



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35

An Autonomous Institution



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

AUGMENTED REALITY AND VIRTUAL REALITY

III YEAR – V SEM

UNIT 2 – INTERACTION AND MOBILE AUGMENTED REALITY

TOPIC 1 – Mobile Augmented Reality



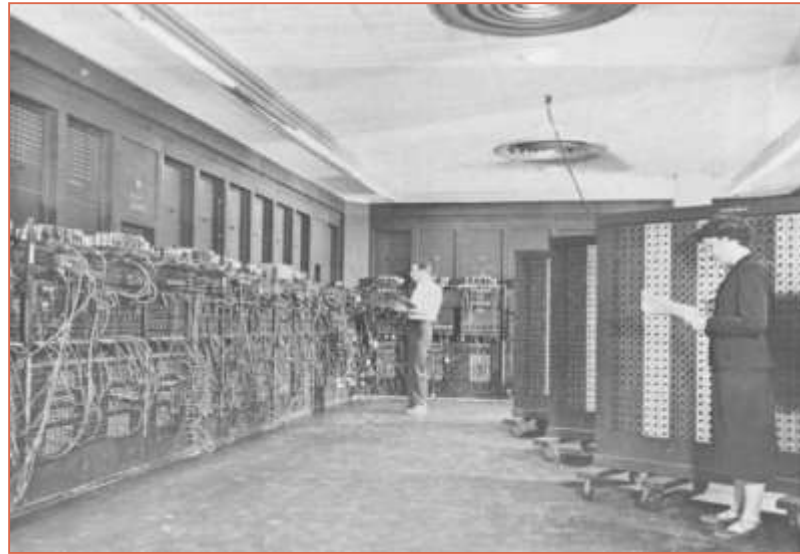
Introduction to Interaction – Mobile Augmented Reality – Advantages and Disadvantages of Mobile Augmented Reality – Architecture for Mobile Augmented Reality Systems – Applications of Augmented Reality



INTERACTION AND MOBILE AUGMENTED REALITY/AR&VR/ S.Rajarajeswari /AIML/SNSCT



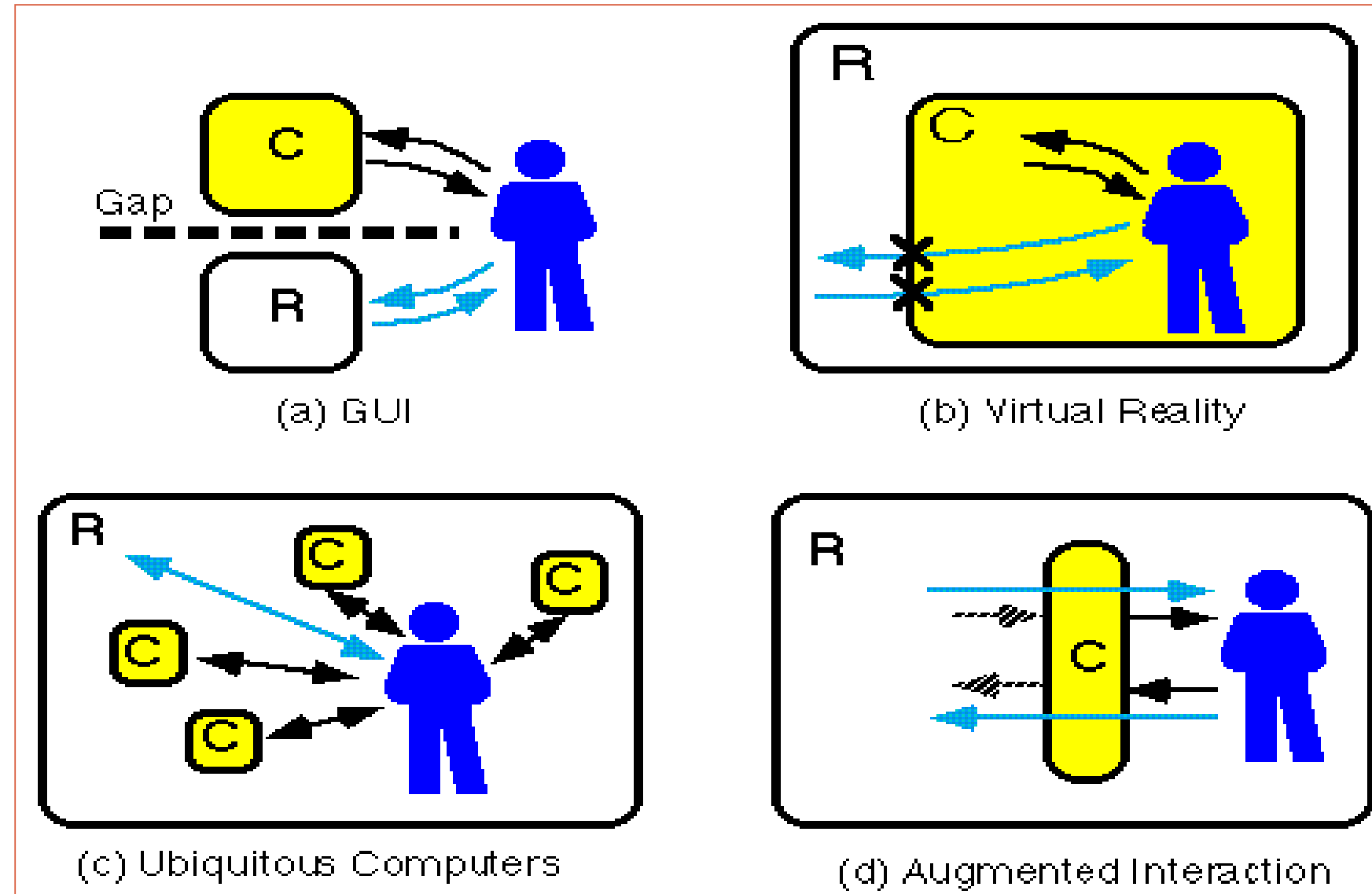
A Brief History of Computing



- **Trend**
 - smaller, cheaper, faster, more intimate, intelligent objects
- **Computers need to become invisible**
 - hide the computer in the real world
 - Ubiquitous /Tangible Computing
 - put the user inside the computer
 - Virtual Reality INTERACTION AND MOBILE AUGMENTED REALITY/AR&VR/ S.Rajarajeswari /AIML/SNSCT



Making Interfaces Invisible



Rekimoto, J. and Nagao, K. 1995. The world through the computer: computer augmented interaction with real world environments. In *Proceedings of the 8th Annual ACM Symposium on User interface and Software Technology. UIST '95*. ACM, New York, NY, 29-36.



Ubiquitous Computing





Ubiquitous computing is the method of enhancing computer use by making many computers available throughout but the physical environment, making them effectively invisible to the user.

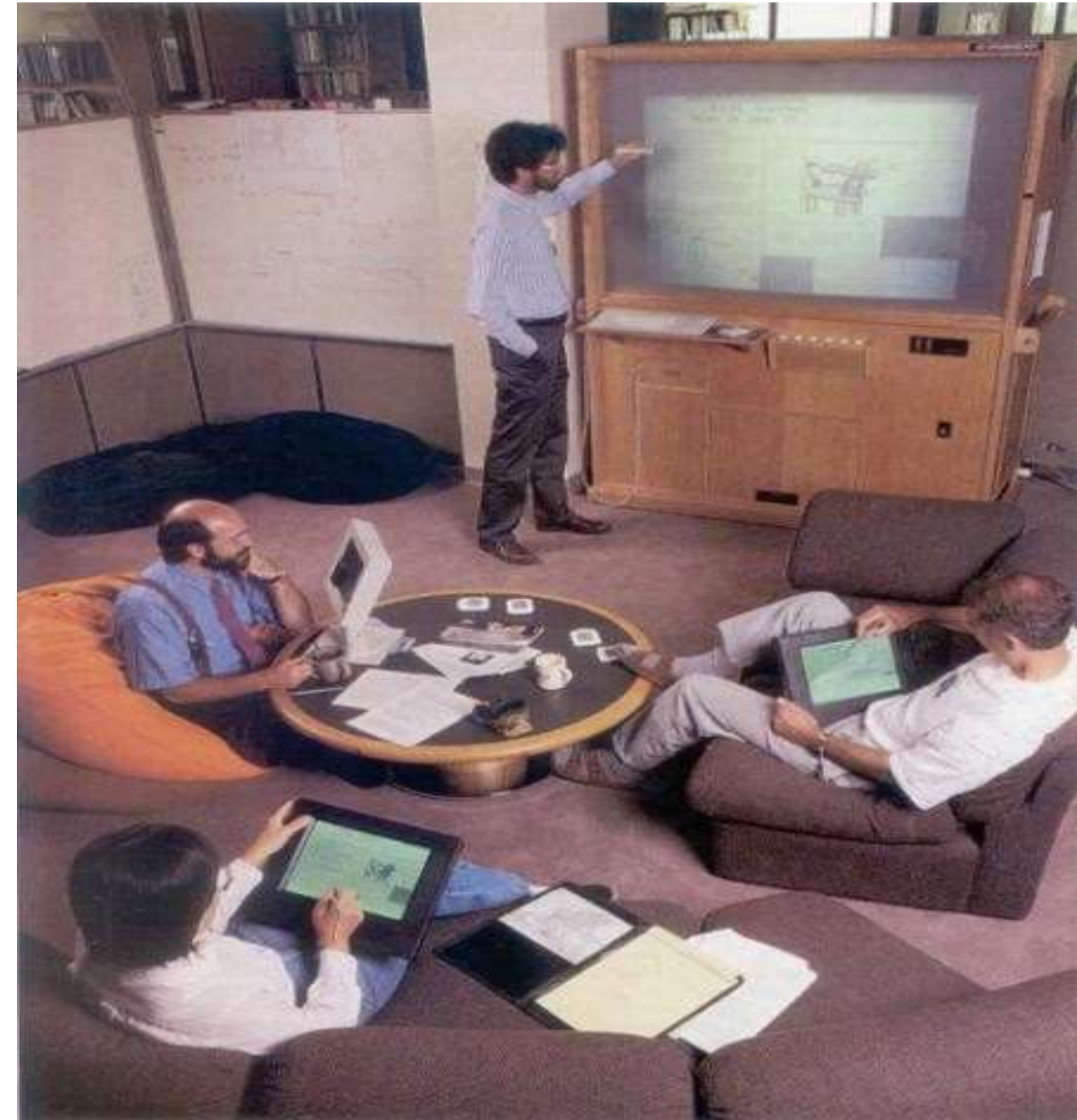
– Mark Weiser



Ubiquitous Computing



- Mark Weiser, Xerox PARC
- TAB, Slate, Wall display





Ubiquitous Computing



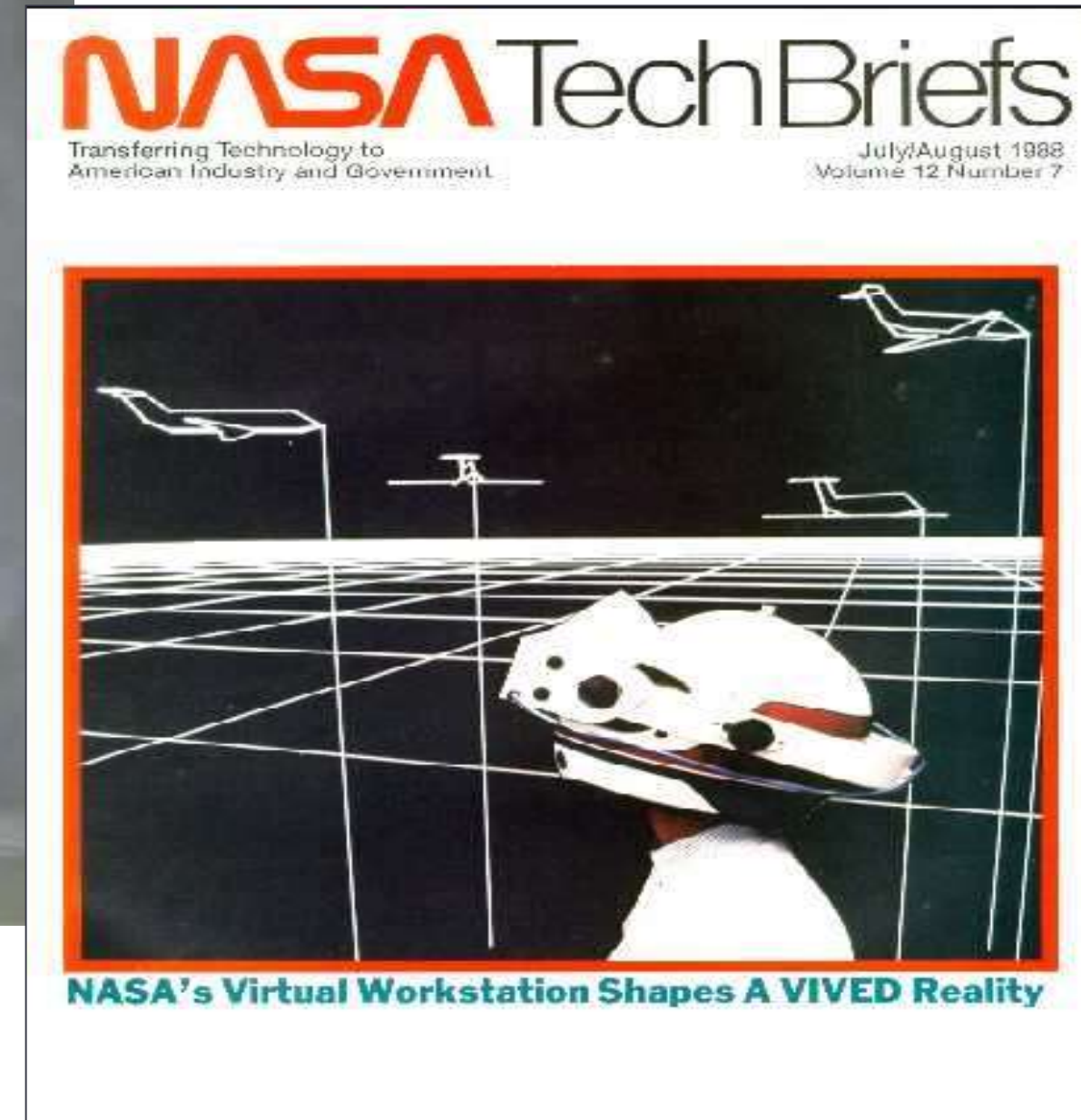
Smart Home Sensor Networks



Virtual Reality



- 1989...





