

TOWARDS THE ENGINEERING OF AGENT-BASED **AUGMENTED WORLDS**

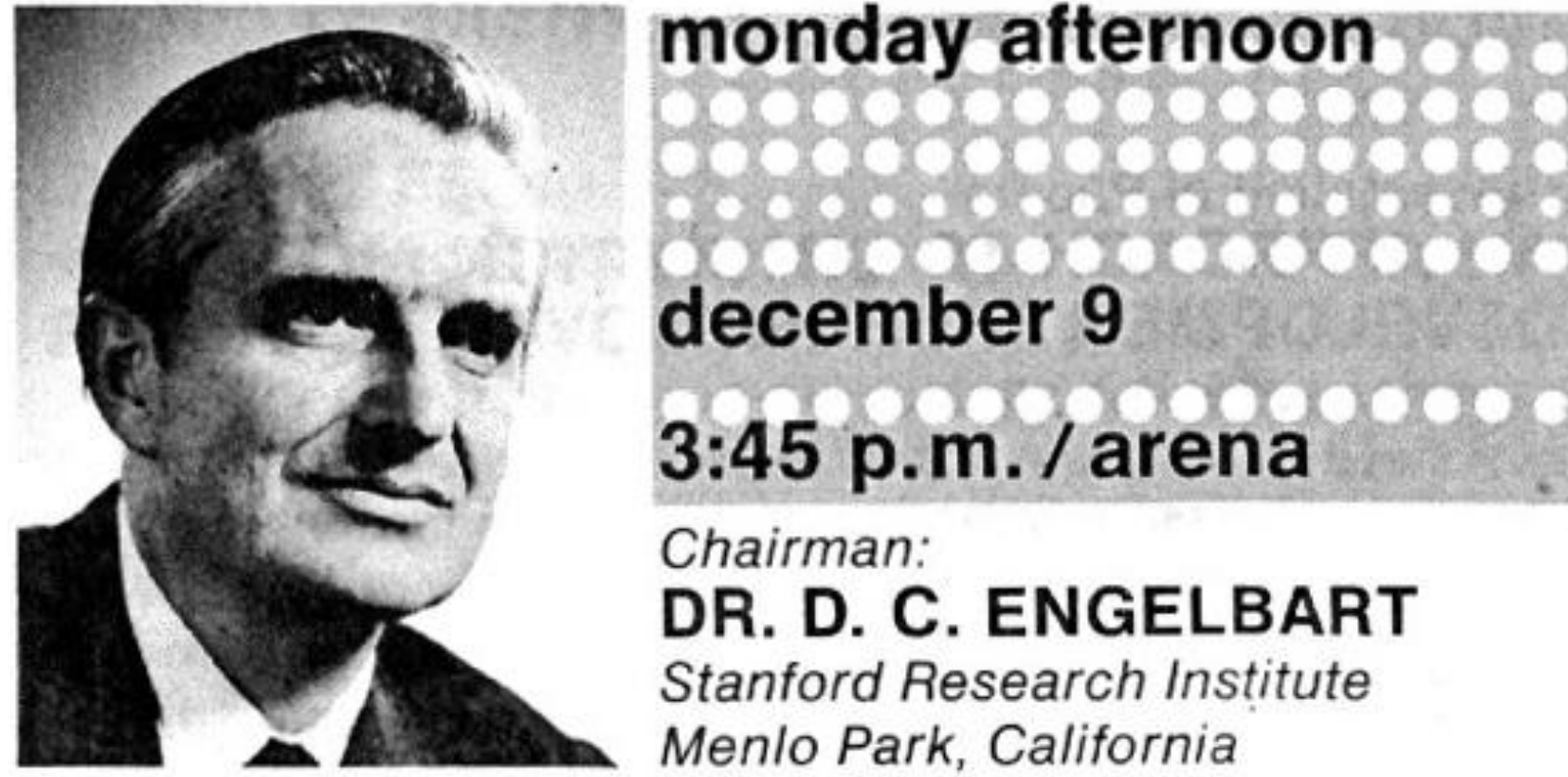
Angelo Croatti, Alessandro Ricci

DISI - University of Bologna - Italy

EMAS 2017

“AUGMENTATION”

“AUGMENTING HUMAN INTELLECT” FRAMEWORK (1962)

