACTION

- Augmented worlds shaped in terms of augmented entities
 - full-fledged computational objects
 - state+behaviour



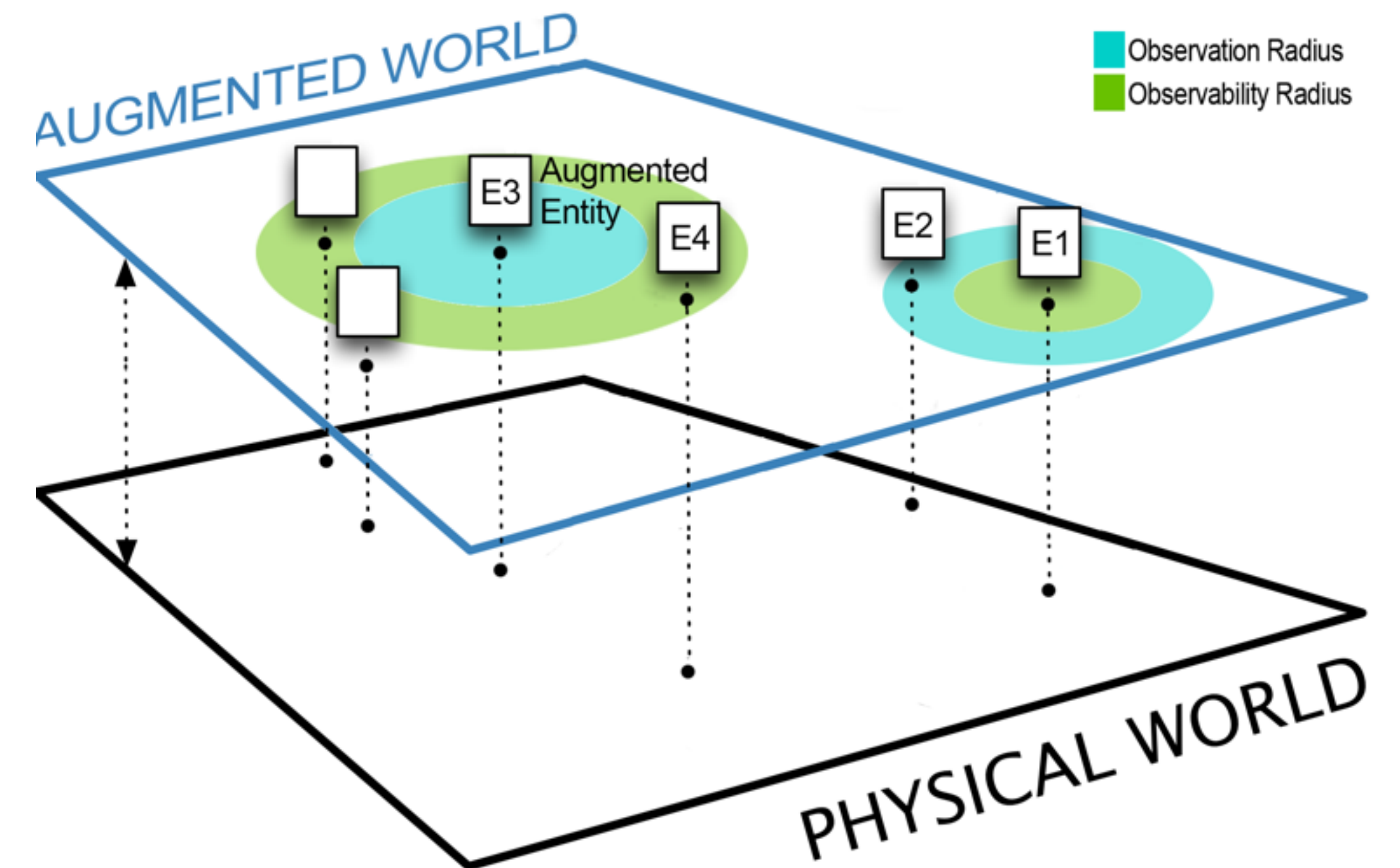
AUGMENTED ENTITY ABSTRACTION

- Augmented worlds shaped in terms of augmented entities
 - full-fledged computational objects
 - state+behaviour
- **Spatial coupling**
 - location & extension
 - explicit system of reference