INTERACTION AND MOBILE AUGMENTED REALITY/AR&VR/ S.Rajarajeswari /AIML/SNSCT



Virtual Reality



- **Immersive VR**
 - Head mounted display, gloves
 - Separation from the real world



Augmented Reality Definition

- **Defining Characteristics [Azuma 97]**
 - **Combines Real and Virtual Images**
 - Both can be seen at the same time
 - **Interactive in real-time**
 - The virtual content can be interacted with
 - **Registered in 3D**
 - Virtual objects appear fixed in space

Azuma, R. T. (1997). A survey of augmented reality. Presence, 6(4), 355-385.



AR vs VR

	Virtual Reality <i>Replaces Reality</i>	Augmented Reality <i>Enhances Reality</i>
<i>Scene Generation</i>	Requires realistic images	Minimal rendering okay
<i>Display Device</i>	Fully immersive, wide field of view	Non-immersive, small field of view
<i>Tracking</i>	Low to medium accuracy is okay	The highest accuracy possible



Where Can You Use AR/VR?

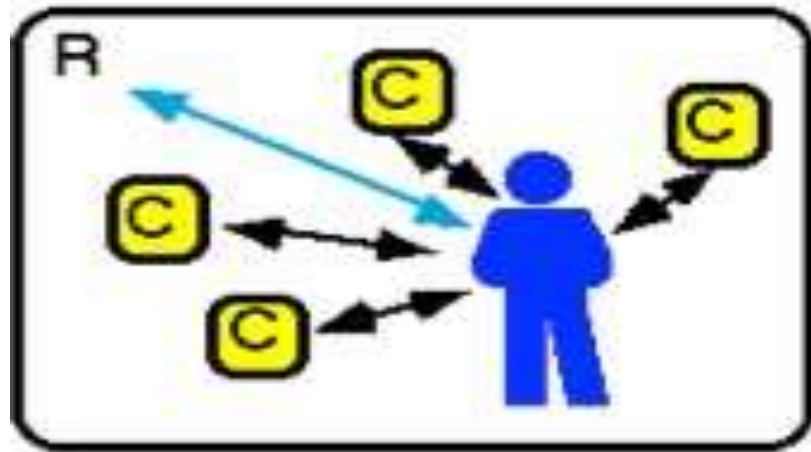
VR – stable environments

AR - anywhere

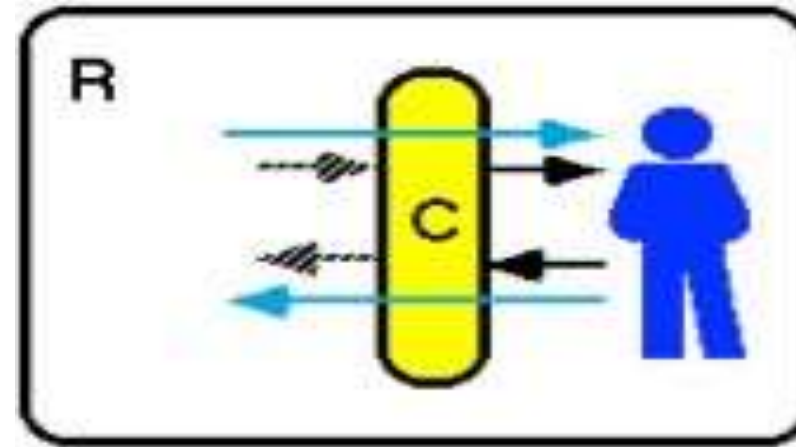




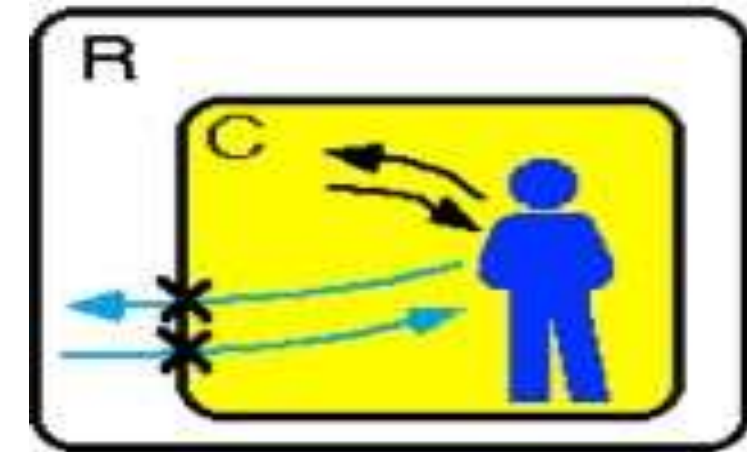
From Reality to Virtual Reality



Ubiquitous Computing



Augmented Reality



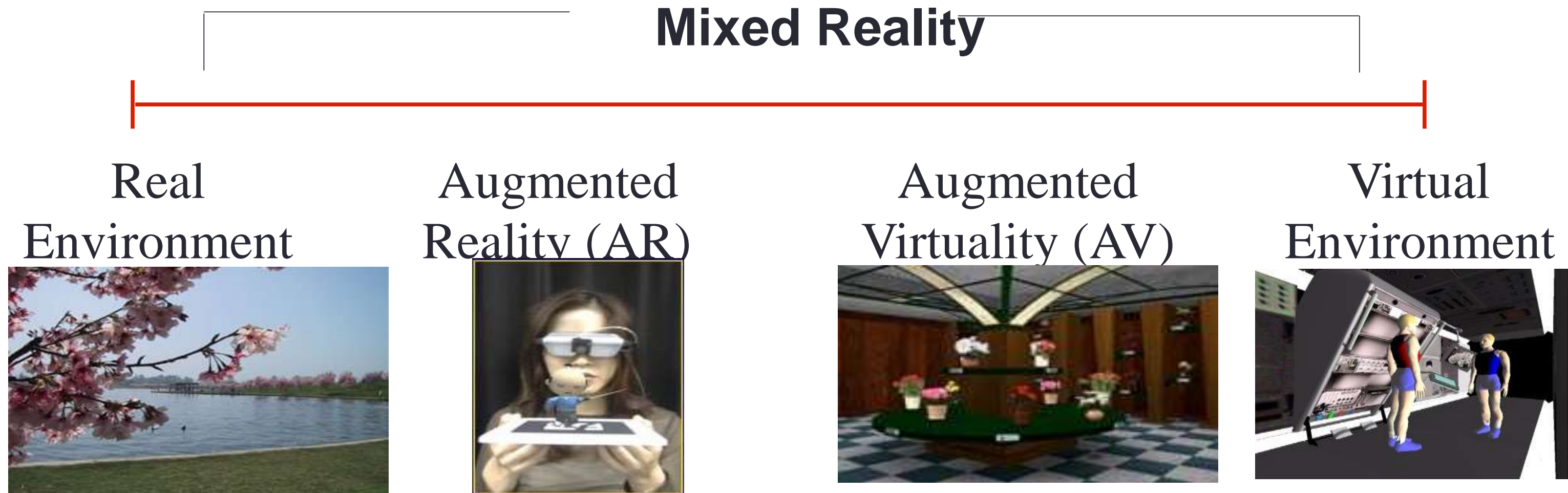
Virtual Reality





Milgram's Reality-Virtuality continuum

"...anywhere between the extrema of the *virtuality continuum*."

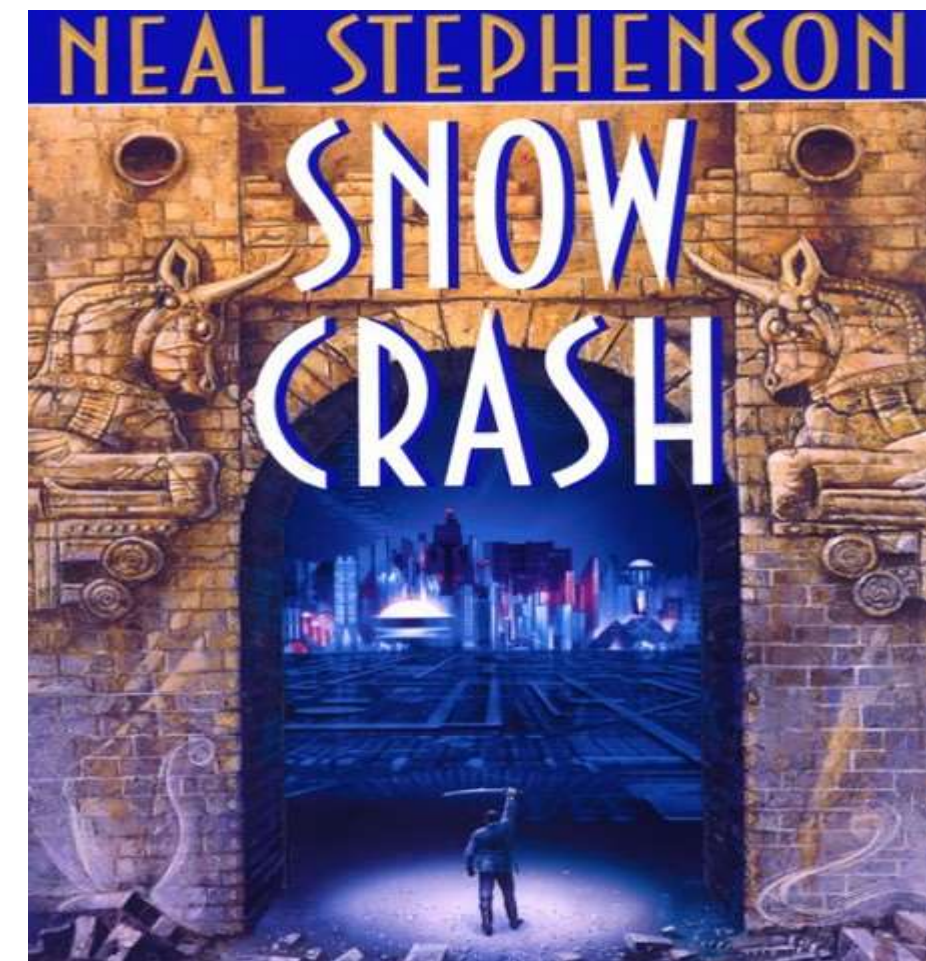


Reality - Virtuality (RV) Continuum



Metaverse

- Neal Stephenson's "SnowCrash"
- The Metaverse is the convergence of:
 - 1) virtually enhanced physical reality
 - 2) physically persistent virtual space
- Metaverse Roadmap
 - <http://metaverseroadmap.org/>





Metaverse Dimensions

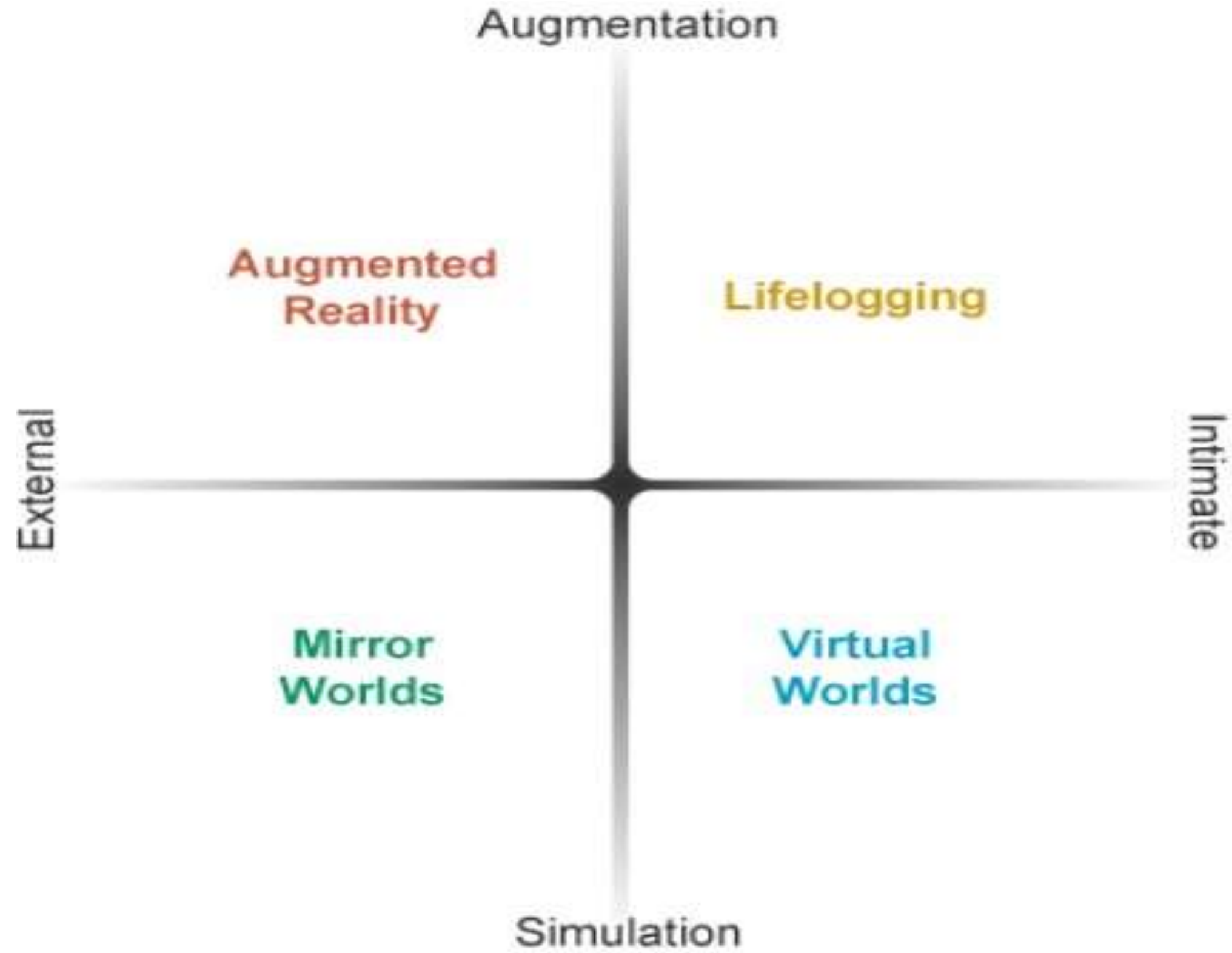
- *Augmentation* technologies that layer information onto our perception of the physical environment.
- *Simulation* refers to technologies that model reality
- *Intimate* technologies are focused inwardly, on the identity and actions of the individual or object;
- *External* technologies are focused outwardly, towards the world at large;



Metaverse Components

- **Four Key Components**
 - Virtual Worlds
 - Augmented Reality
 - Mirror Worlds
 - Lifelogging