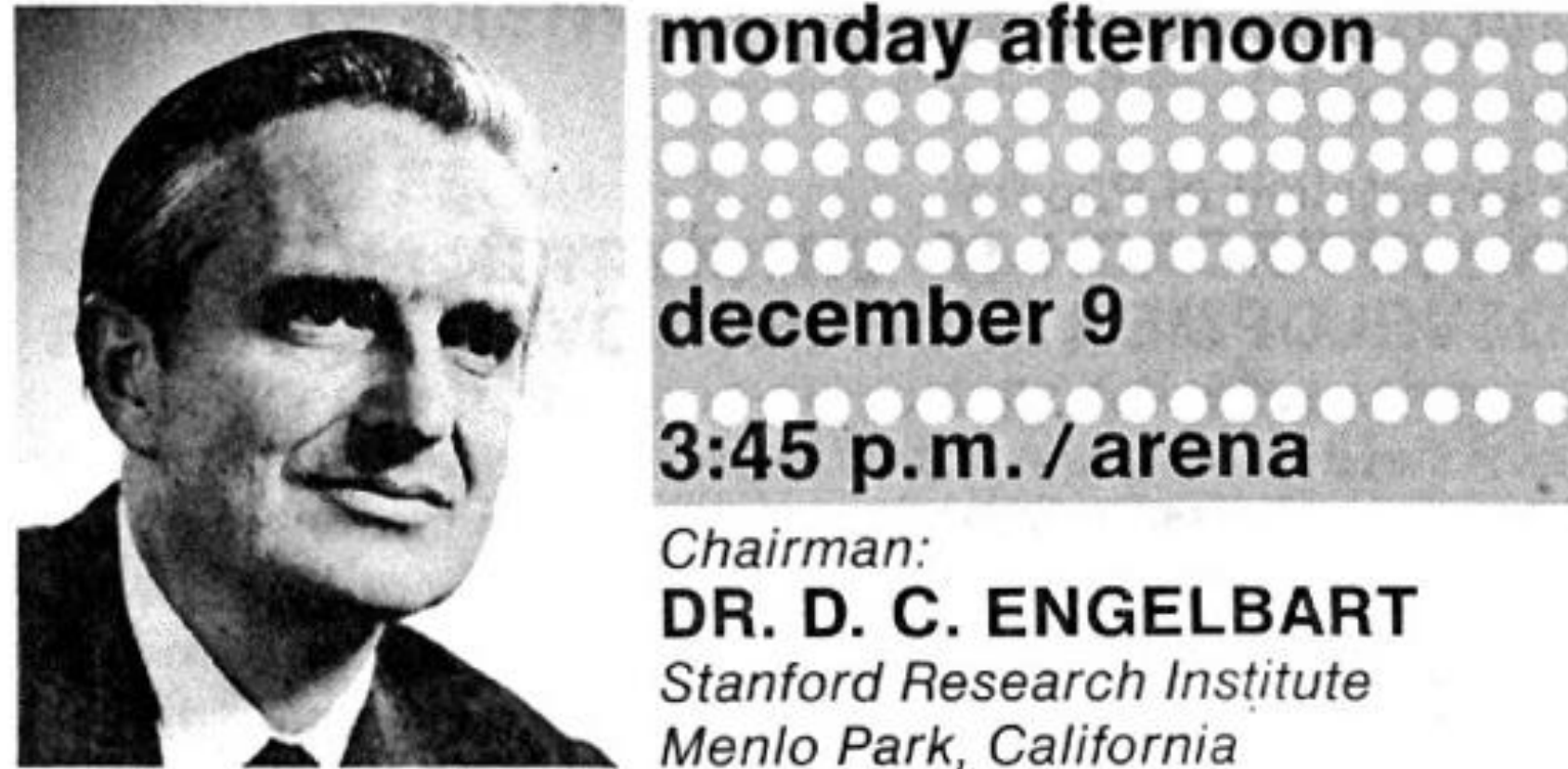


**a research center
for augmenting human
intellect**

(DOUG ENGELBART, 1962/1968)

<http://www.1968demo.org/>

“AUGMENTING HUMAN INTELLECT” FRAMEWORK (1962)



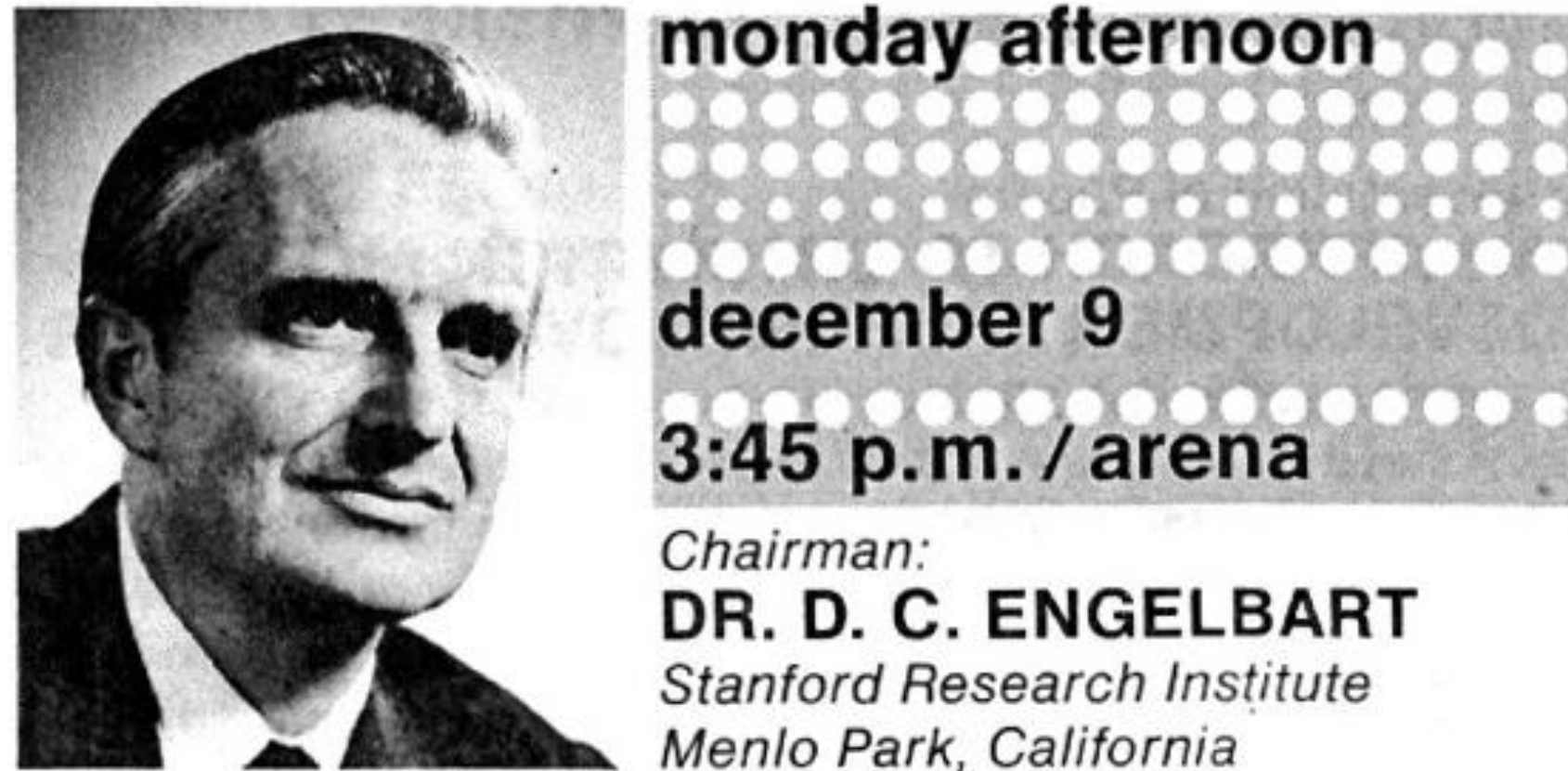
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*"we mean **increasing the capability** of a man
to approach a complex problem situation,
to **gain comprehension** to suit his particular
needs, and to **derive solutions** to problems"*

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*"we mean **increasing the capability** of a man
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needs, and to **derive solutions** to problems"*

*"**more-rapid** comprehension, **better**
comprehension, the possibility of gaining a
useful degree of comprehension in a
situation that previously was too complex,
speedier solutions, better solutions, and the
possibility of **finding solutions** to problems
that before seemed insoluble"*

“AUGMENTED WORLDS” (AW)

- Augmentation of the *physical environment*
 - **augmented reality & pervasive computing**
- augmentation of the *human users*
 - **wearable computing**