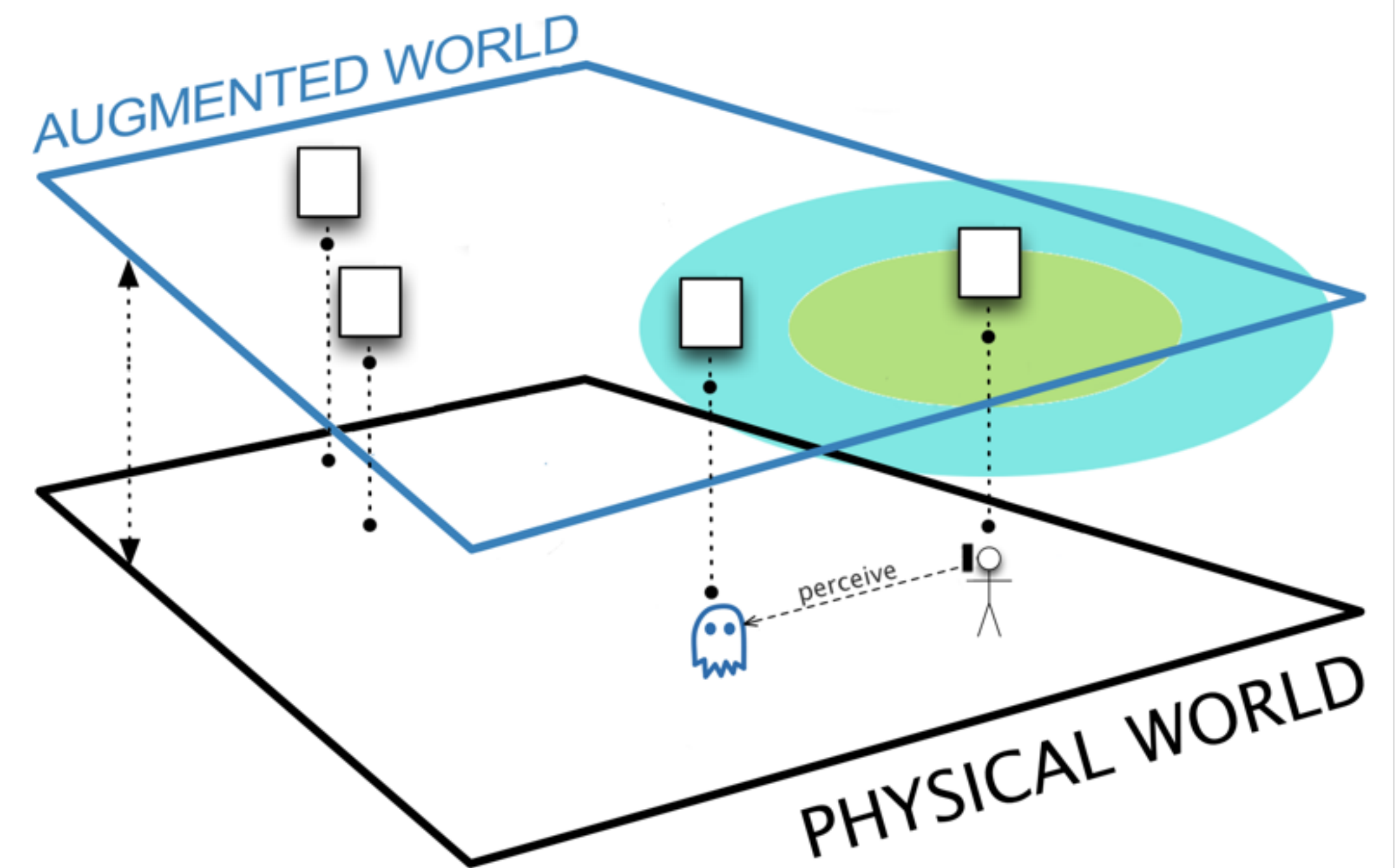
AUGMENTED ENTITY ABSTRACTION

- **Discovery and Observability**
 - lookup based and event-driven observation
 - location/distance-based filters