Summary

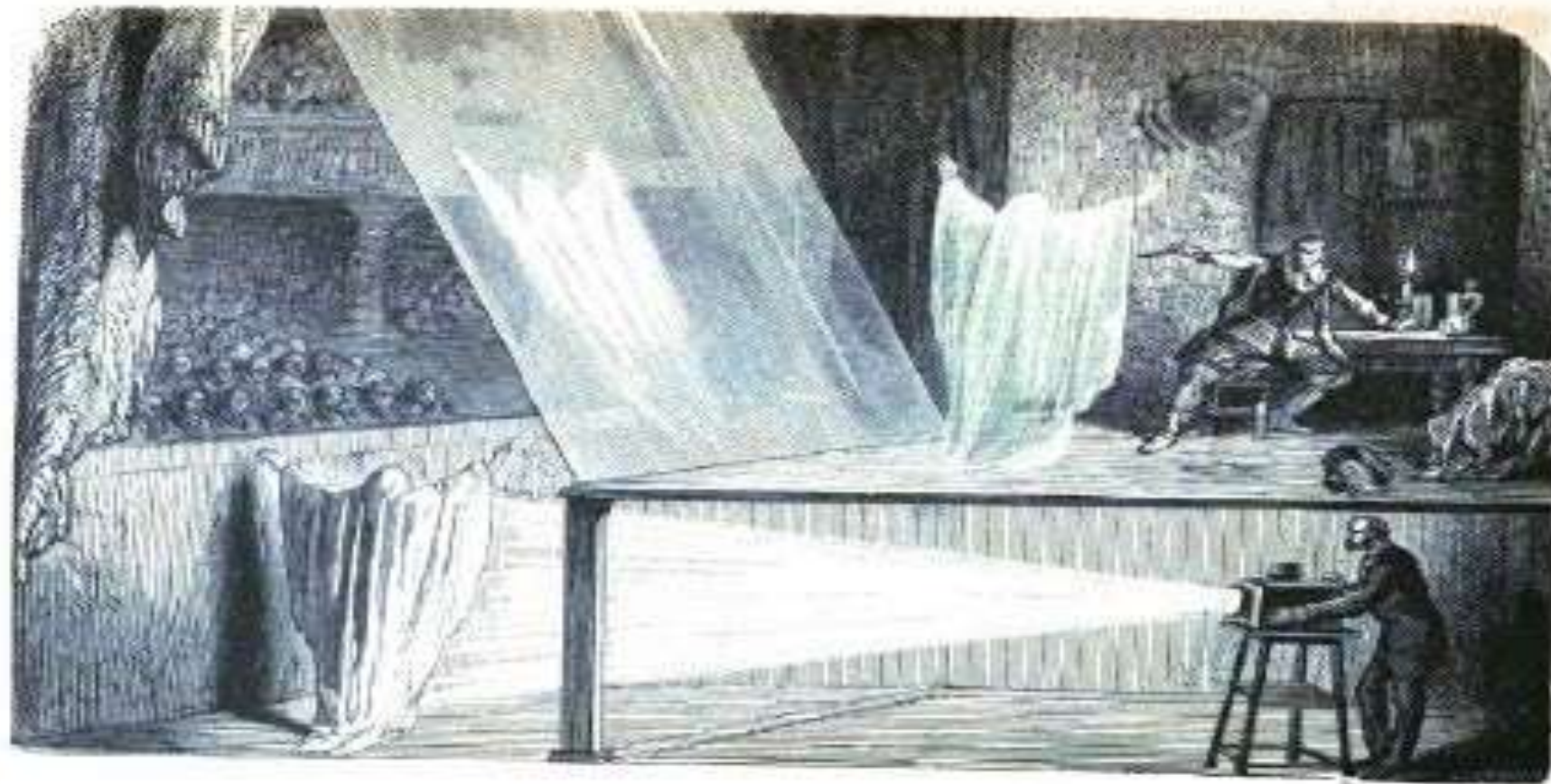
- **Augmented Reality has three key features**
 - Combines Real and Virtual Images
 - Interactive in real-time
 - Registered in 3D
- **AR can be classified alongside other technologies**
 - Invisible Interfaces
 - Milgram's Mixed Reality continuum
 - Stephenson's MetaVerse



HISTORY



Pepper's Ghost (1862)

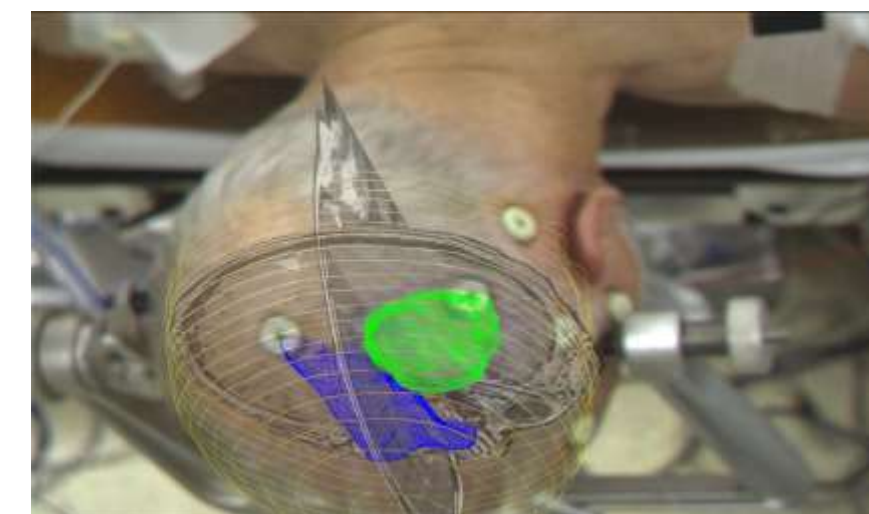
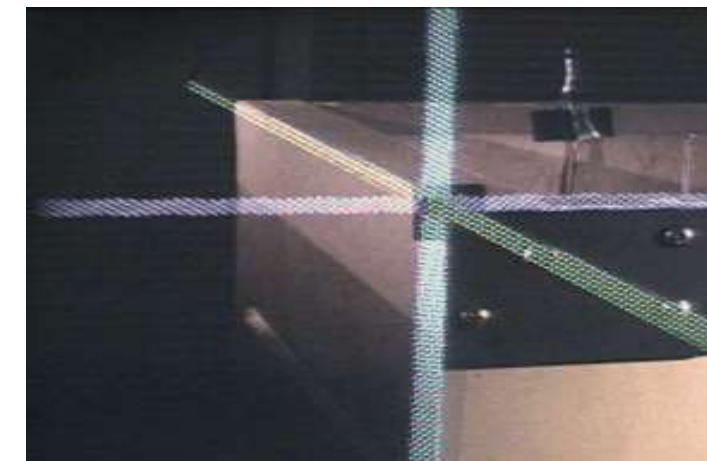


- Dates back to Giambattista della Porta (1584)



AR History

- 1960's – 80's: Early Experimentation
 - Military, Academic labs
- 1980's – 90's: Basic Research
 - Tracking, Displays
- 1995 – 2005: Tools/Applications
 - Interaction, Usability, Theory
- 2005 - : Commercial Applications
 - Games, Medical, Industry. Mobile

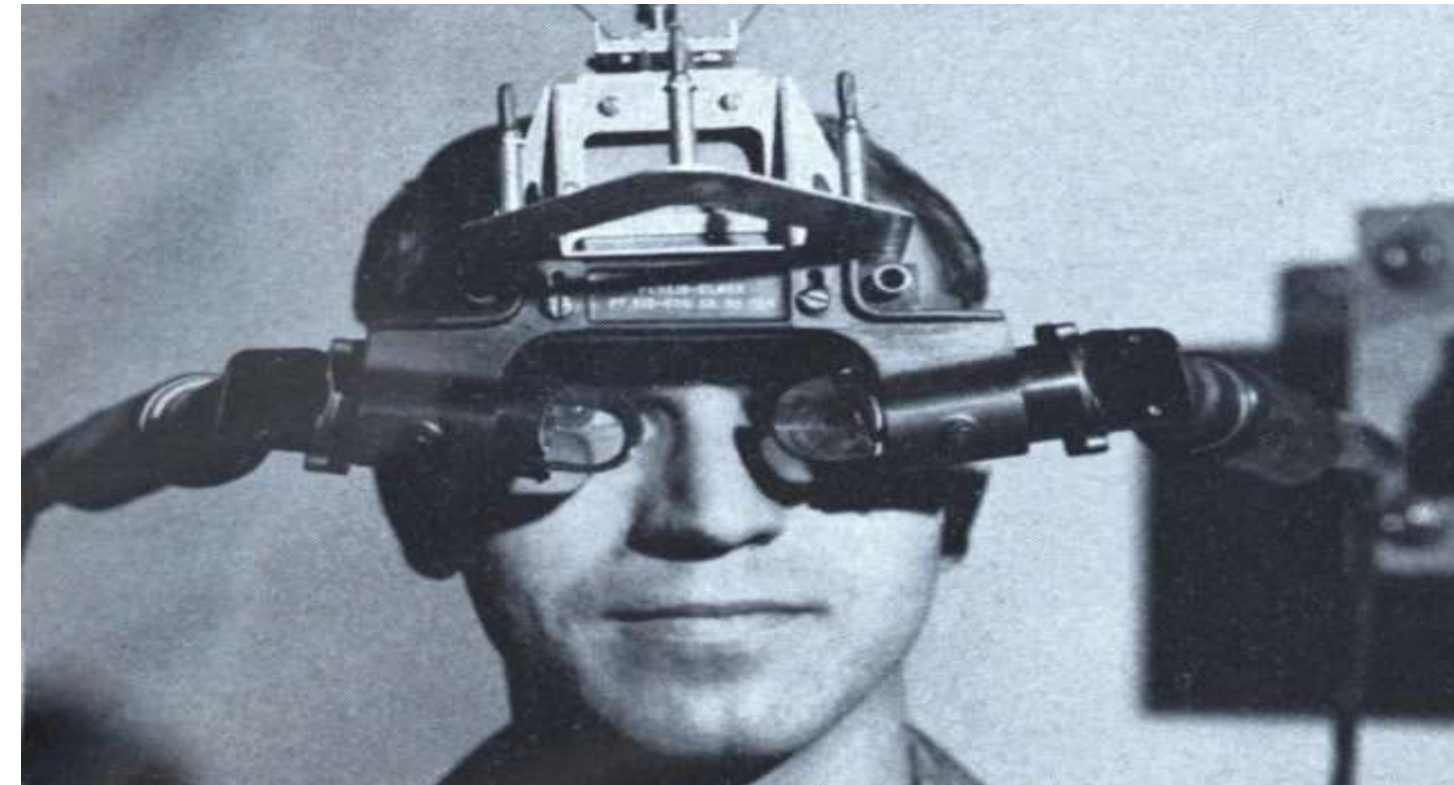




Early HMDs and HUDs (1960's)



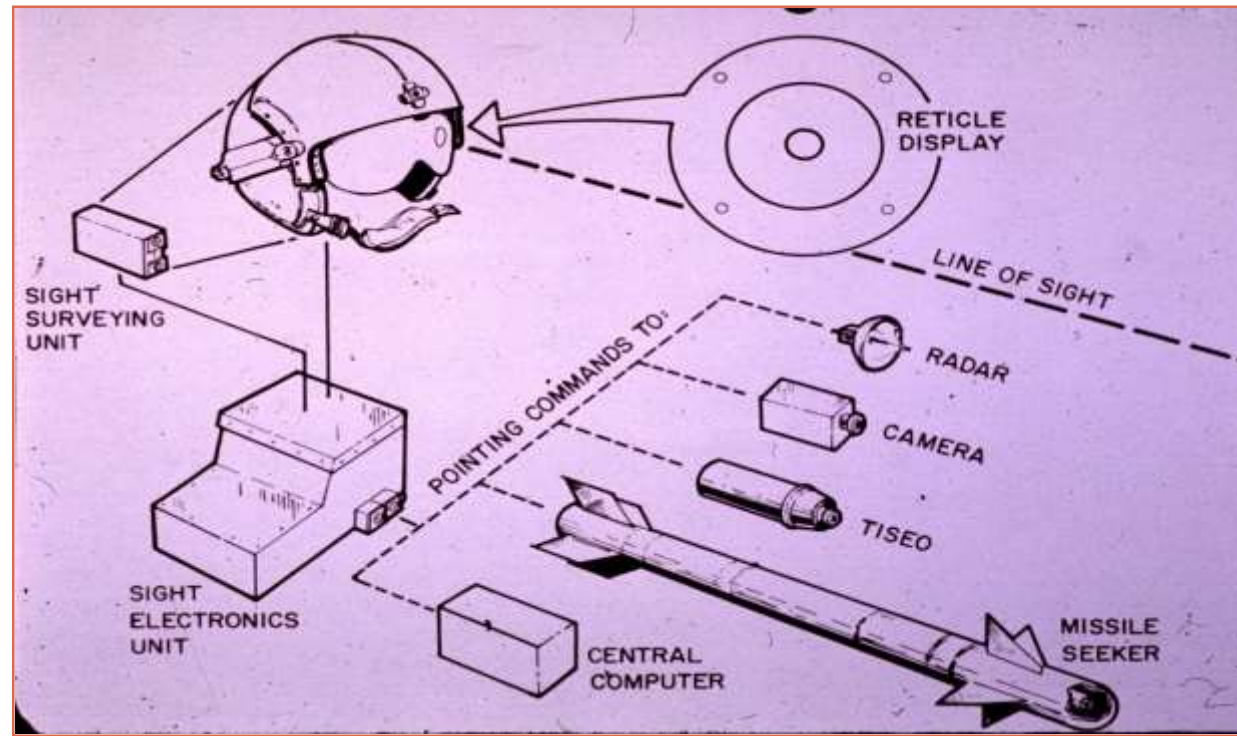
Bucaneer HUD (1958)



Sutherland / Sproull's see-through HMD (1965)