AUGMENTED & MIXED REALITY

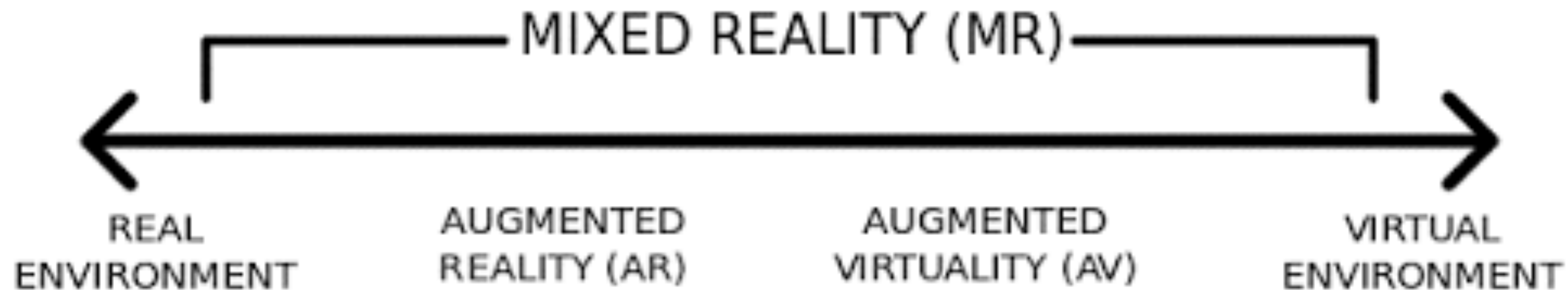
AUGMENTED & MIXED REALITY

*“Merging of **real** and **virtual** worlds to produce new environments and visualizations where physical and digital objects **co-exist** and **interact** in **real time**”*

"Understanding Augmented Reality" - by Alan B. Craig

AUGMENTED & MIXED REALITY

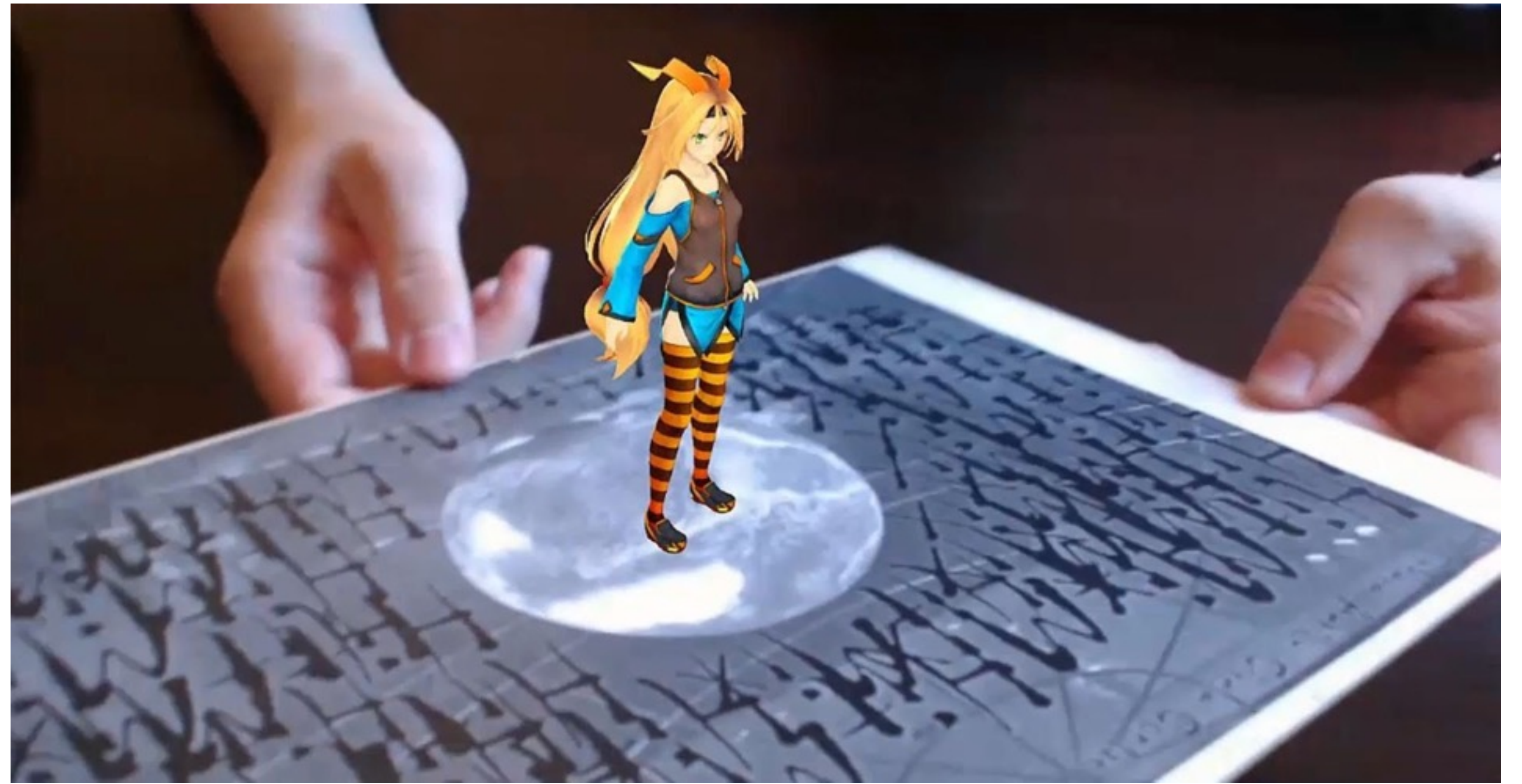
*“anywhere between the extrema of the **virtuality continuum**”* [Milgram, Kishino]



“MERGING” (REGISTRATION)