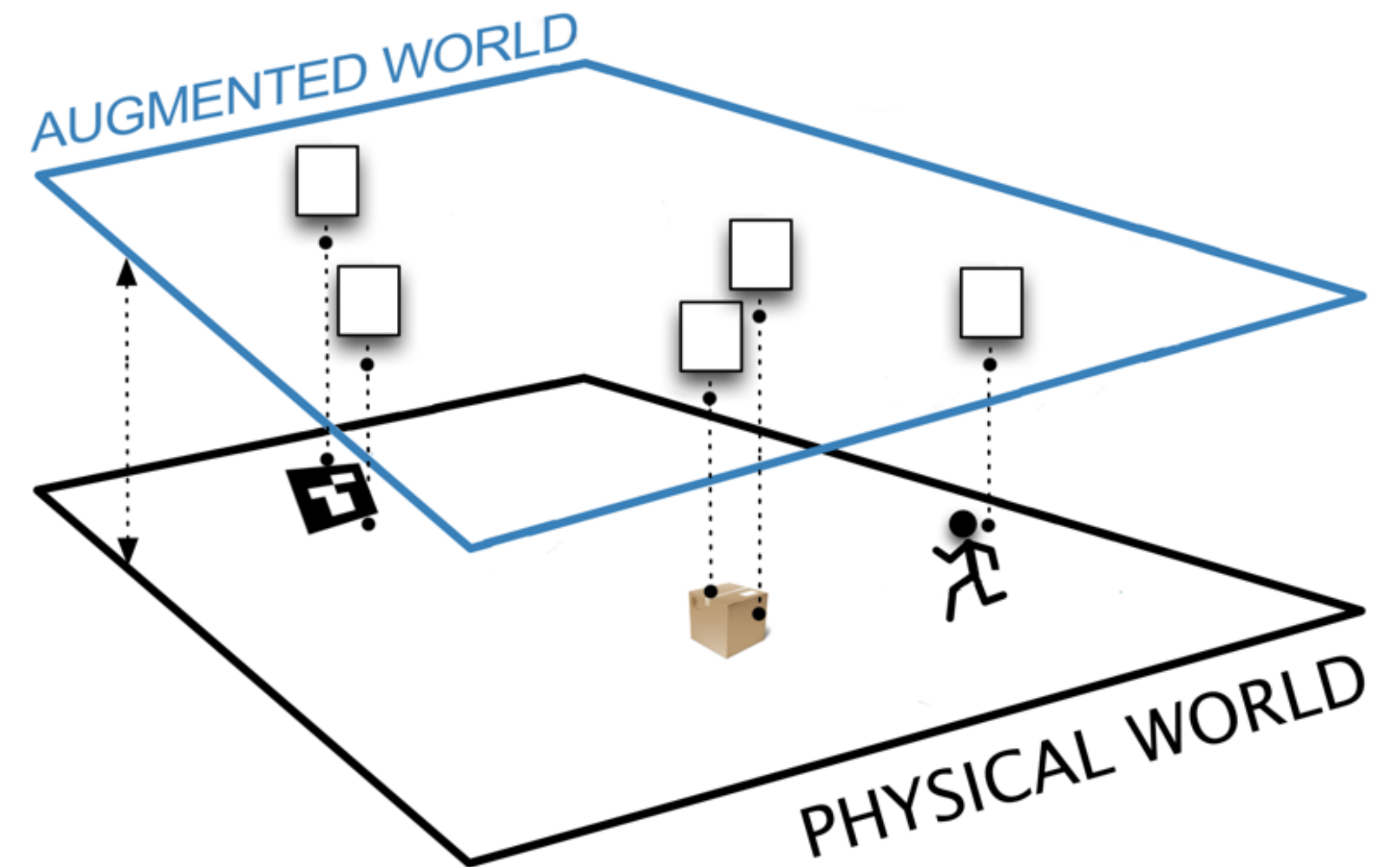
AUGMENTED ENTITY ABSTRACTION

- **User modelling and interaction**
 - user explicitly modelled inside the AW by proper augmented entities
 - making them observable
 - allowing them to perceive the other entities
 - multi-user applications