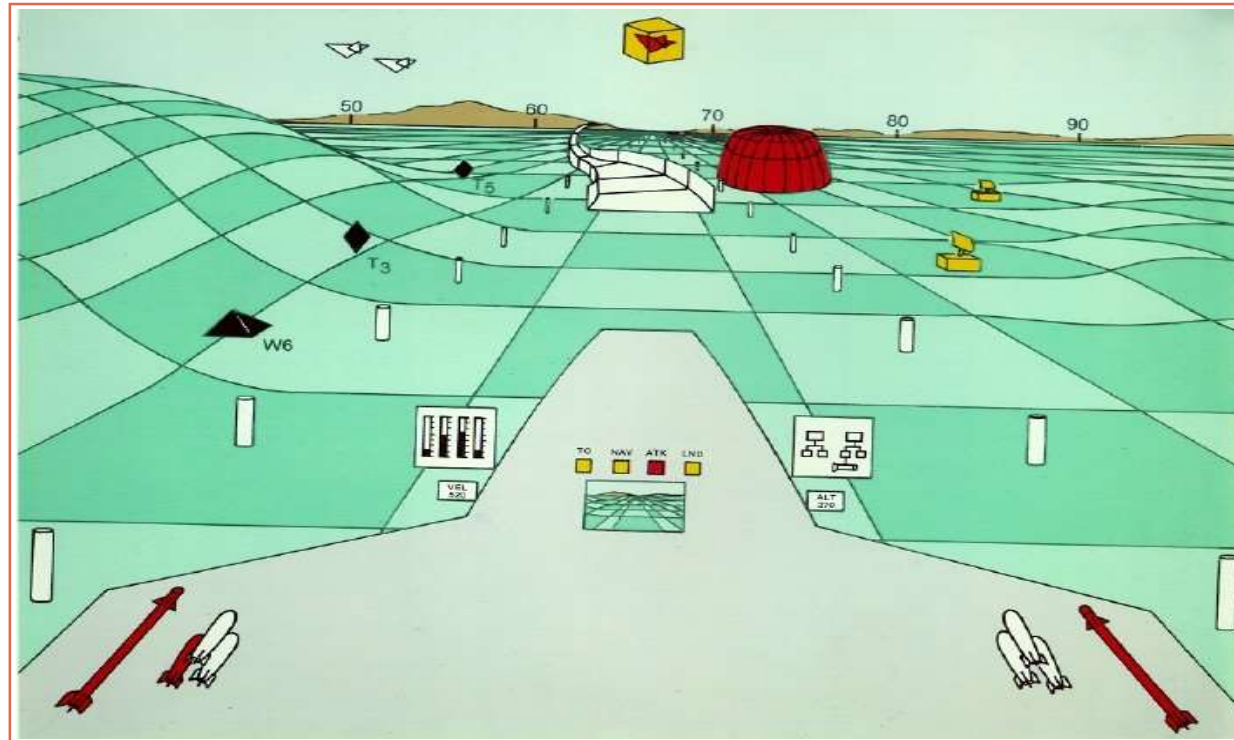
Military Research



1960 - 70's: US Air Force helmet mounted displays (T. Furness)



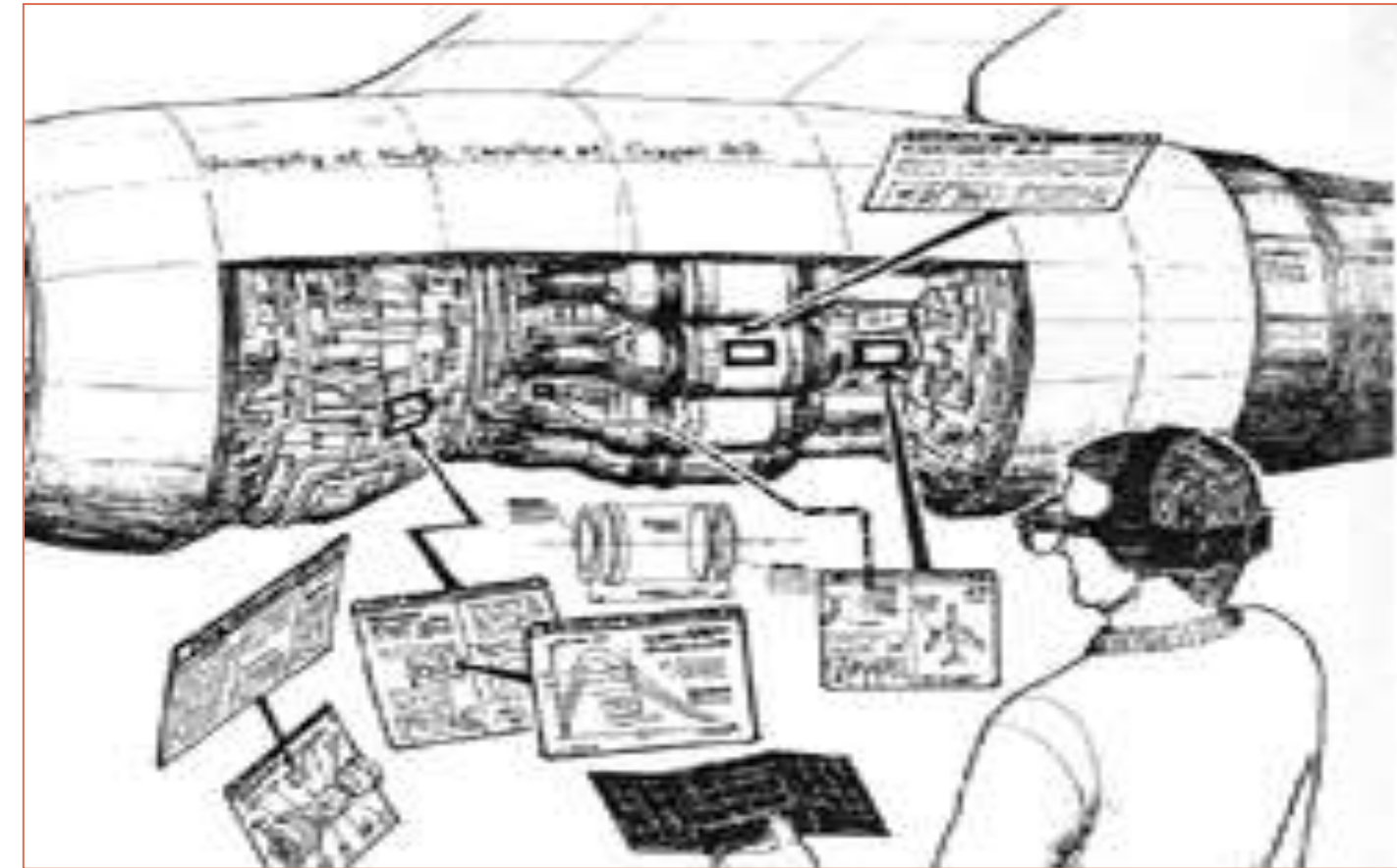
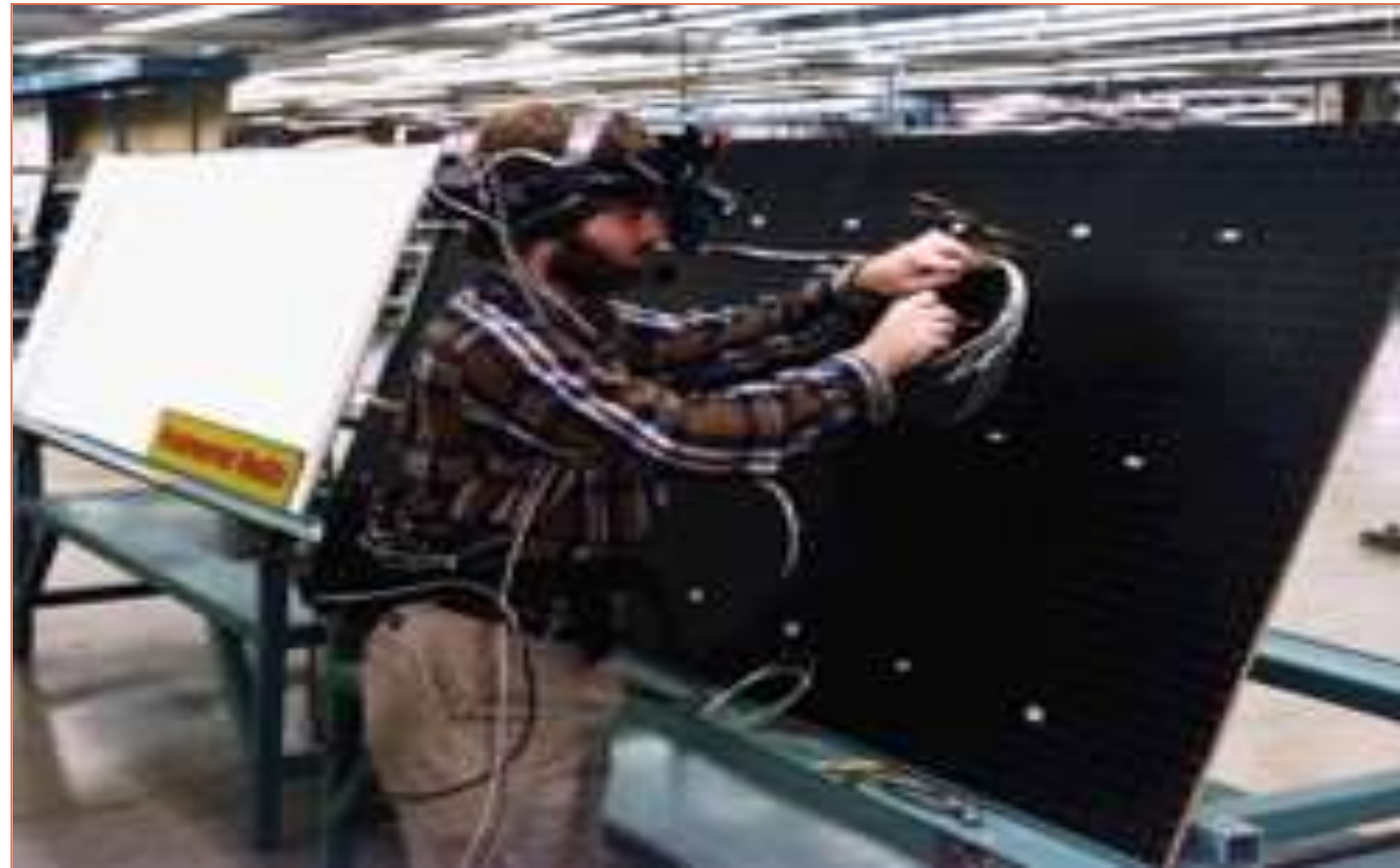
Military Research



1970 - 80's: US Air Force Super Cockpit (T. Furness)



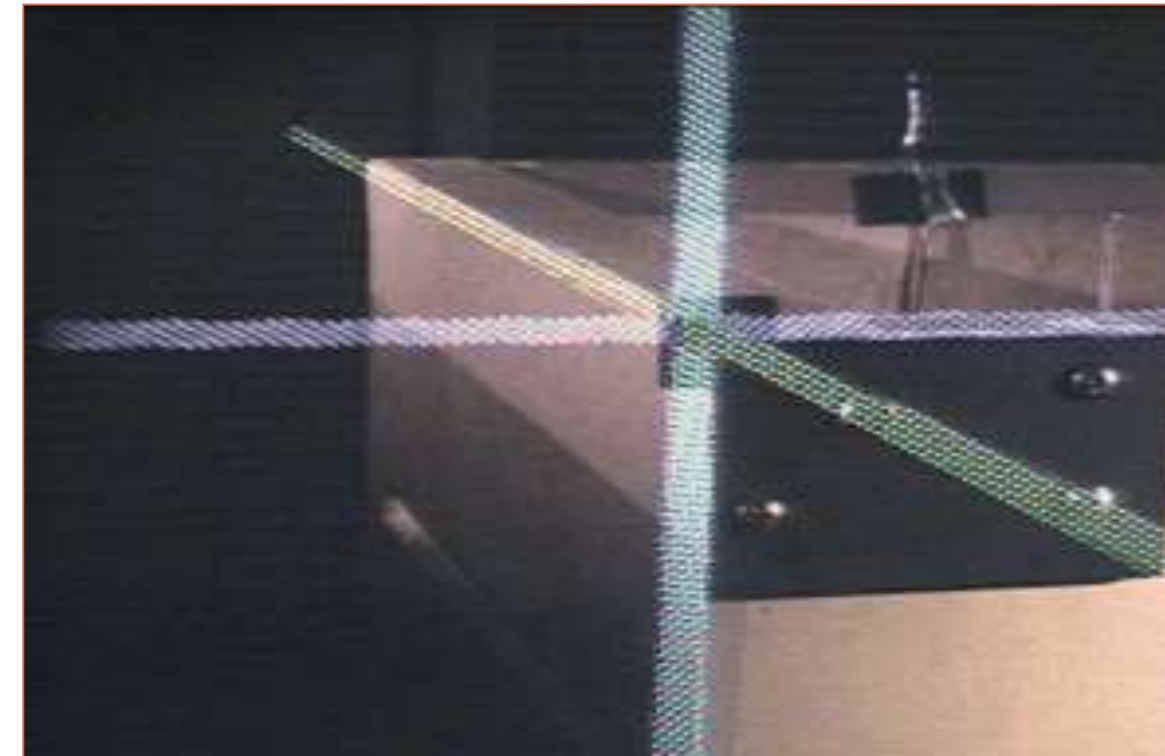
Early Industrial Research



- Early 1990's: Boeing coined the term "AR." Wire harness assembly application begun (T. Caudell, D. Mizell).
- Early to mid 1990's: UNC ultrasound visualization project



Early Academic Research



- 1994: Motion stabilized display [Azuma]
- 1995: Fiducial tracking in video see-through [Bajura]
- 1996: U N C hybrid magnetic-vision tracker



Spreading AR Research



- 1996: MIT Wearable Computing efforts
- 1998: Dedicated conferences begin
- Late 90's: Collaboration, outdoor, interaction
- Late 90's: Augmented sports broadcasts
- 1998 - 2001: Mixed Reality Systems Lab