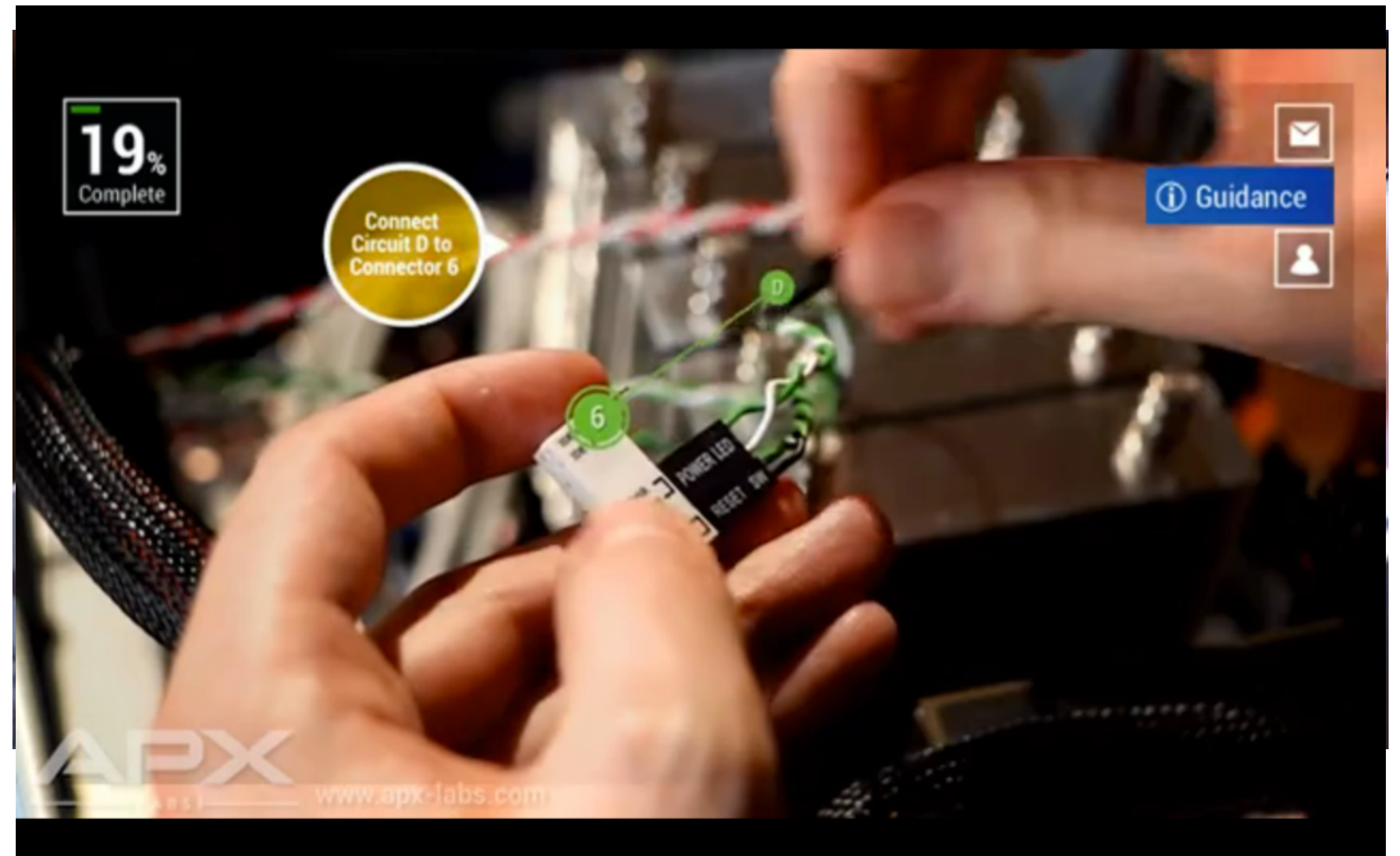
“MERGING” (REGISTRATION)

- Indoor / outdoor AR/MR
 - computer vision & sensor-based techniques



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“MERGING” (REGISTRATION)

- Indoor / outdoor AR/MR
 - computer vision & sensor-based techniques
 - fiducial markers, GPS, depth-sensors,...
- **Hologram** perspective
 - Microsoft Hololens, Meta2, Magic Leap...





www.Bandicam.com

(Microsoft HoloLens, Project X-ray, October 2015)



www.Bandicam.com

(Microsoft HoloLens, Project X-ray, October 2015)

AR/MR DEVICES

- Smartphones
- Head Mounted Display
 - smartglasses
 - visors
 - future (?): contact-lens



PHYSICAL ENVIRONMENT AUGMENTATION: PERVASIVE/UBIQUITOUS COMPUTING

(~90ies)

PHYSICAL ENVIRONMENT AUGMENTATION: PERVASIVE/UBIQUITOUS COMPUTING

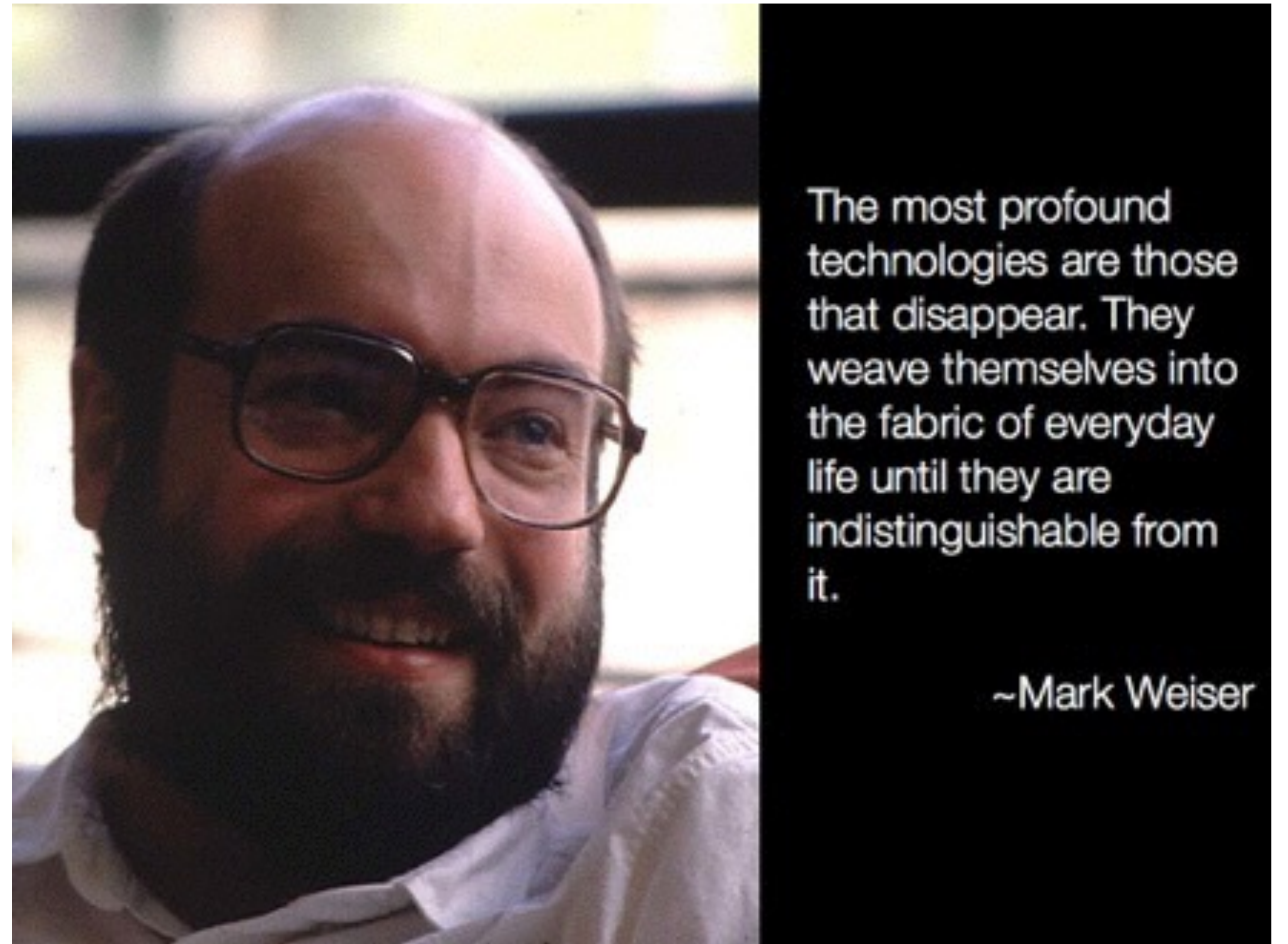
(~90ies)

- Enhancing the functionalities of physical environments and objects by means of embedded computational and network capabilities