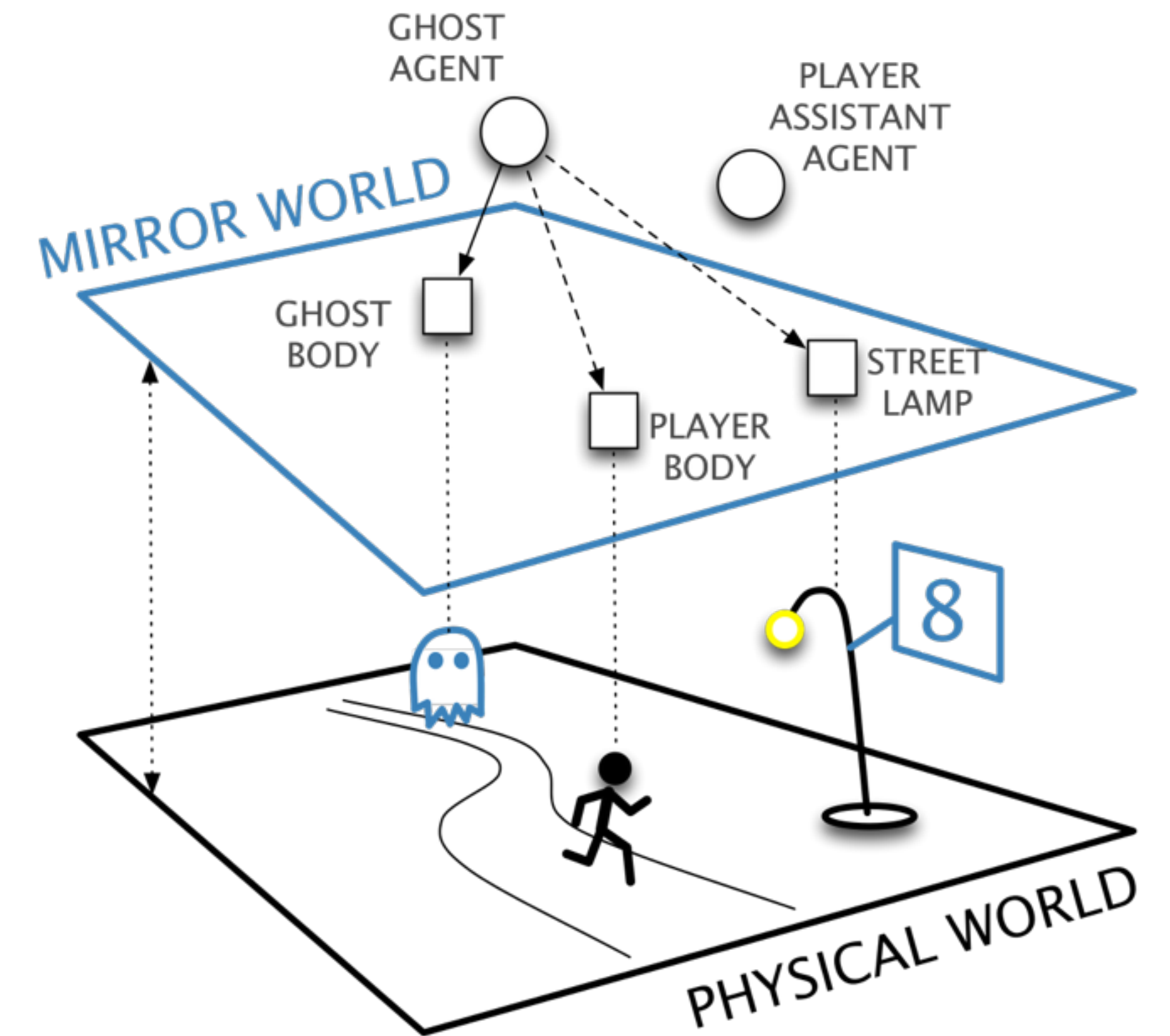
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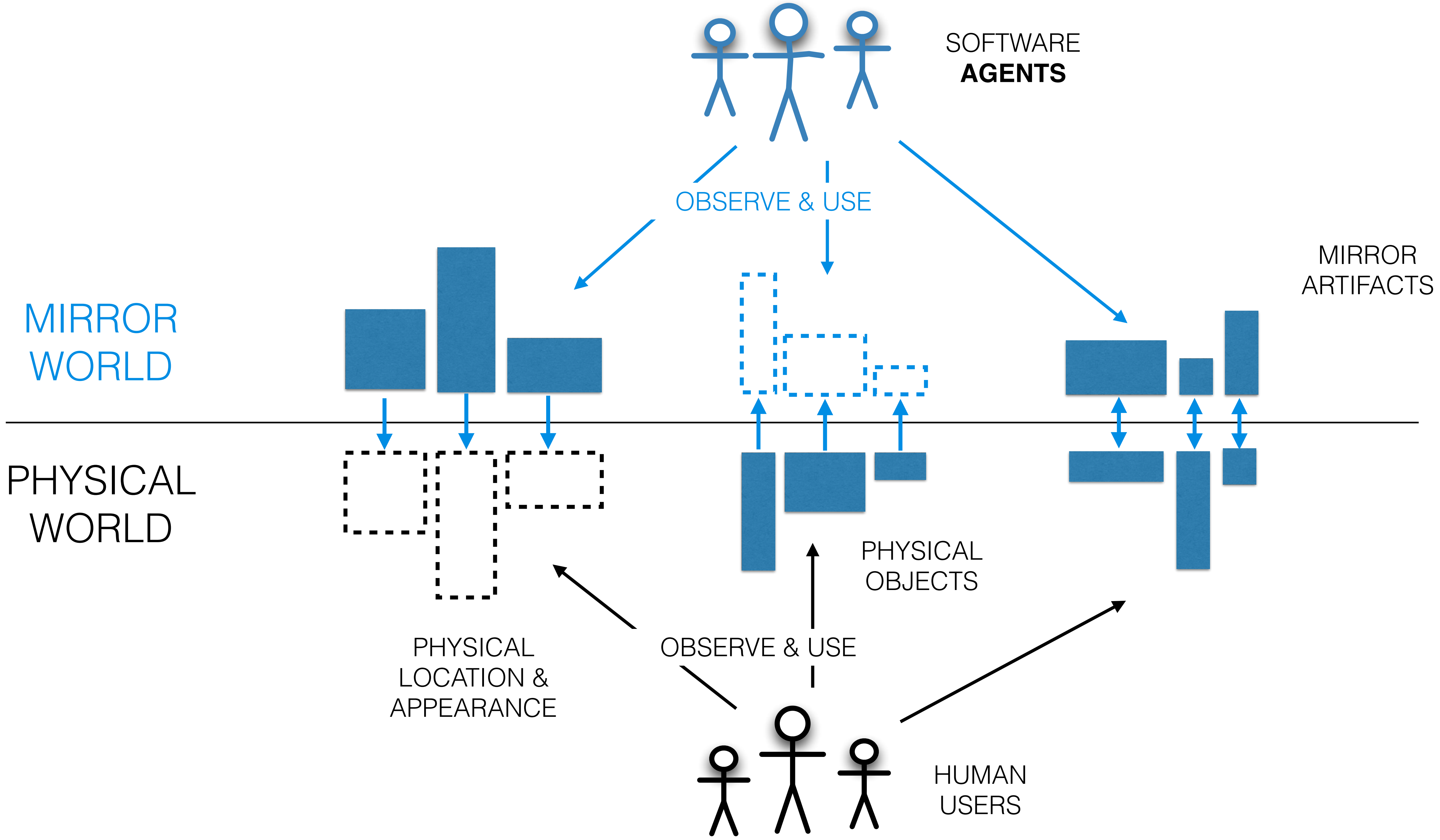
- **Physical embedding & coupling**
 - coupling augmented entities to physical objects or phenomena
 - state synchronisation