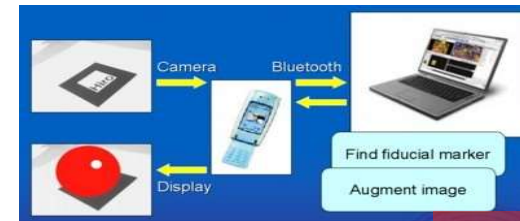
MOBILE AR HISTORY



Evolution of Mobile AR



Camera phone



Camera phone
- Thin client AR



Wearable
Computers

Wearable AR



Handheld
AR Displays



PDA's
-Thin client AR



PDA's
-Self contained AR



Camera phone
- Self contained AR

1995

1997

2001

2003

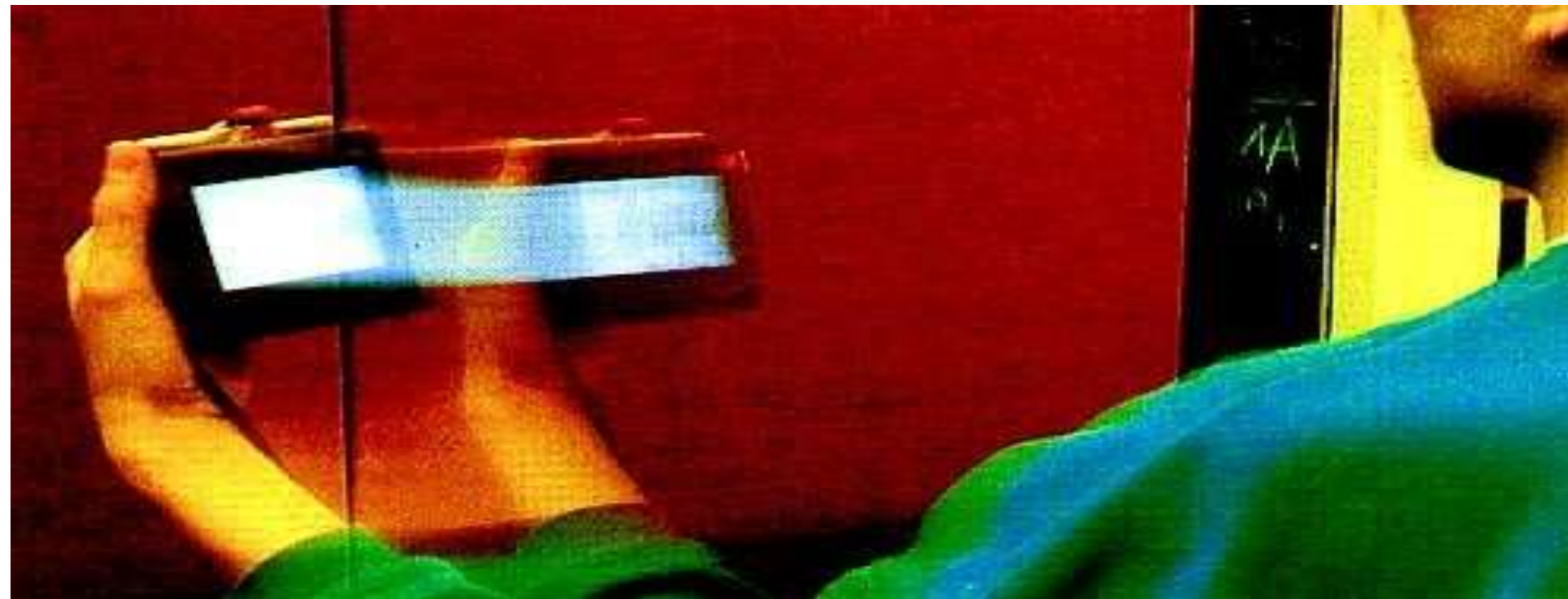
2004



Handheld Displays

Tethered Applications

- Fitzmaurice Chameleon (1994)
- Rekimoto's Transvision (1995)
- Tethered LCD
- PC Processing and Tracking

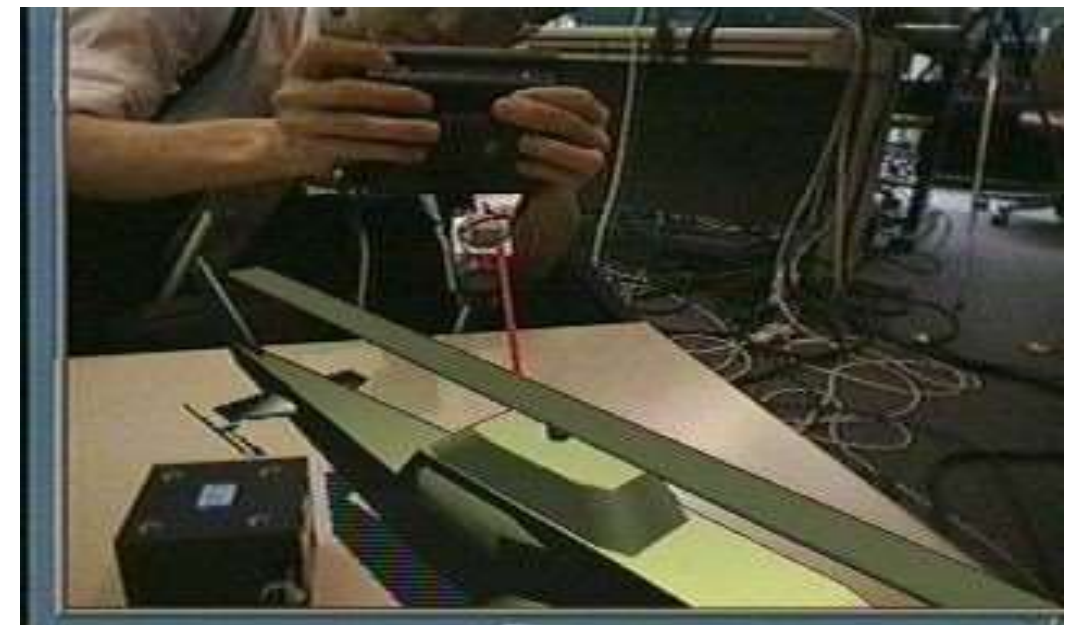




Handheld AR Display - Tethered

1995, 1996 Handheld AR

- ARPad, Cameleon
- Rekimoto's NaviCam, Transvision
- Tethered LCD
- PC Processing and Tracking





NaviCam (Rekimoto, 1995)

Information is registered to real-world context

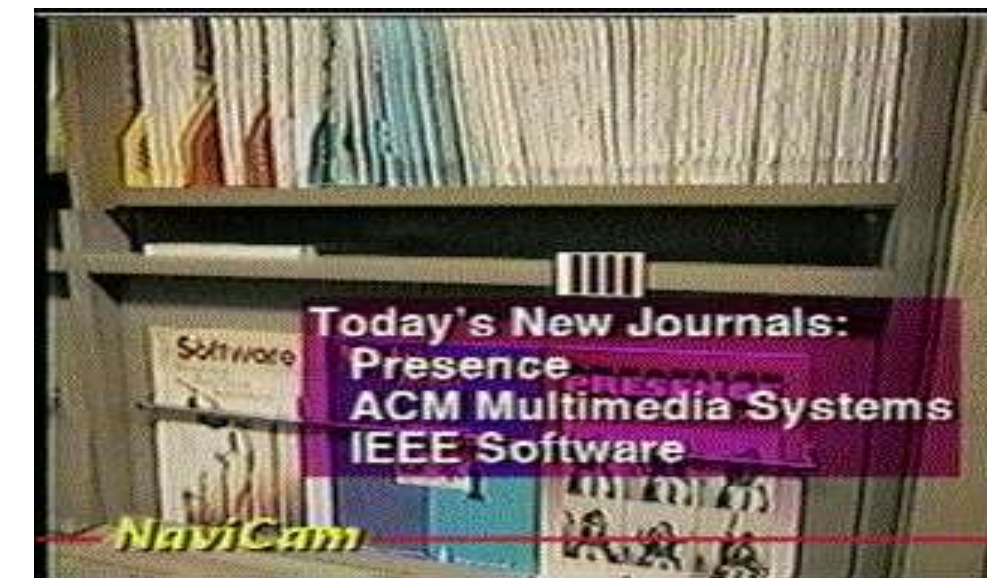
- Hand held AR displays

Interaction

- Manipulation of a window into information space

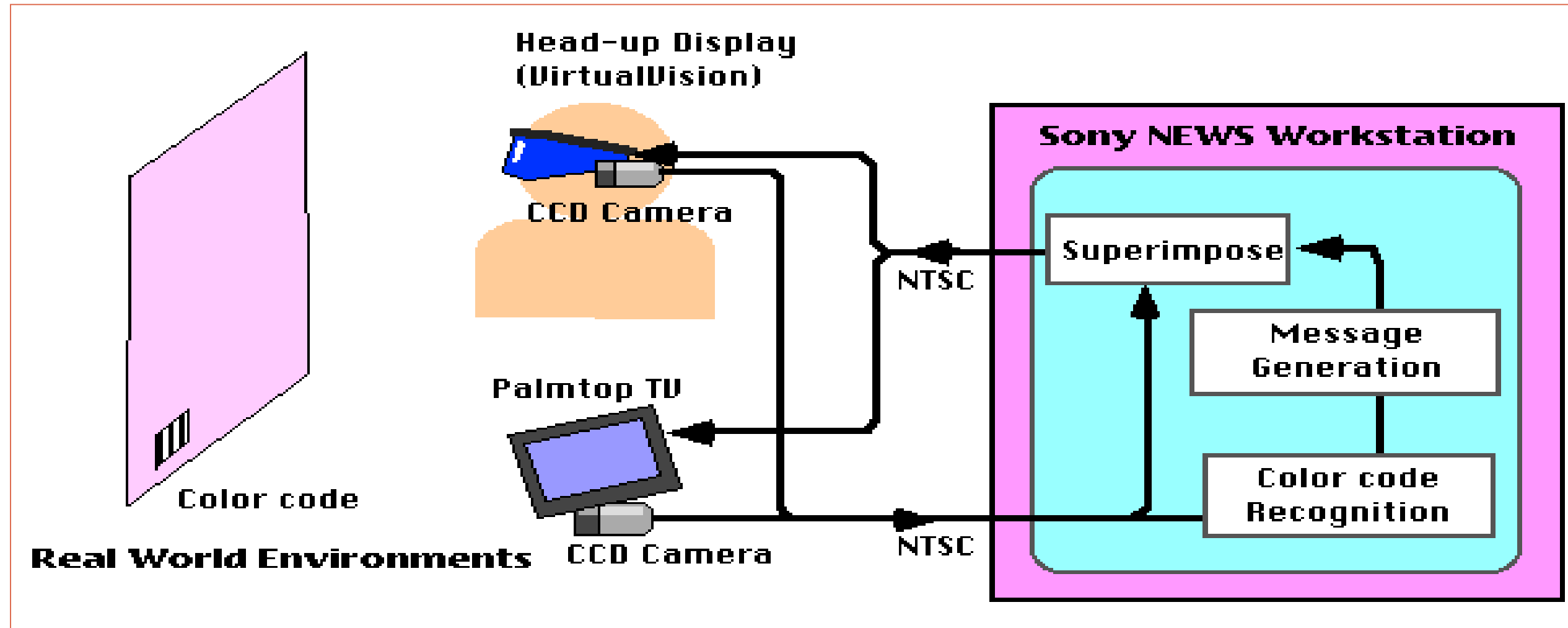
Applications

- Context-aware information displays





NaviCam Architecture



Jun Rekimoto and Katashi Nagao, "The World through the Computer: Computer Augmented Interaction with Real World Environments", User Interface Software and Technology (UIST '95)



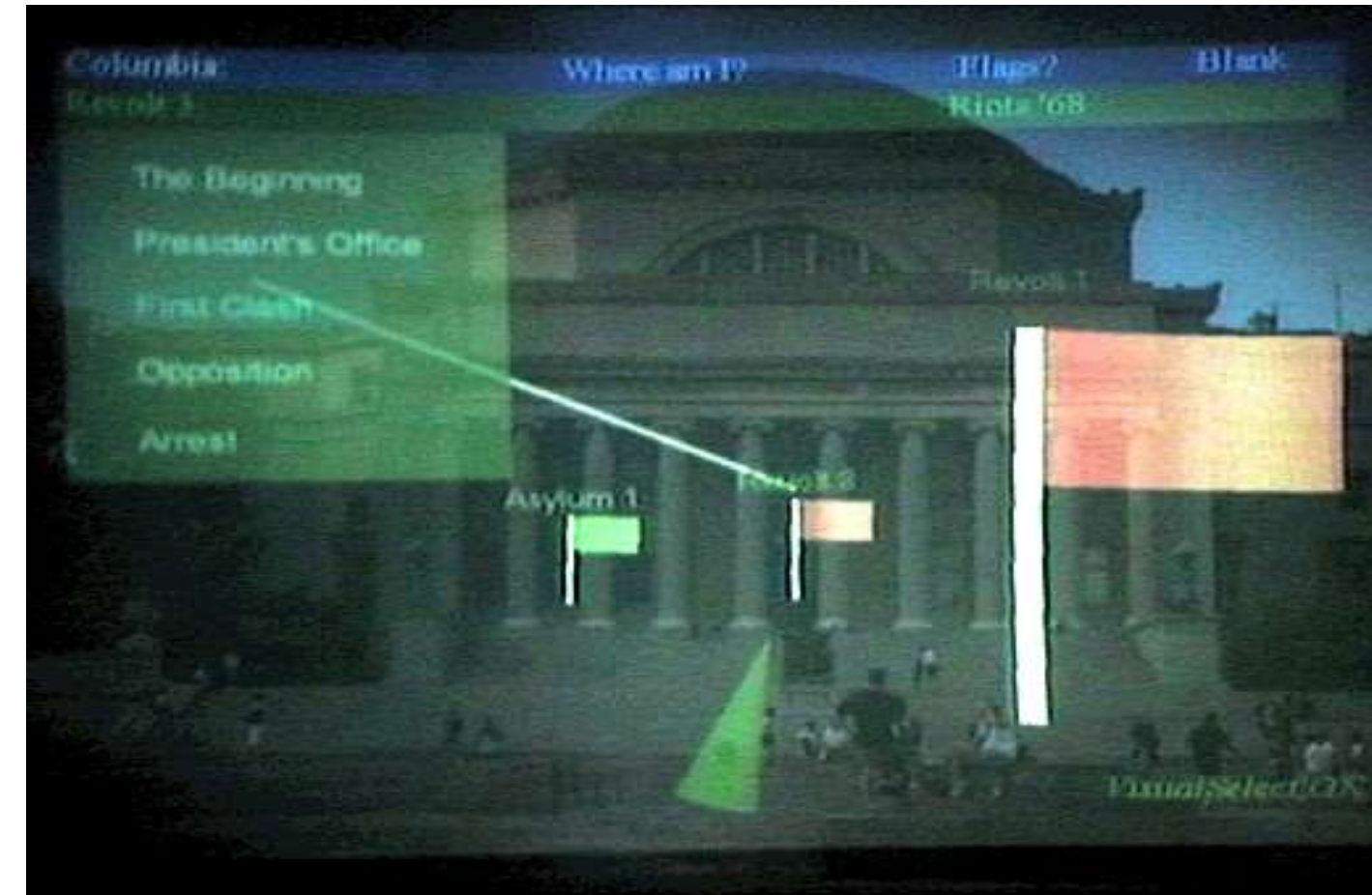
Mobile AR: Touring Machine (1997)

- **University of Columbia**
 - Feiner, MacIntyre, Höllerer, Webster
- **Combines**
 - See through head mounted display
 - GPS tracking
 - Orientation sensor
 - Backpack PC (custom)
 - Tablet input