PHYSICAL ENVIRONMENT AUGMENTATION: PERVASIVE/UBIQUITOUS COMPUTING

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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

HUMAN AUGMENTATION

HUMAN AUGMENTATION

WEARABLE
COMPUTING

EYEWER
COMPUTING

HUMAN AUGMENTATION

WEARABLE
COMPUTING

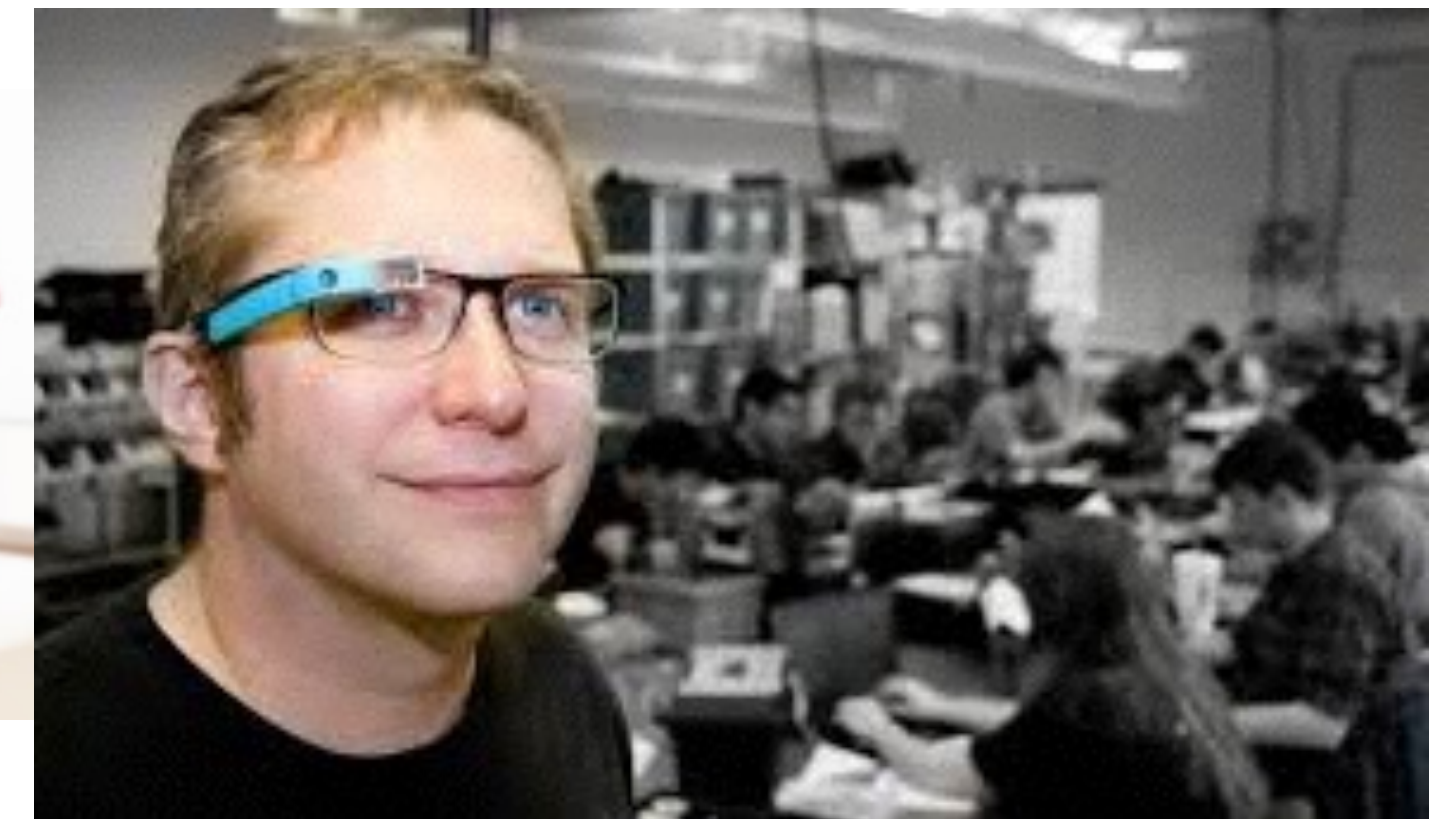
EYEWER
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HUMAN AUGMENTATION

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“HANDS-FREE” SYSTEMS

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- Exploiting computer-based functionalities and services ***on-the-go***, without interrupting your activities
 - wearable devices as “***extension of the self***”
 - T. Starner (IEEE Pervasive Computing - Volume 12 Issue 2, April 2013)

“HANDS-FREE” SYSTEMS

- Exploiting computer-based functionalities and services ***on-the-go***, without interrupting your activities
 - wearable devices as “***extension of the self***”
 - T. Starner (IEEE Pervasive Computing - Volume 12 Issue 2, April 2013)
- Strong impact on applications
 - maintenance & repair, manufacturing, healthcare, logistics, ...

WHAT AGENTS
CAN DO FOR AW?

WHAT AGENTS CAN DO FOR AW?

- Principled way (models, methods, techniques, technologies) to model, design, develop AW featuring levels of
 - autonomous behaviour
 - pro-activity, besides reactivity
 - decentralisation of control and distribution

WHAT AW CAN DO
FOR AGENTS?

WHAT AW CAN DO FOR AGENTS?

- Conceptual framework to integrate existing agent research lines
 - agents & augmented/mixed reality
 - agents & pervasive computing
 - interface agents, virtual agents
 - ...
- Providing new issues and perspectives to consider