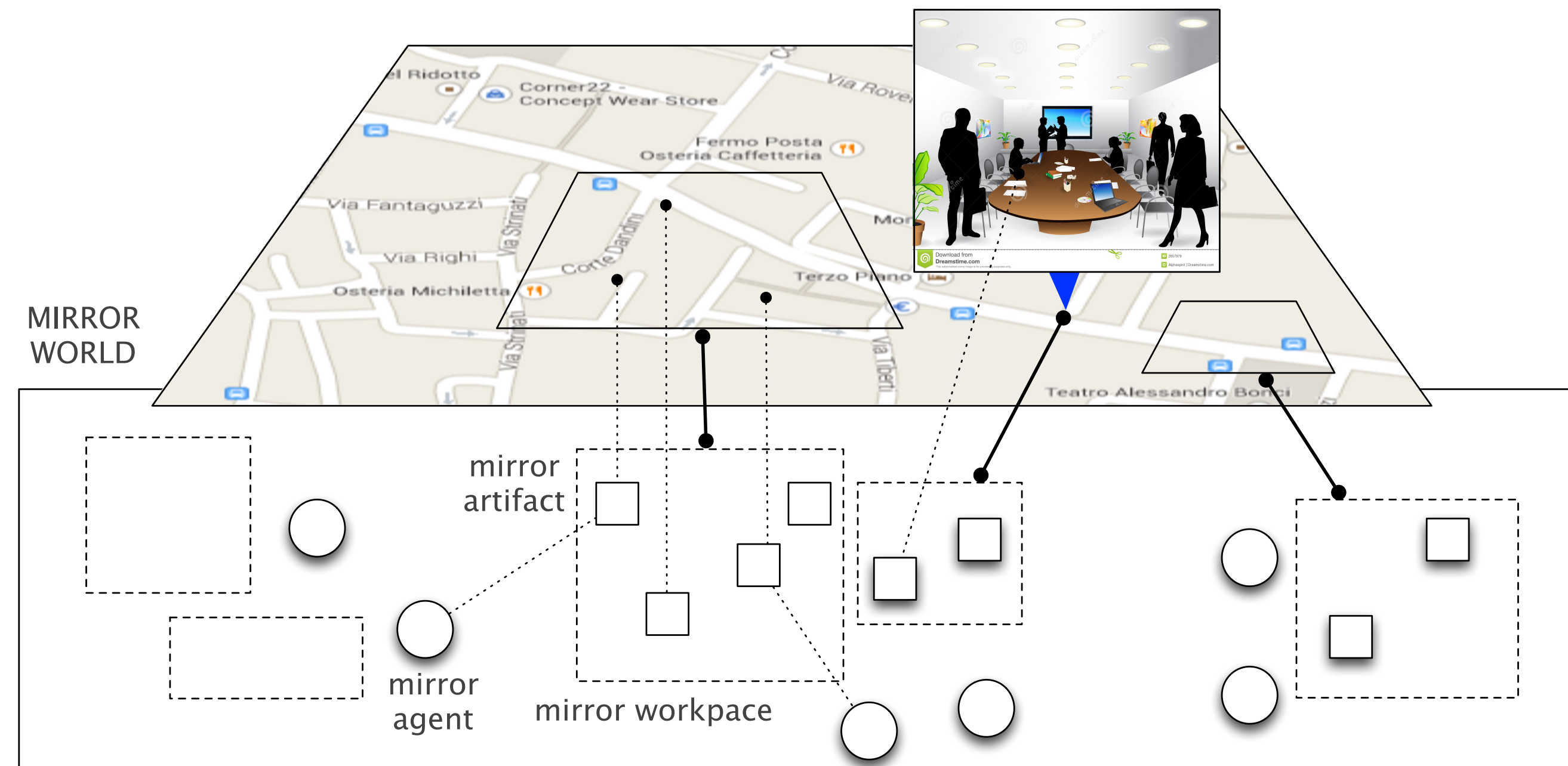
THE MIRROR WORLD MODEL

- Augmented worlds programmed as a multi-agent system
 - **agents**
 - autonomous citizens of the augment world, observing and manipulating the augmented entities
 - **agents' environment**
 - set of ~objects (called mirror artifacts) representing the augmented entities