MARS View



- Virtual tags overlaid on the real world
- “Information in place”



Backpack/Wearable AR

1997 Backpack AR

- Feiner's Touring Machine
- AR Quake (Thomas)
- Tinmith (Piekarski)
- MCAR (Reitmayr)
- Bulky, HMD based



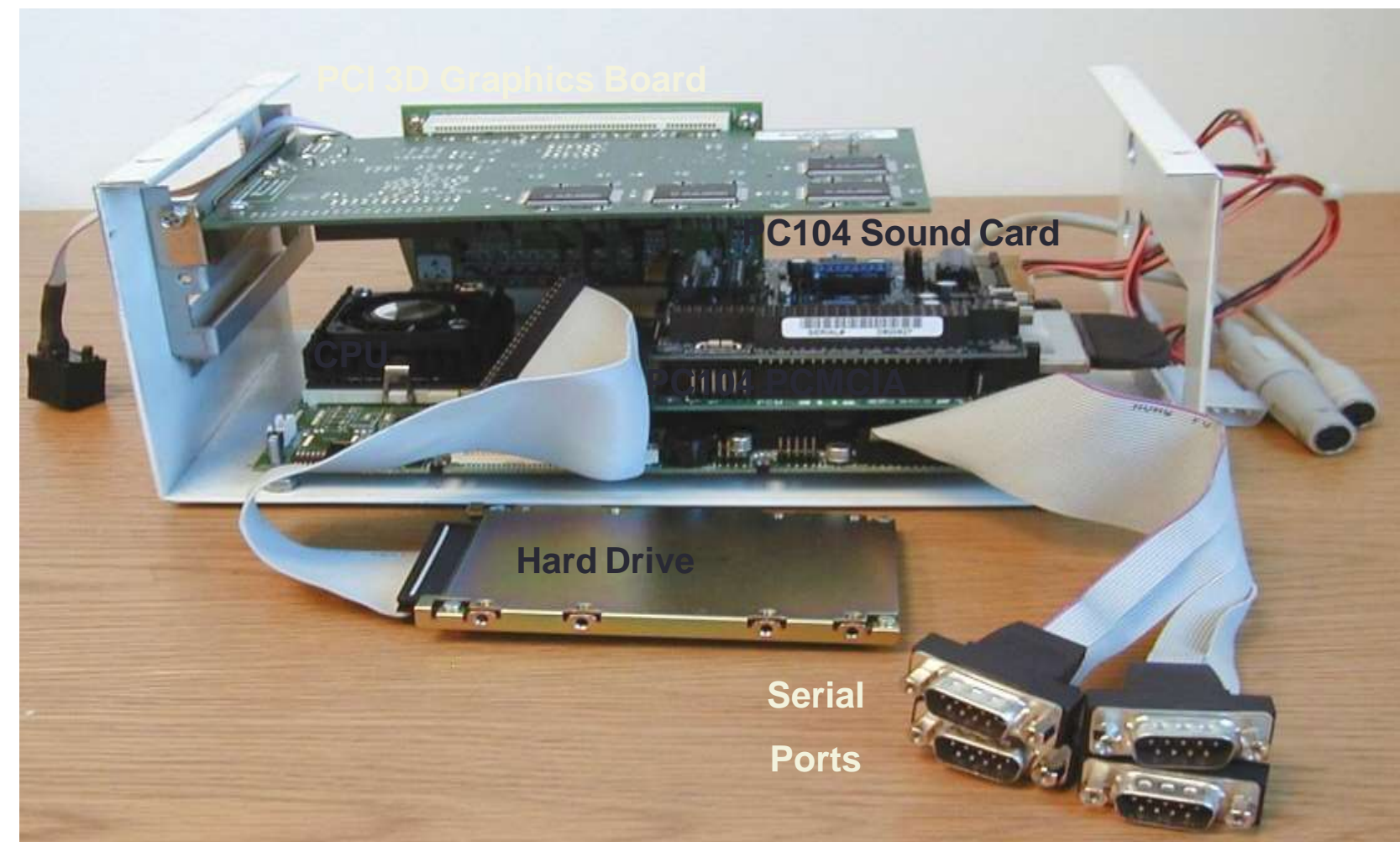


Mobile AR - Hardware



Columbia Touring Machine

Example self-built working solution with PCI-based 3D graphics





First Camera Phone



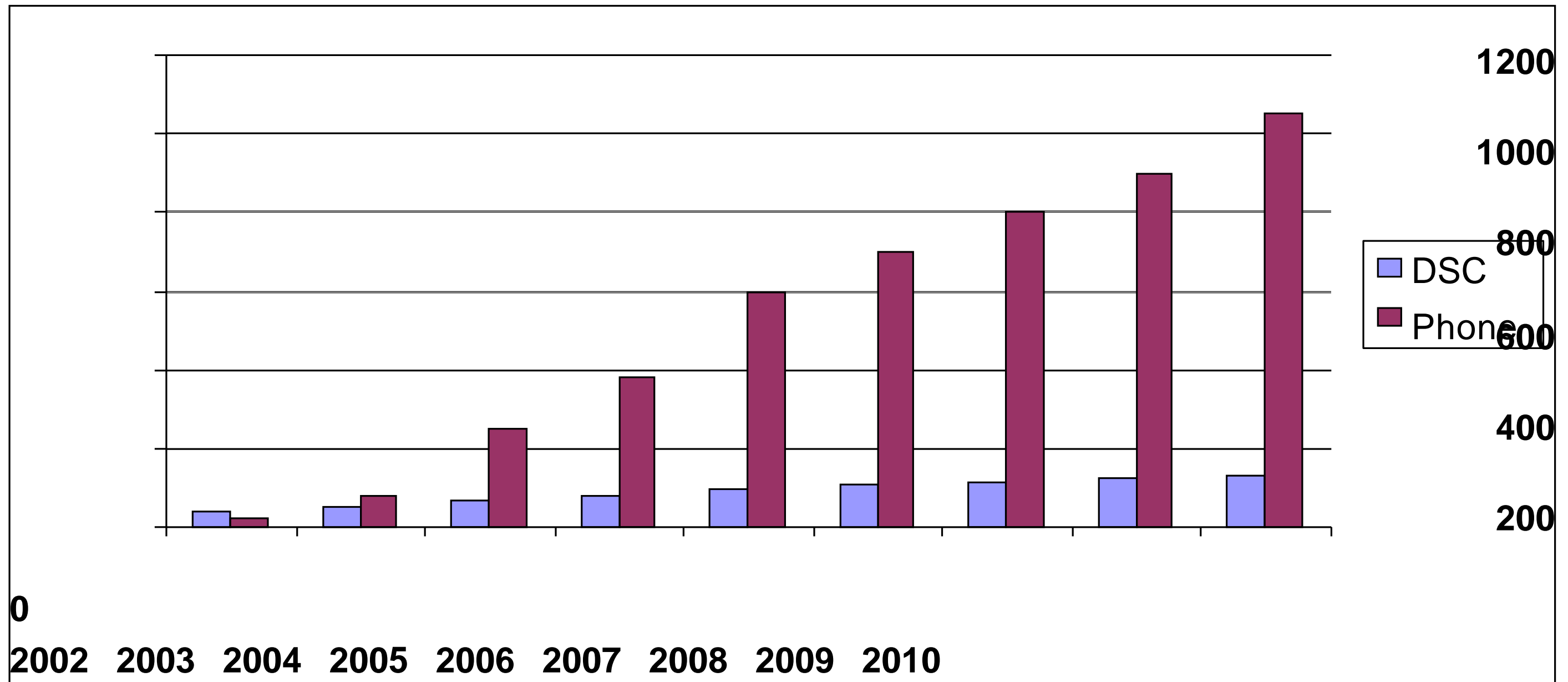
- 1997 Philip Kahn invents camera phone
- 1999 First commercial camera phone



Sharp J-SH04



Millions of Camera Phones

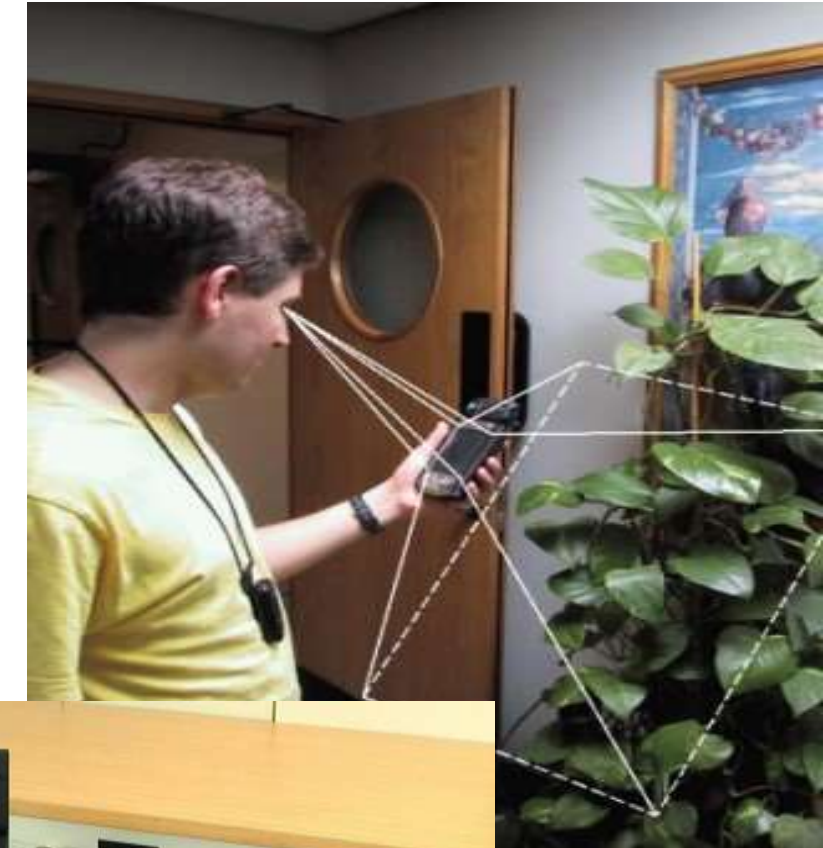




Handheld AR - Thin Client

2001 BatPortal (AT&T Cambridge)

- PDA used as I/O device
- Wireless connection to workstation
- Room-scale ultrasonic tracking (Bat)



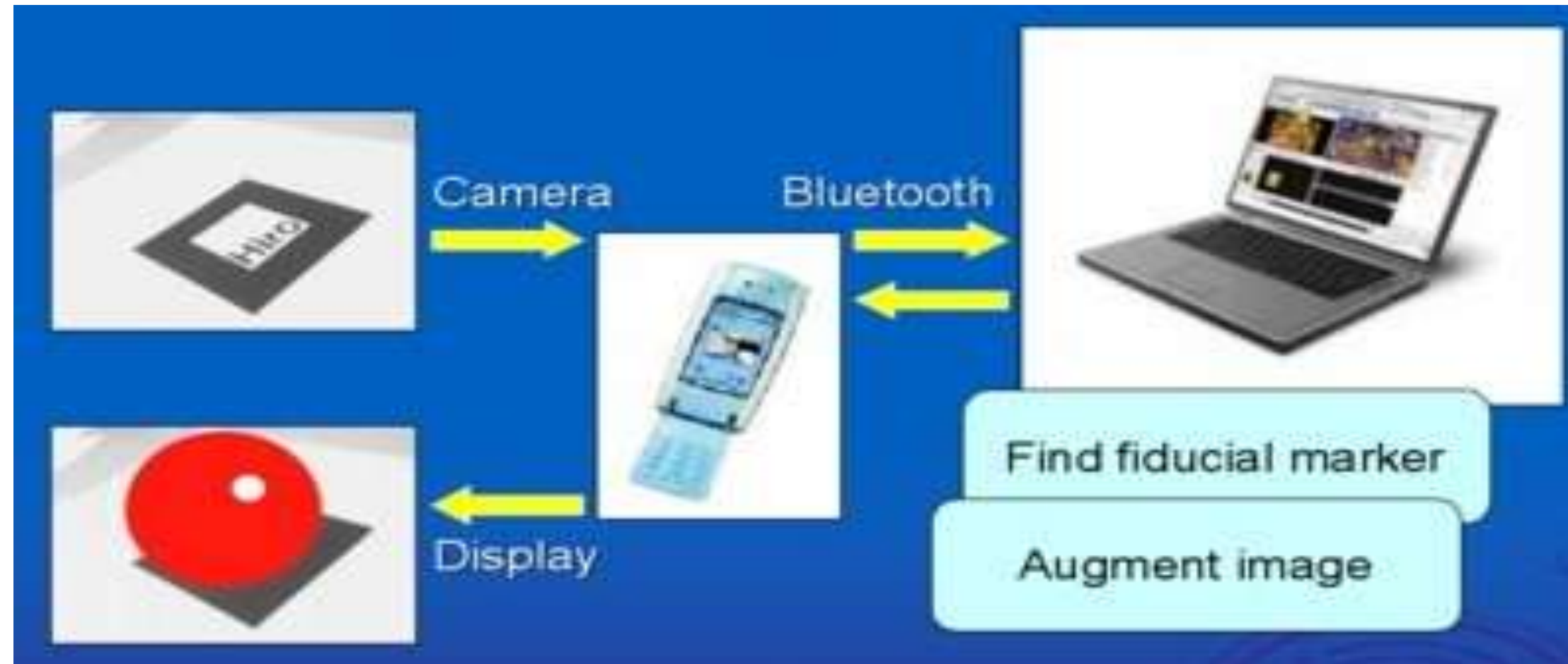
2001 AR-PDA (C Lab)

- PDA thin graphics client
- Remote image processing
- www.ar-pda.com





Mobile Phone AR - Thin Client



2003 ARphone (U niv. of Sydney)

- Transfer images via Bluetooth (slow - 30 sec/image)
- Remote processing - AR Server