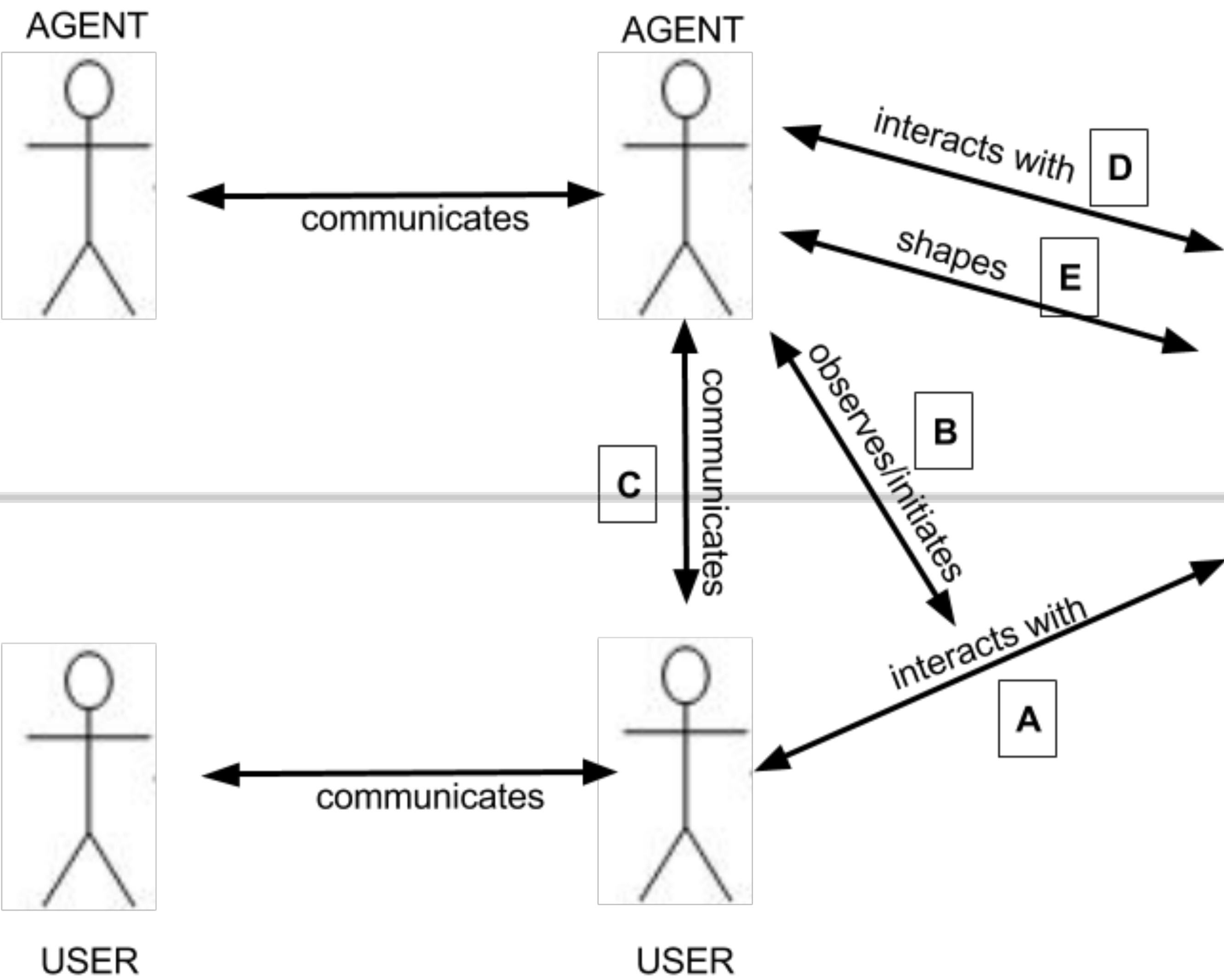
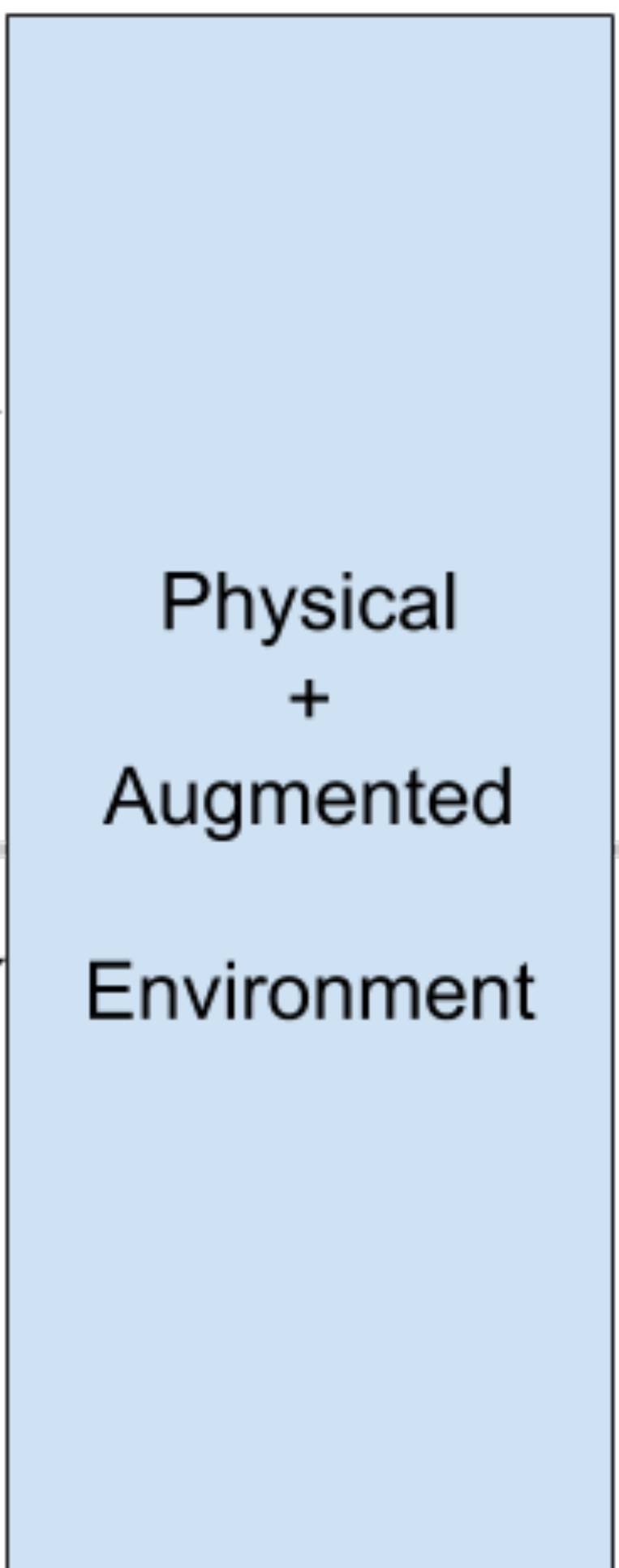
AGENTS FOR AW: TWO MAIN PERSPECTIVES

- Agents augmenting the users
- Agents augmenting the physical environment

AUGMENTED WORLD

AUGMENTED LAYER

PHYSICAL WORLD



A NEW GENERATION OF PERSONAL ASSISTANT AGENTS

- ***“I see what you see”***
 - perceiving and reasoning about what the users is perceiving (and is not perceiving) of the physical context
- Fruitful interaction with *eyewear computing* research community

A NEW GENERATION OF PERSONAL ASSISTANT AGENTS

- **Agents as an *augmentation of the self***
 - from the “delegation perspective” to the “augmentation perspective”
 - from explicit to implicit interaction/communication
- Agents capability empowering humans’ ones
 - both at the individual and group level

A NEW GENERATION OF PERSONAL ASSISTANT AGENTS

- **Agents as *mediators* for augmented realities**
 - to deal with of rich worlds
 - filtering/selecting/focusing/hiding...
- Enriching the spectrum of agent research in
 - context-aware computing
 - interface agents

A NEW GENERATION OF SMART ENVIRONMENTS

- **Agents shaping augmented realities**
 - agents used to model and design the structure and behaviour of augmented realities
- Existing agent research
 - AR/MR
 - Ambient Intelligence