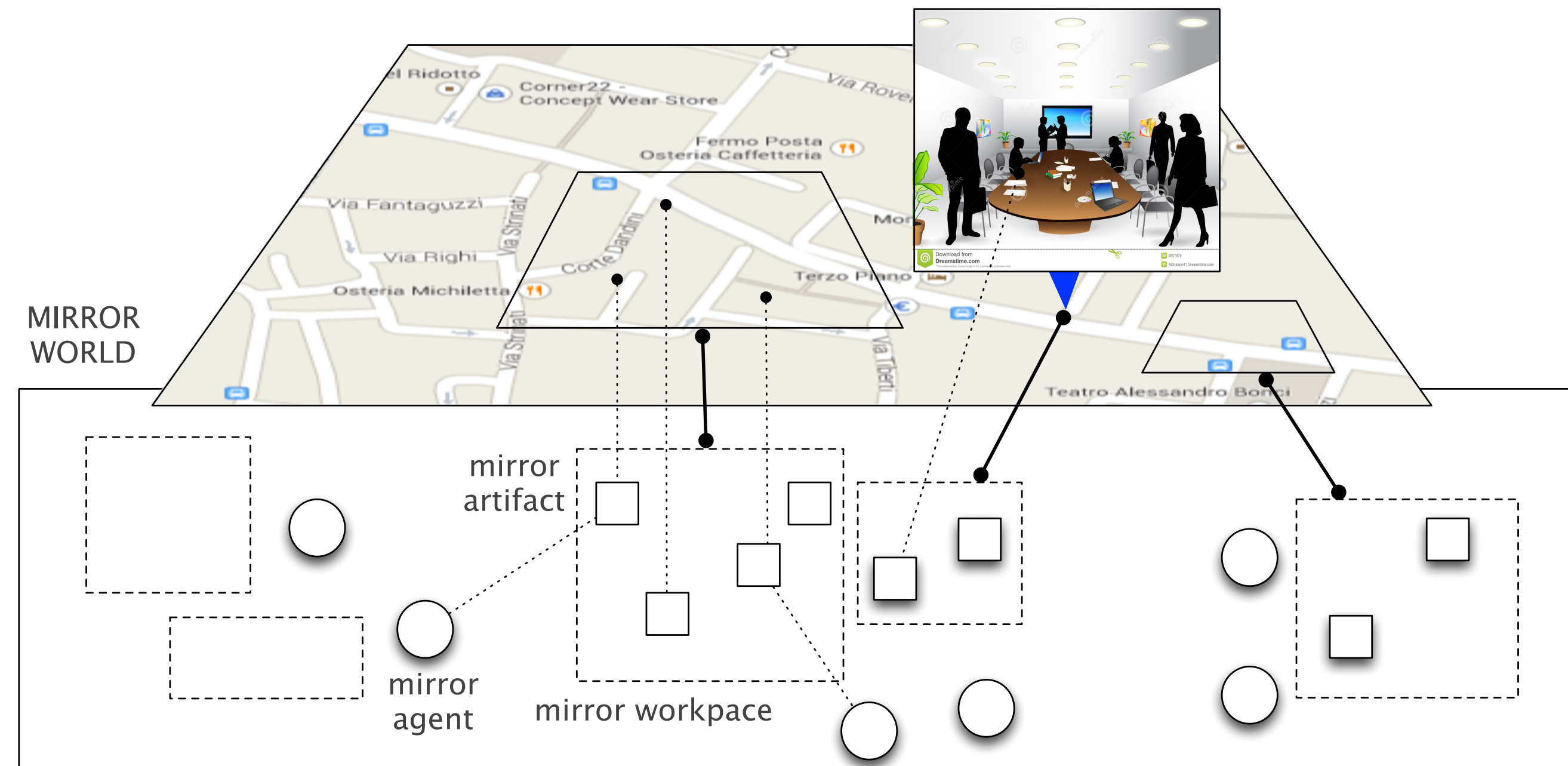


A FIRST PLATFORM FOR MIRROR WORLDS



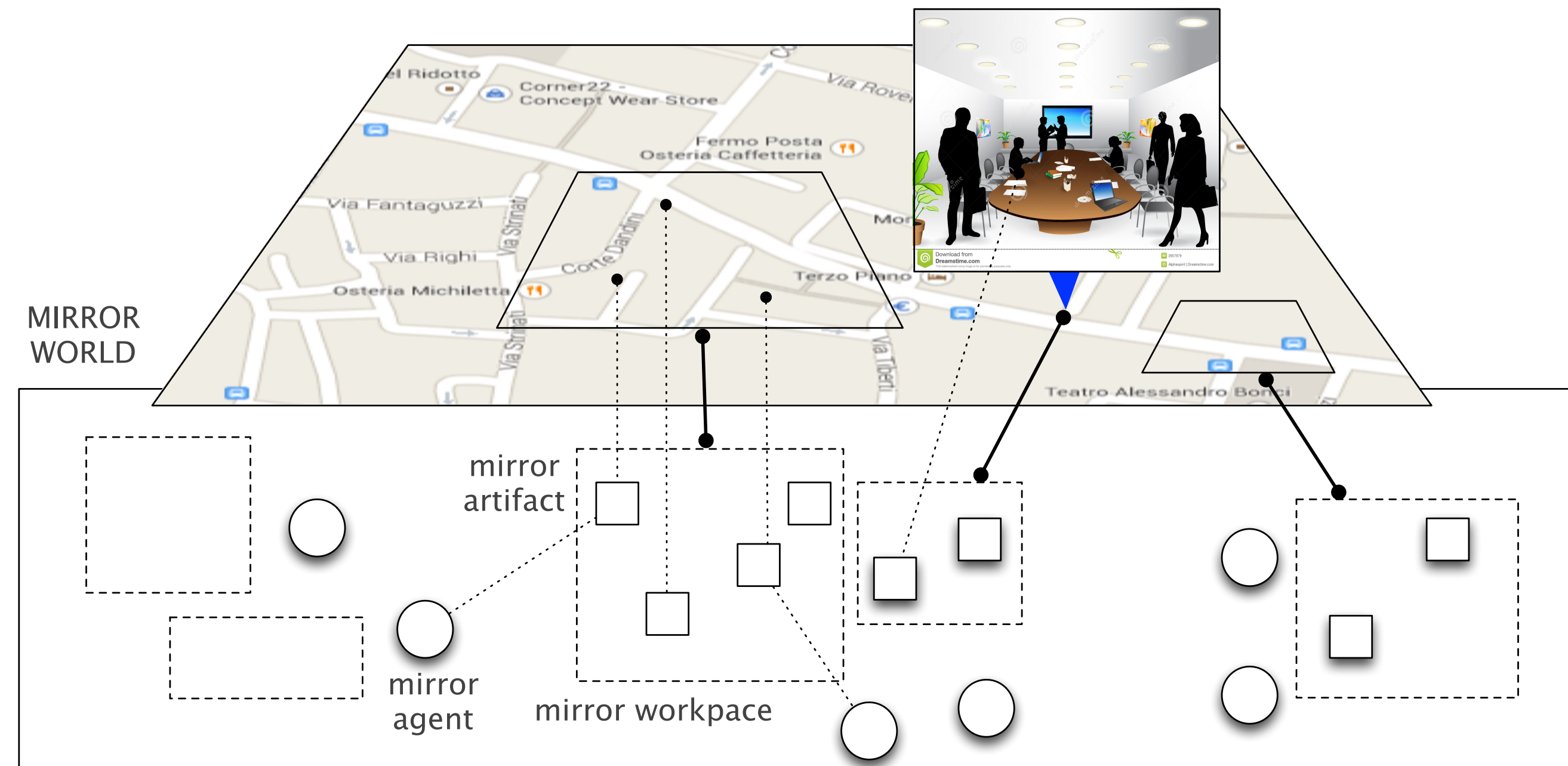
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- Based on JaCaMo Framework for multi-agent programming
 - Jason agent programming language + CArtAgO Java API for implementing the environment