•



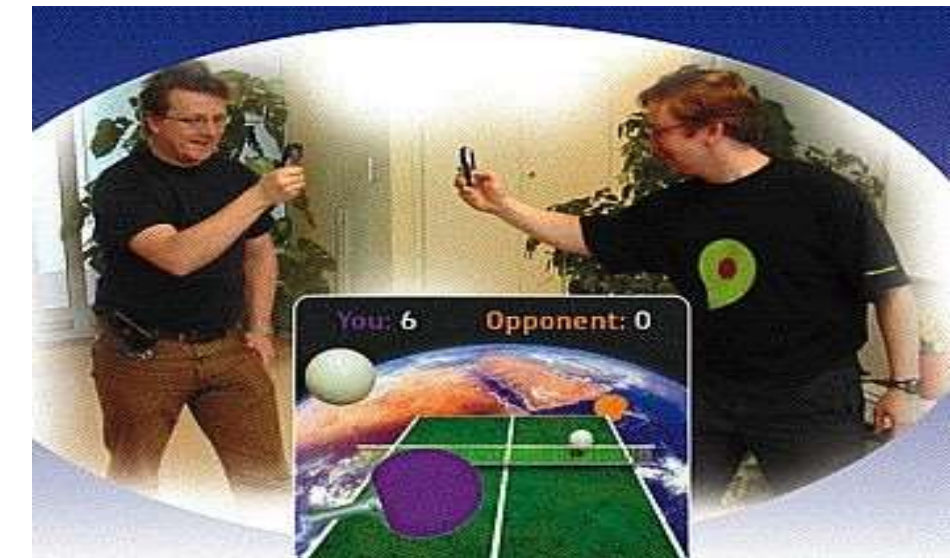
Early Phone Computer Vision Apps

2003 - Mozzies Game- Best mobile game
Optical motion flow detecting phone orientation
Siemens SX1 - Symbian,
120Mhz, VGA Camera



2005 - Marble Revolution (Bit-Side GmbH)
Winner of Nokia's Series 60 Challenge 2005

2005 - SymBall (VTT)

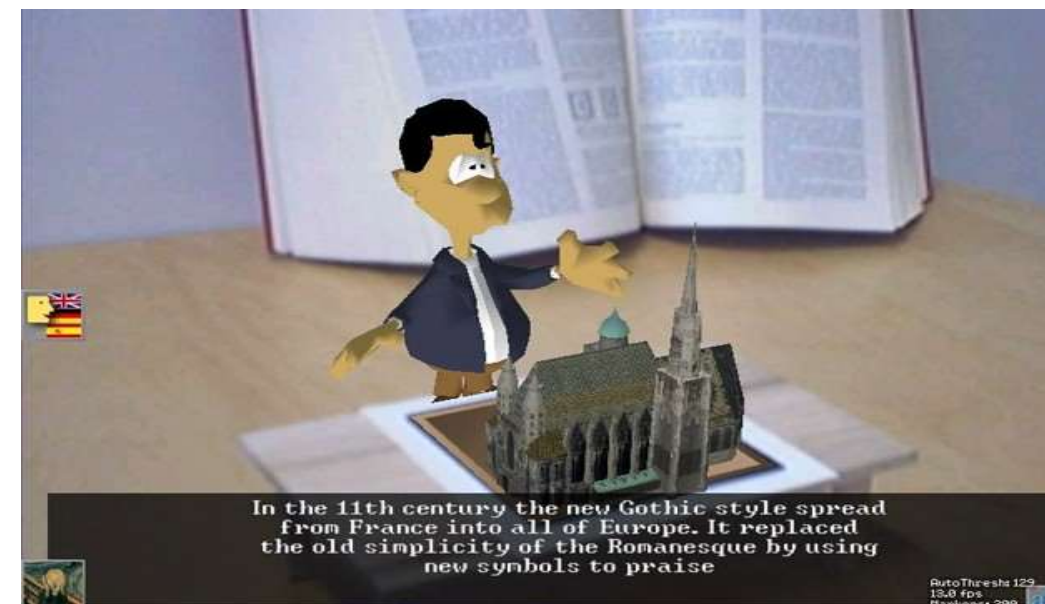




Handheld AR - Self Contained

2003 PDA-based AR

- ARToolKit port to PDA
- Studierstube ported to PDA
- AR Kanji Educational App.
- Mr Virtuoso AR character
- Wagner's Invisible Train
- Collaborative AR





Mobile Phone AR - Self Contained

2004 Mobile Phone AR

- Moehring, Bimber
- Henrysson (ARToolKit)
- Camera, processor, display together





AR Enters Mainstream (2007-)

- **Magazines**
 - MIT Tech. Review (Mar 2007)
 - 10 most exciting technologies
 - Economist (Dec. 2007)
 - Reality, only better
- **Games**
 - Sony “Eye of Judgement”
 - 300,000+ units shipped
- **Broadcast TV**
 - Sports broadcasting





Google Searches for AR





Browser Based AR (2008 -)

- Flash + Camera + 3D graphics
- High impact
 - High marketing value
- Large potential install base
 - 1.6 Billion web users
- Ease of development
 - Lots of developers, mature tools
- Low cost of entry
 - Browser, web camera





Mobile AR (2005 -)

- **Mobile Phones**
 - Camera, processor, display
 - Computer vision based AR
- **Advertising**
 - HIT Lab NZ (2007)
 - AR print advertisement
 - Txt to download app





Mobile Outdoor AR (2009 -)

- Mobile phones with GPS
- Tag real world locations
 - GPS + Compass input
 - Overlay graphics data on live video
- Applications
 - Travel guide, Advertising, etc
- Wikitude, Layar, Junaio, etc. Public API released



Motorola Droid





Layar - www.layar.com





Qualcomm



- Acquired Imagination
- October 2010 - Releases free Android AR SDK
- Computer vision tracking - marker, markerless
- Integrated with Unity 3D renderer
- <http://developer.qualcomm.com/ar>



Rock-em Sock-em



- SharedAR Demo
- Markerless tracking



Wearable Computing

- **Computer on the body that is:**
 - Always on
 - Always accessible
 - Always connected
- **Other attributes**
 - Augmenting user actions
 - Aware of user and surroundings





Google Glass (2013)





View Through Google Glass

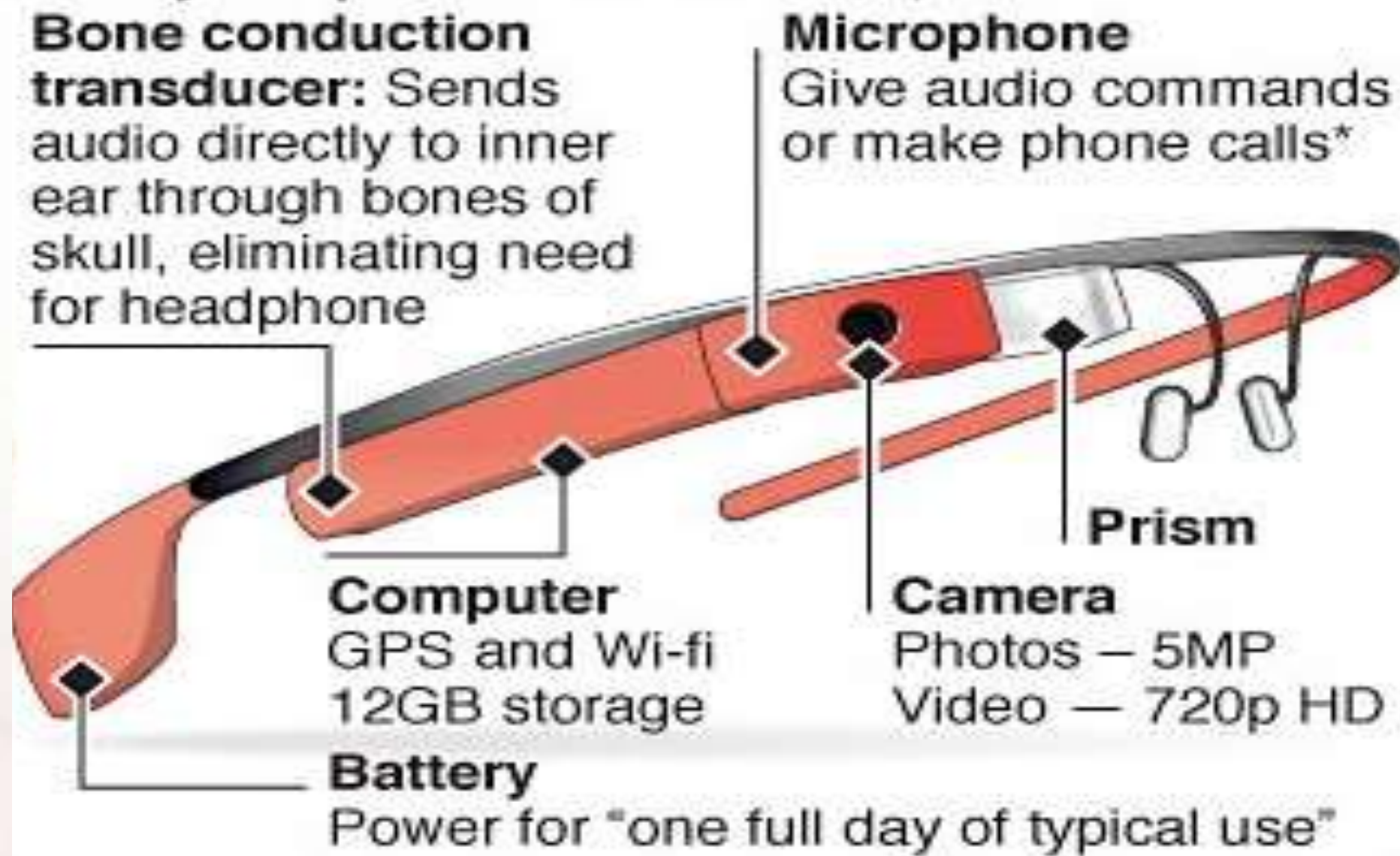


Always available peripheral information display
Combining computing, communications and content capture



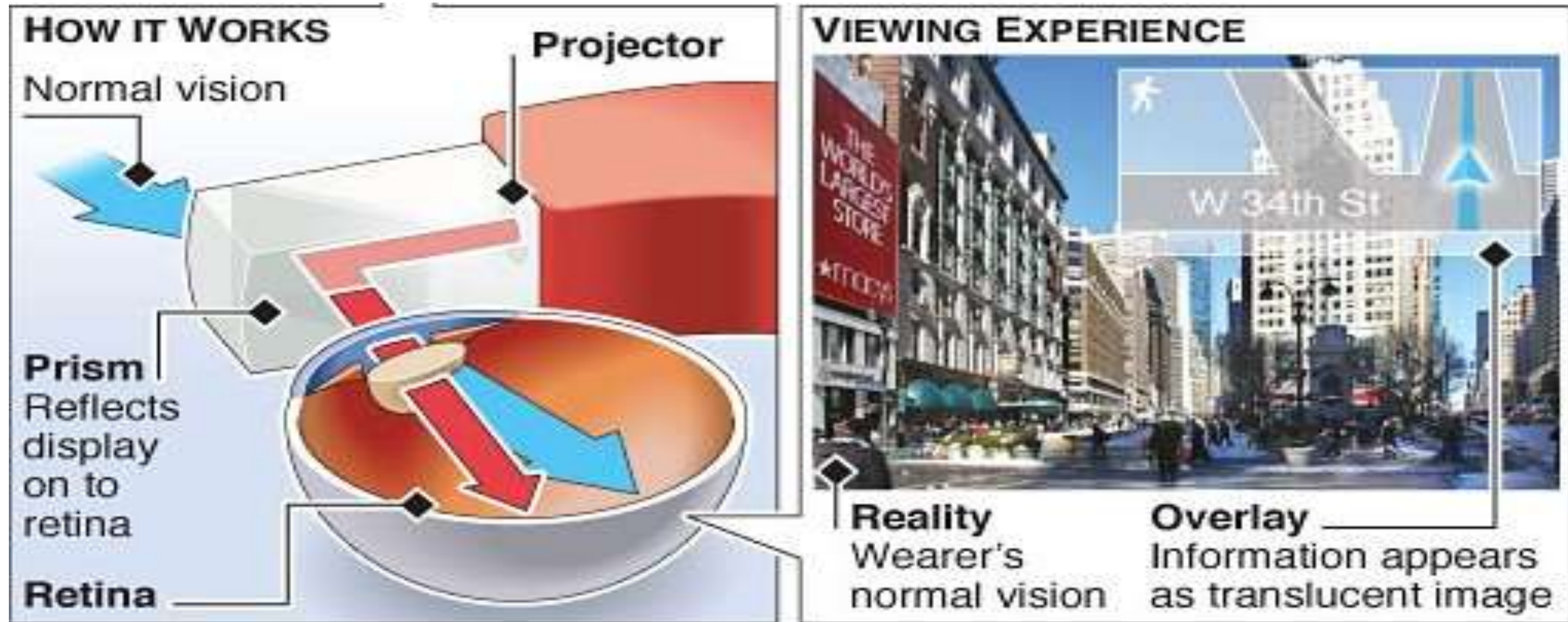
Google Glass augmented reality computer

Google Glass, a wearable computer with a head-mounted display, has gone on sale to early adopters at a cost of \$1,500





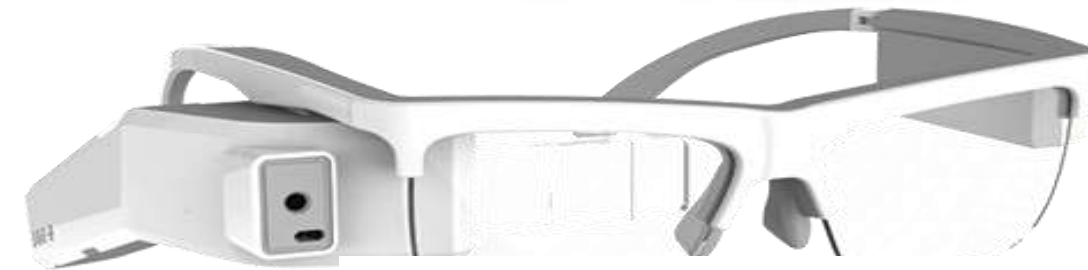
Glass and AR





Display Competitors

- **Vuzix M100**
 - \$1000
- **Recon Jet**
 - \$600, more sensors, sports
- **Optinvent ORA**
 - 500 Euro, multi-view mode
- **Epson Moverio BT-200**
 - \$700 Binocular, stereoscopic 3D





AR Today

- **Key Technologies Available**
 - Robust tracking (Computer Vision, GPS/sensors)
 - Display (Handheld, HMDs)
 - Input Devices (Kinect, etc)
 - Developer tools (PTC, Wikitude)



AR Business Today



- Around \$600 Million USD in 2014 (>\$2B 2015)
- 70-80+% Games and Marketing



AR Business Today

- **Marketing**
 - Web-based, mobile
- **Mobile AR**
 - Geo-located information and service
- **Gaming**
 - Mobile, Physical input (Kinect, PS Move)
- **Upcoming areas**
 - Manufacturing, Medical, Military