A NEW GENERATION OF SMART ENVIRONMENTS

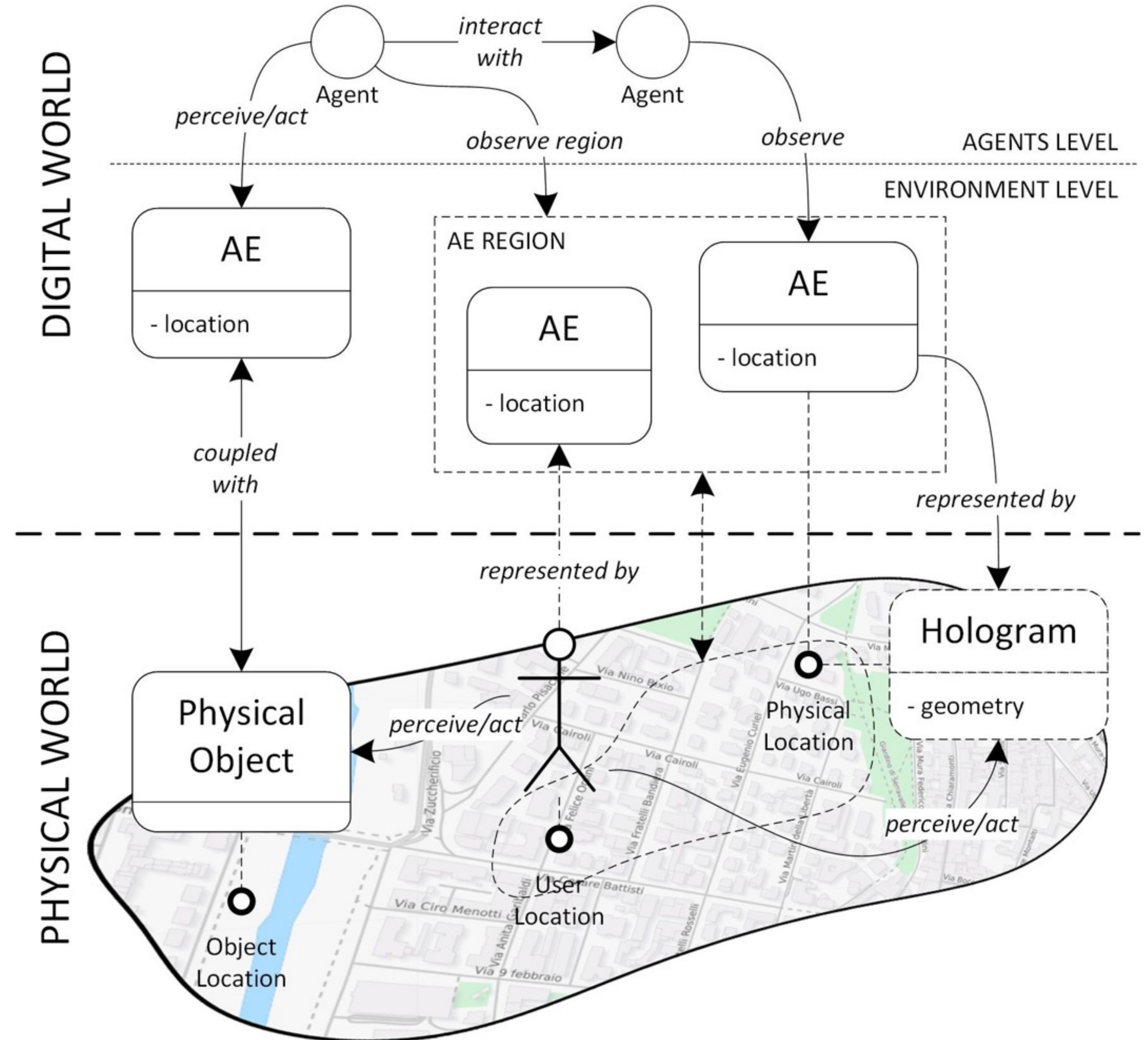
- **Towards augmented societies**
 - exploring cognitive, social, organisational perspective
- Fruitful interaction with research lines in cognitive and social science exploring AR impact

MODELING & ENGINEERING AW

- Agent-based models, methods, technologies, platforms for engineering AW
 - proper level of abstraction
- Integrating existing AW enabling technologies
 - AR/MR platforms
 - e.g. ARToolkit, Vuforia, Unity+Vuforia, Hololens, ..