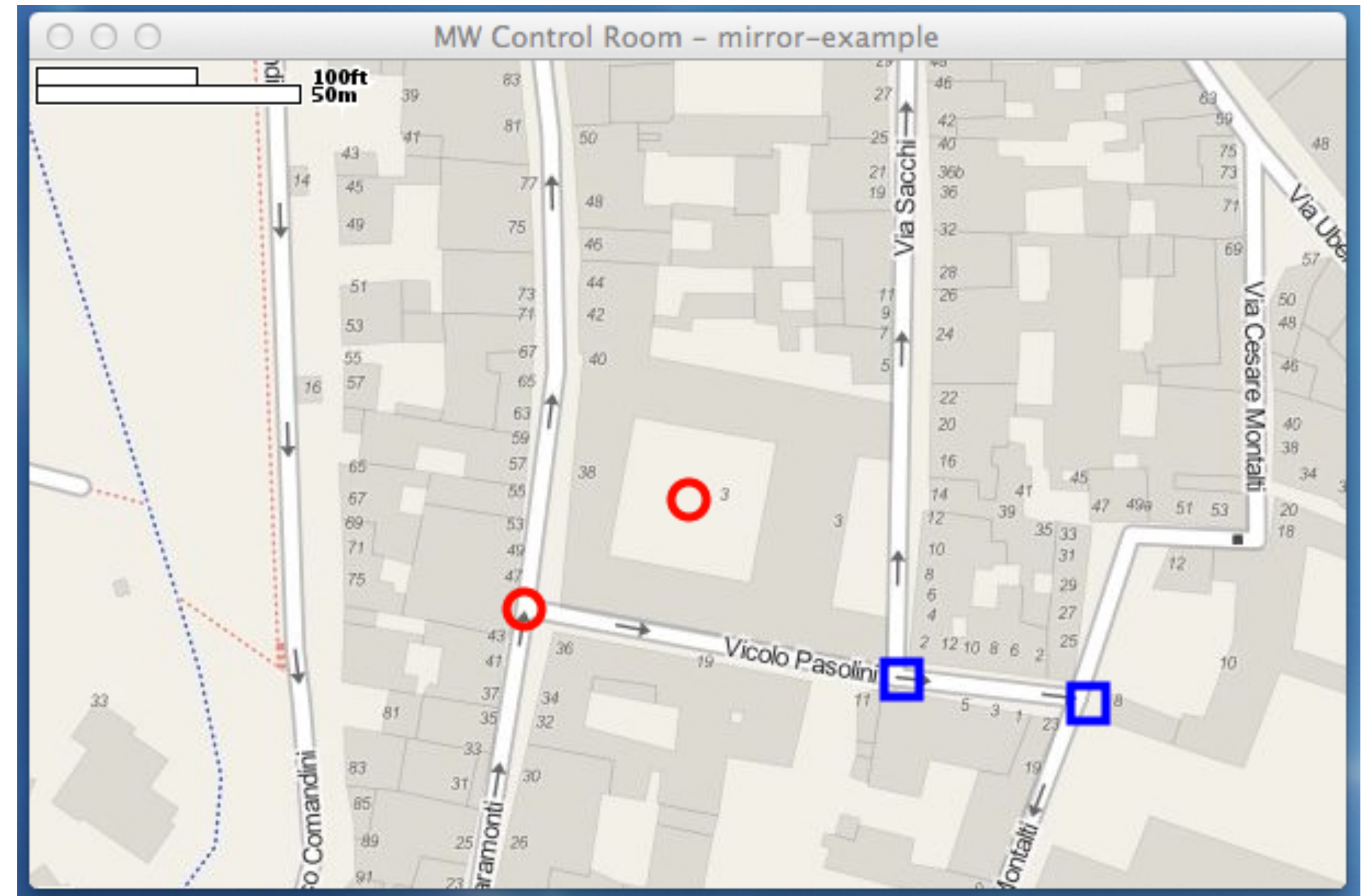
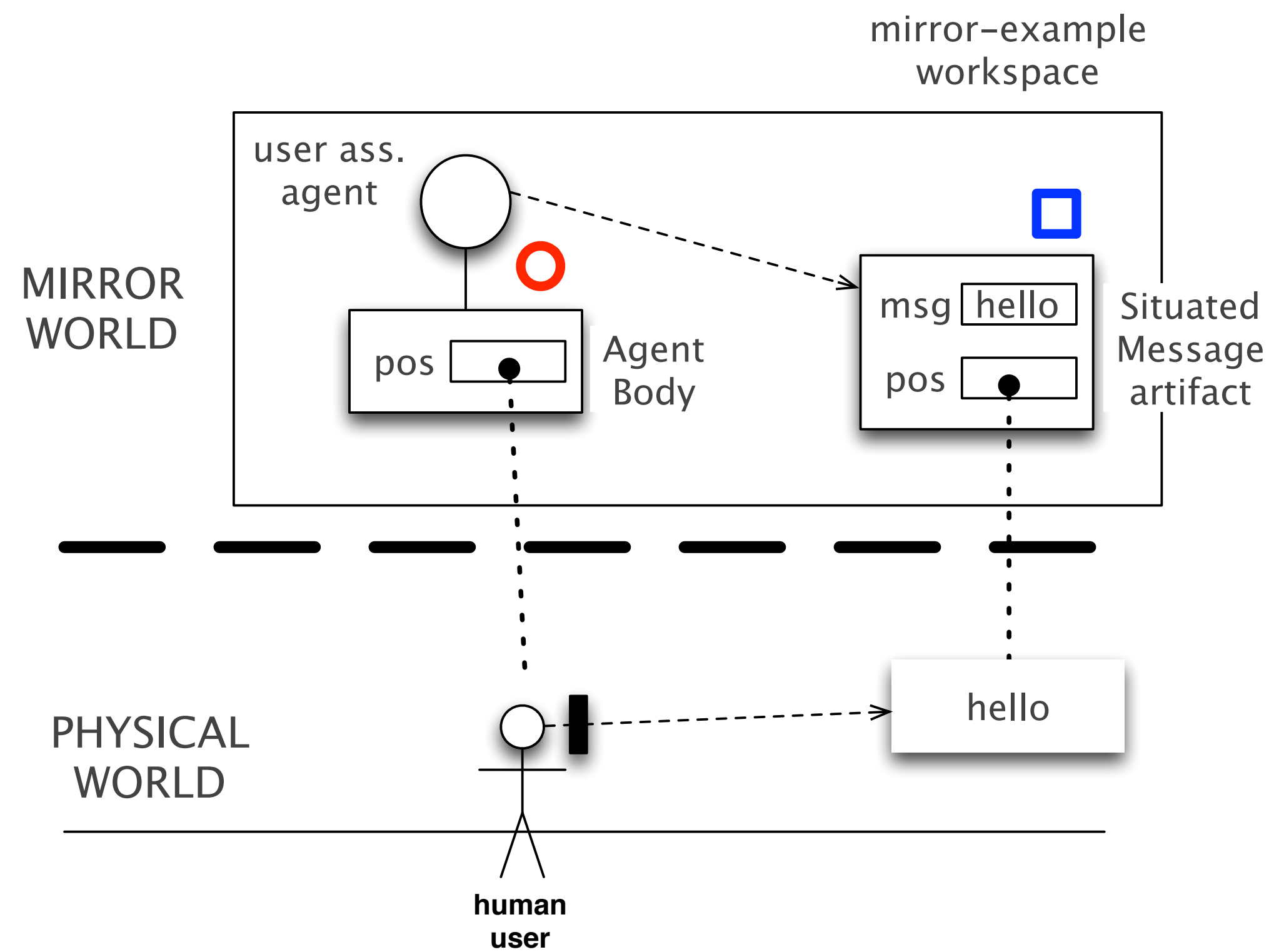


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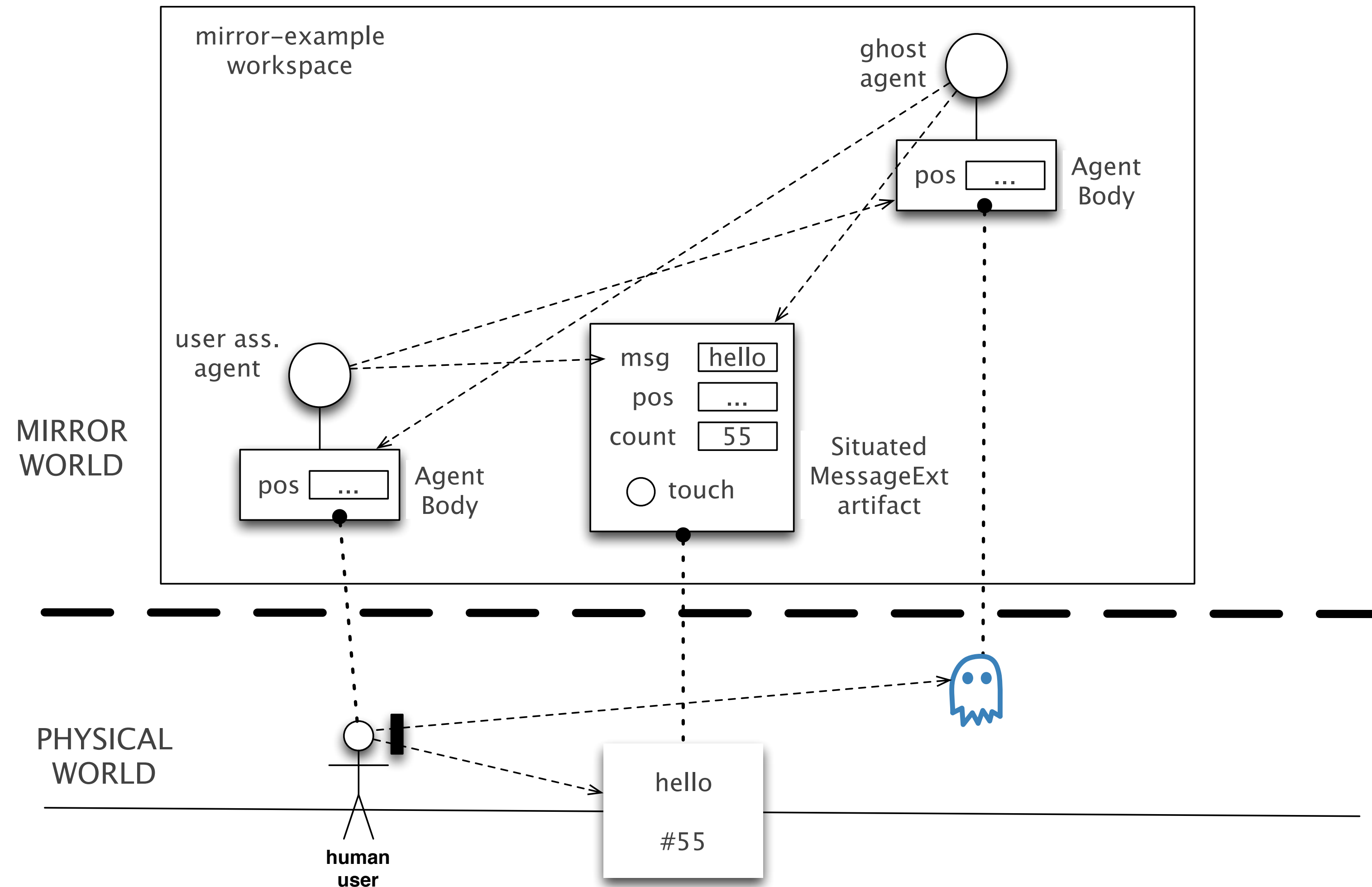
- Based on JaCaMo Framework for multi-agent programming
 - Jason agent programming language + CArtAgO Java API for implementing the environment
- API for developing a MW as a “normal” agent-based systems
 - API for implementing augmented entities as mirror artifacts
 - API for allowing agents to discover/manipulate augmented entities



EXAMPLE #1: “HELLO, MIRROR WORLD!”



EXAMPLE #2: GHOSTS AND TRACES



RESEARCH AGENDA

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- Exploring augmented world programming and development
 - principles and techniques
 - modularity, compositionality, reusability & extensibility
 - supporting tools
 - debugging, profiling, simulating

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 - supporting tools
 - debugging, profiling, simulating
- Real-world case studies
 - collaborative hands-free systems for rescue

CHALLENGES

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 - real-time, distribution

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- Synchronization between the physical layer and the mirror layer
 - real-time, distribution
- Low-level/enabling-layer challenges
 - AR-related - location, tracking, registration