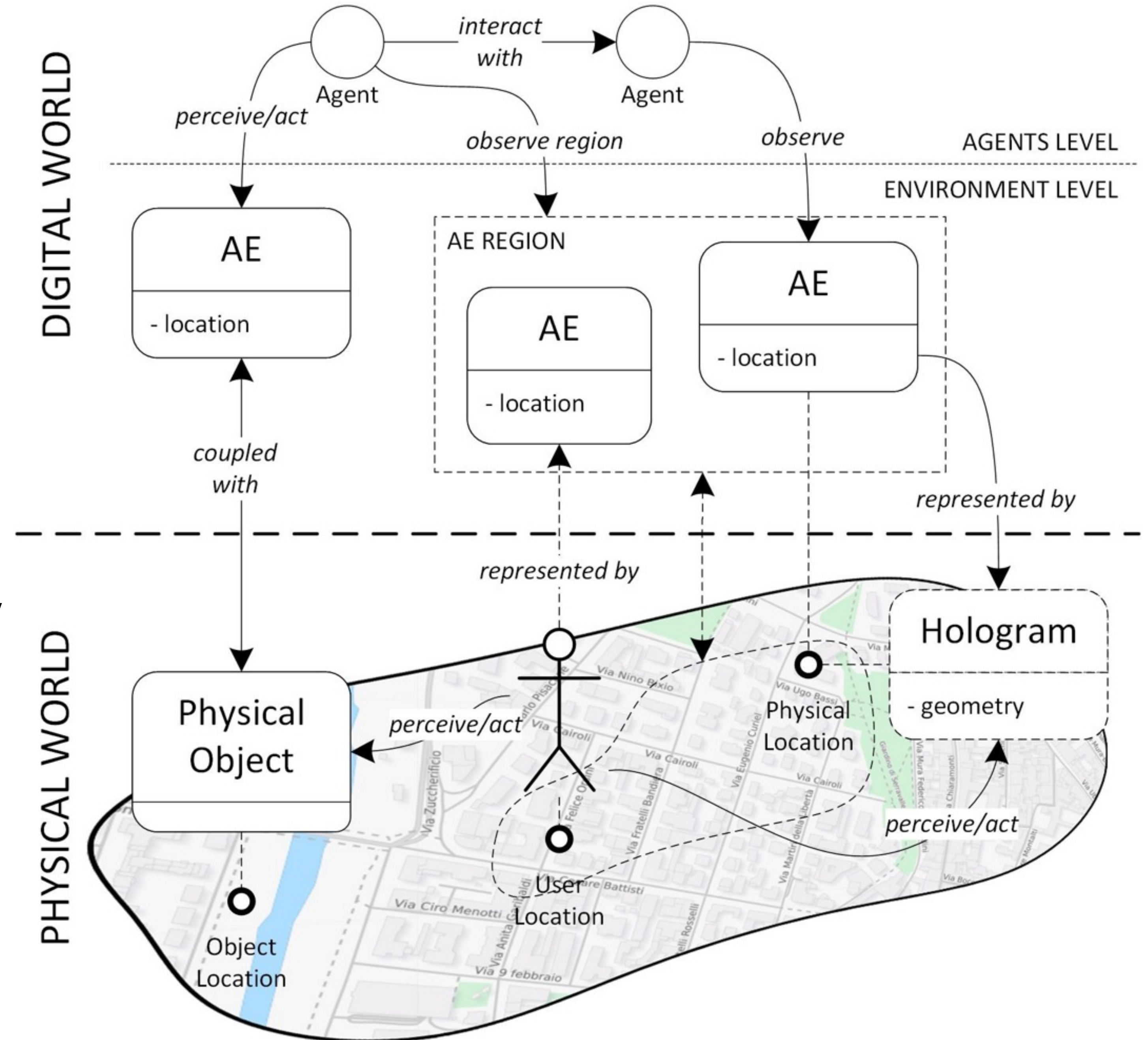
A CONCEPTUAL MODEL FOR AW

- Generalisation of the *Mirror World* model
- Concepts
 - **Augmented Entity (AE)**
 - Holograms
 - Region



A CONCEPTUAL MODEL FOR AW

- Characteristics
 - **Spatial coupling**
 - **Discovery & observability**
 - **User modelling & interaction**
 - **Physical embedding & coupling**



TOWARDS AN OPEN PLATFORM FOR AW

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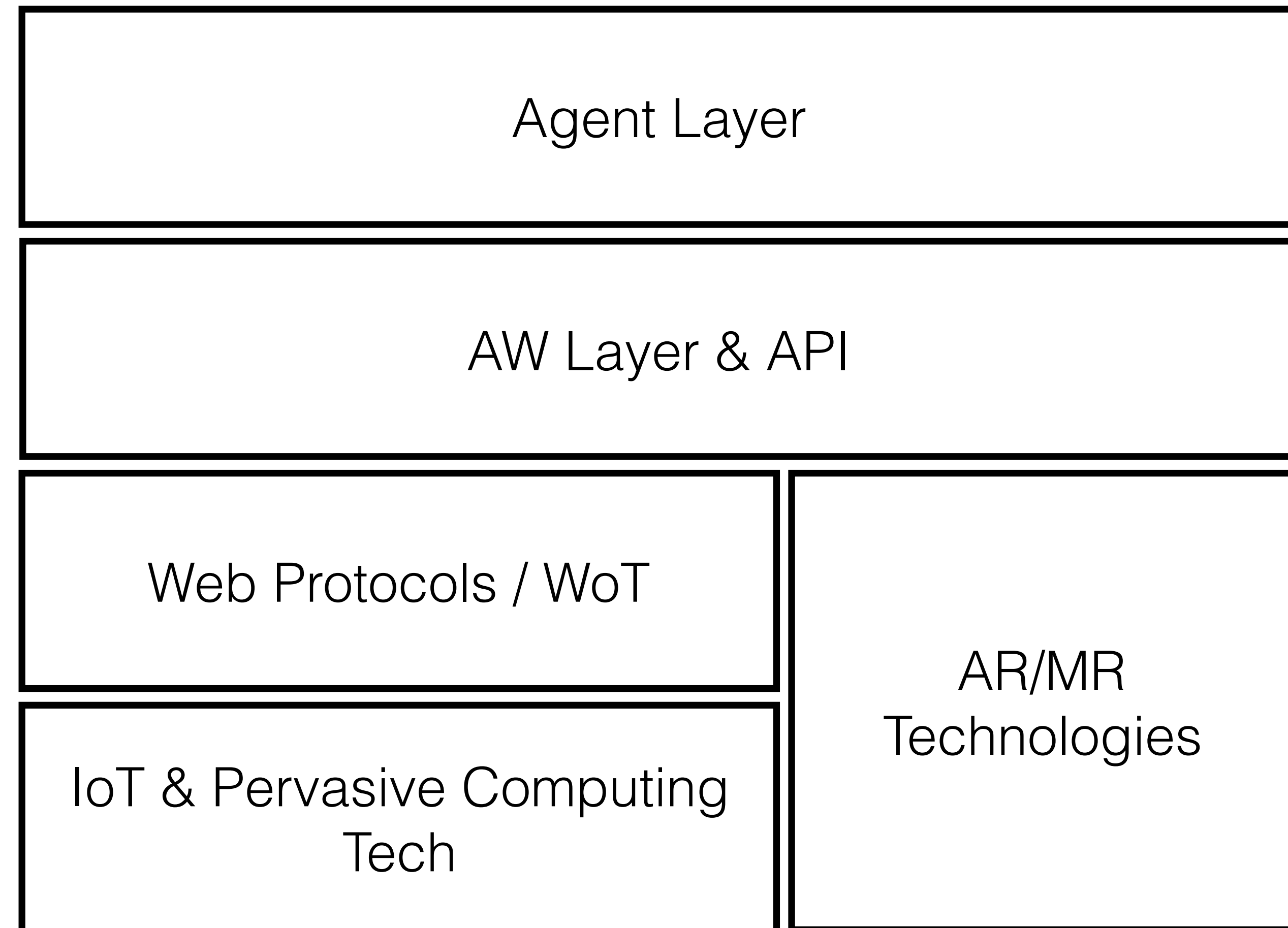
- Objective
 - exploiting existing agent programming platforms / frameworks / technologies for building and running AWs
 - exploiting the “environment” dimension
 - e.g. EIS, CArtAgO

TOWARDS AN OPEN PLATFORM FOR AW

- Objective
 - exploiting existing agent programming platforms / frameworks / technologies for building and running AWs
 - exploiting the “environment” dimension
 - e.g. EIS, CArtAgO
- The idea
 - designing & developing an open platform infrastructure that
 - allows for using different agent technologies for developing agents and agent-related abstractions
 - is based on possibly lower-level heterogeneous augmentation technologies

FROM IoT to WoT to the **WEB OF AUGMENTED THINGS** (WoAT)

- Reusing the IoT/WoT lesson for conceiving the platform
 - Web as a REST-based platform
- Integration with research work on Web/REST + Agents
 - see e.g. Ciortea, EMAS 2017



IN THE RESEARCH AGENDA...

- Refining and formalizing a (reference ?) model for *AW*
- Designing and developing an open platform for *AW*
- Relevant case studies
 - e.g. healthcare domain:
 - “augmented hospitals” or “Hospitals 4.0”
 - first steps: paper in A2HC workshop

THANK YOU.