Augmented Reality Landscape

Version 1.4, May 11th, 2013



Agencies

Apps

Browser

Developer

Events

Games

Glasses / Lenses

Platforms / SDK

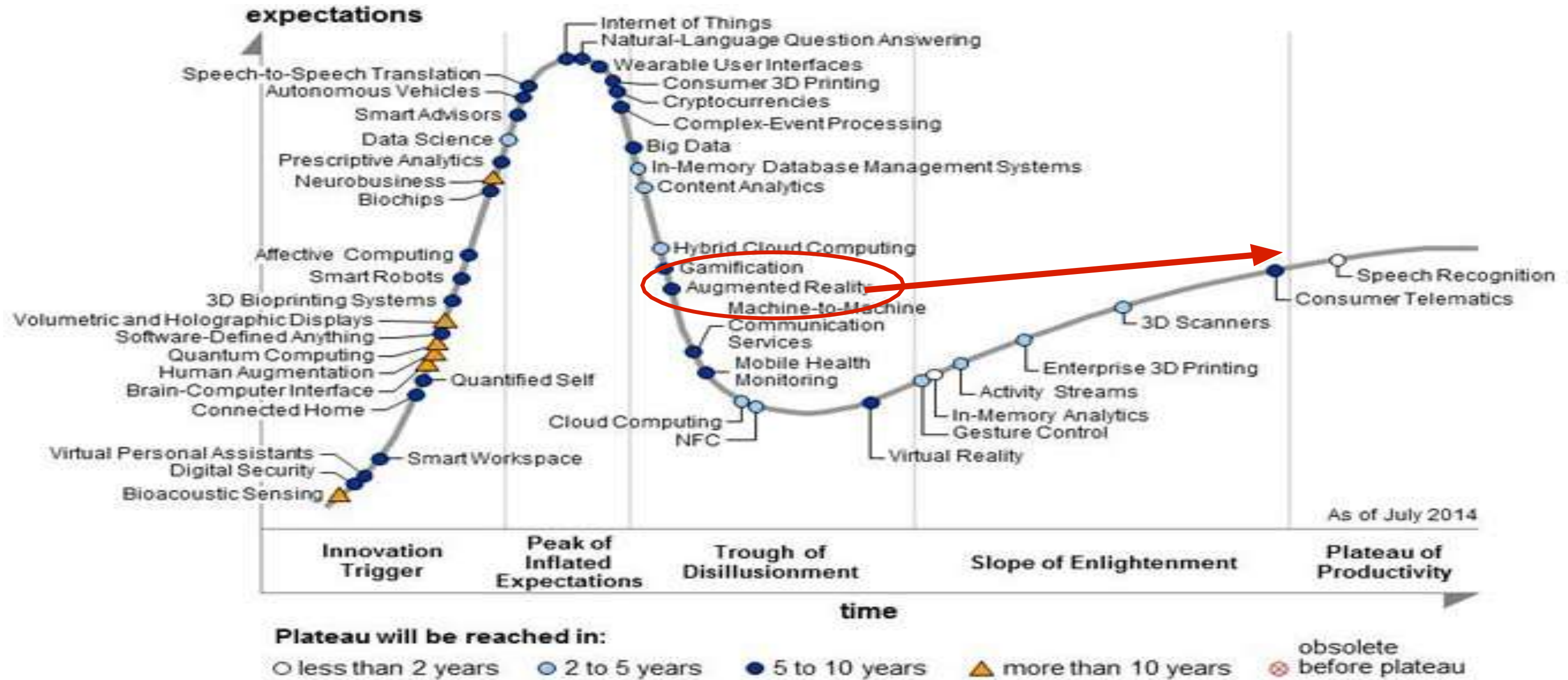
Image Recognition

Institutions / Science

Software

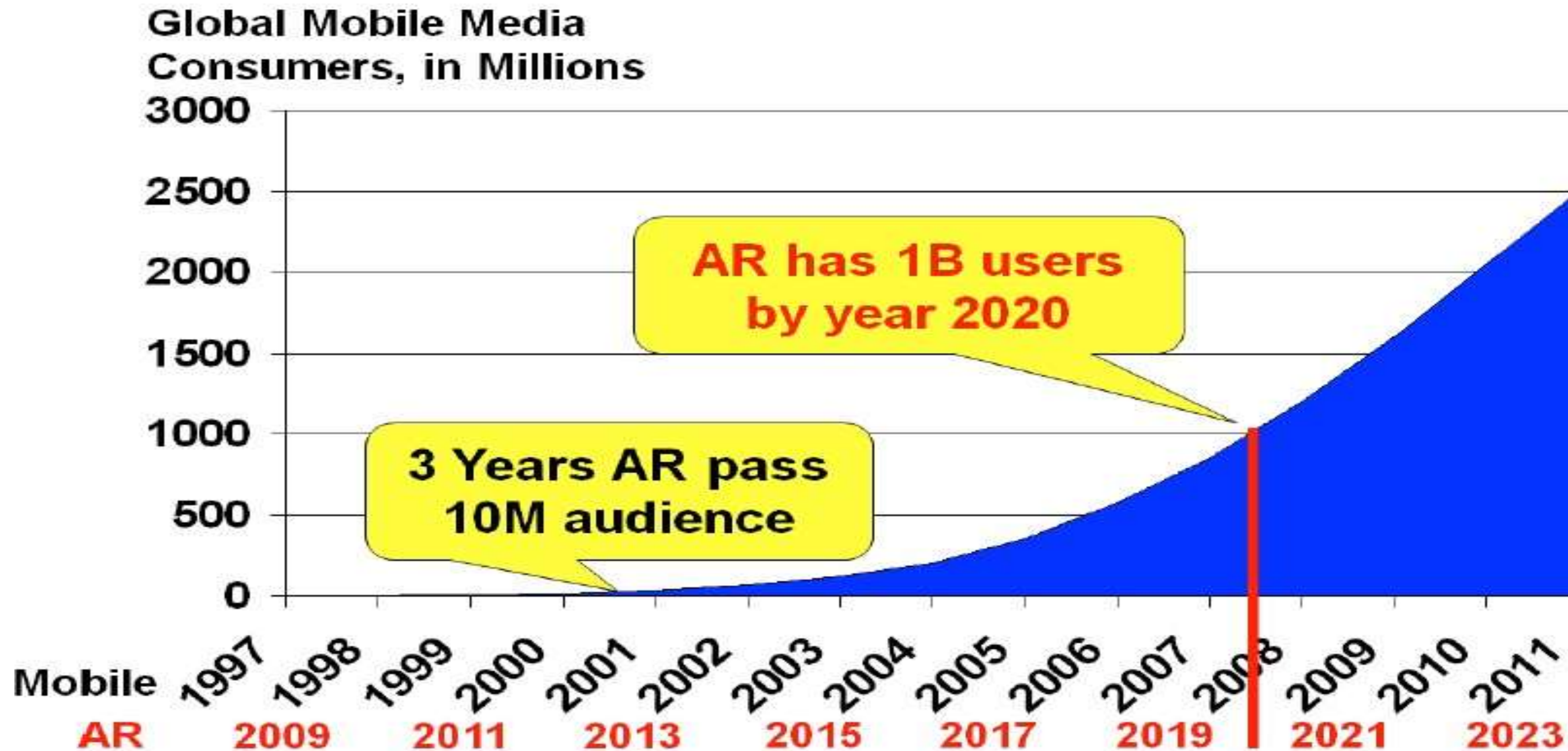


Gartner Hype Cycle





User Forecast



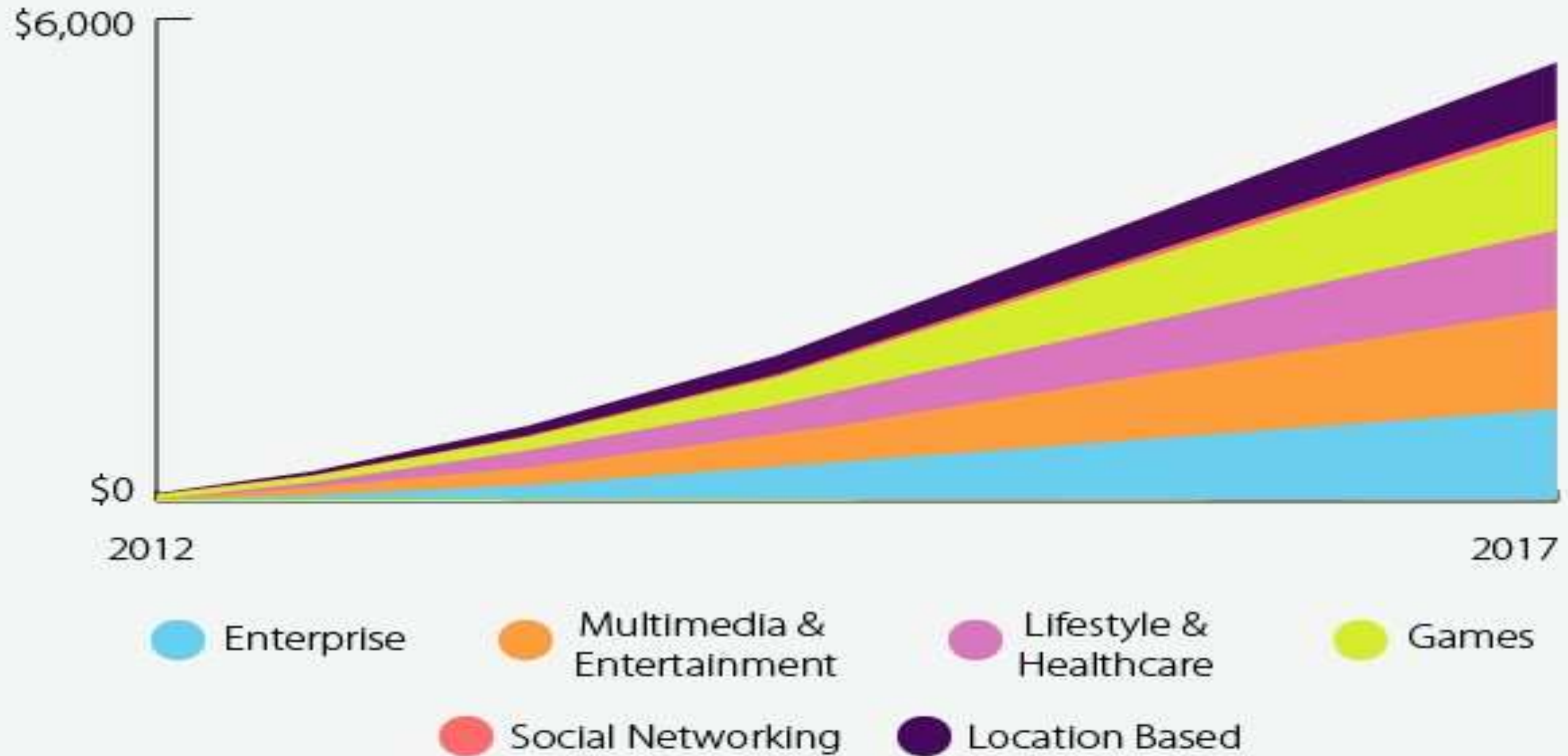
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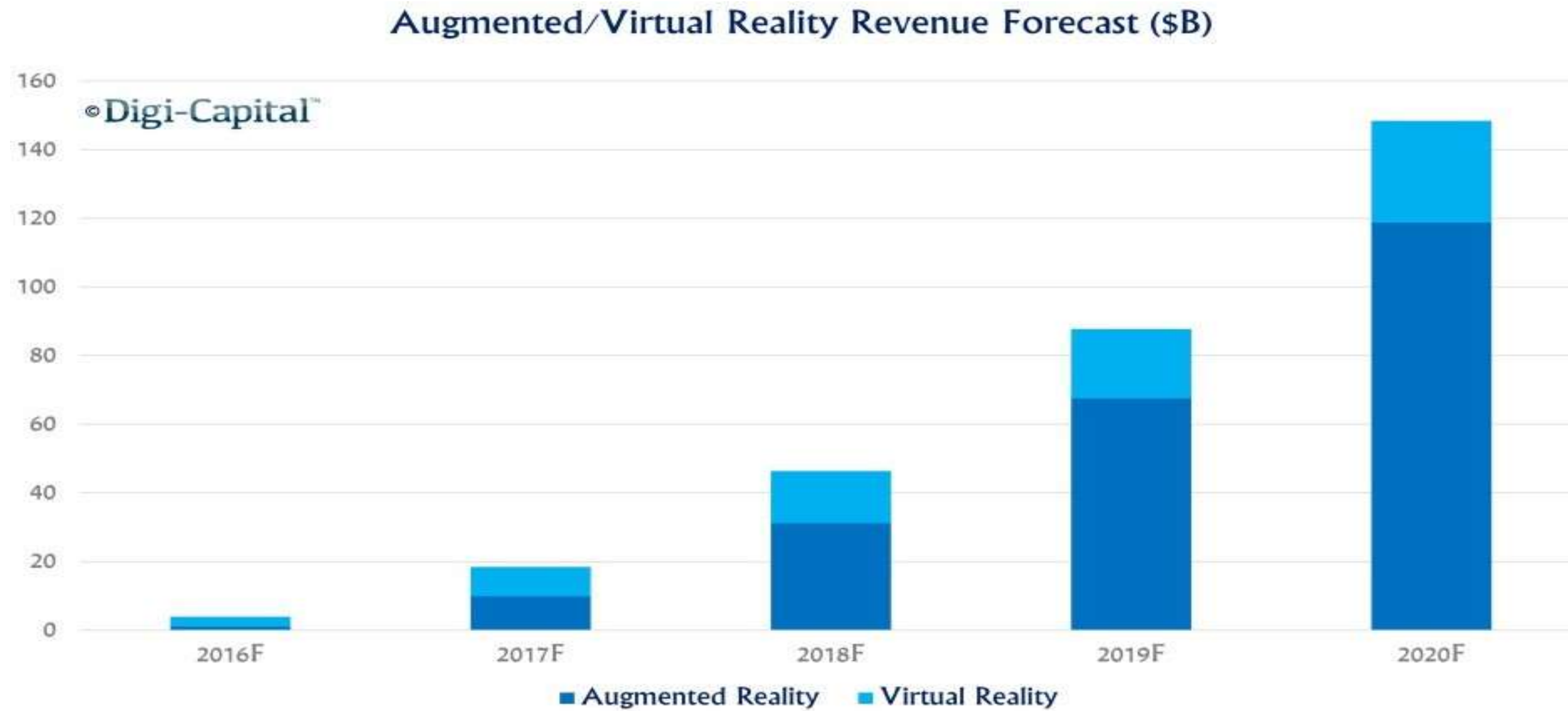


Total Mobile AR Revenues (\$5.2bn) on Mobile Devices Split by Category - 2012 to 2017





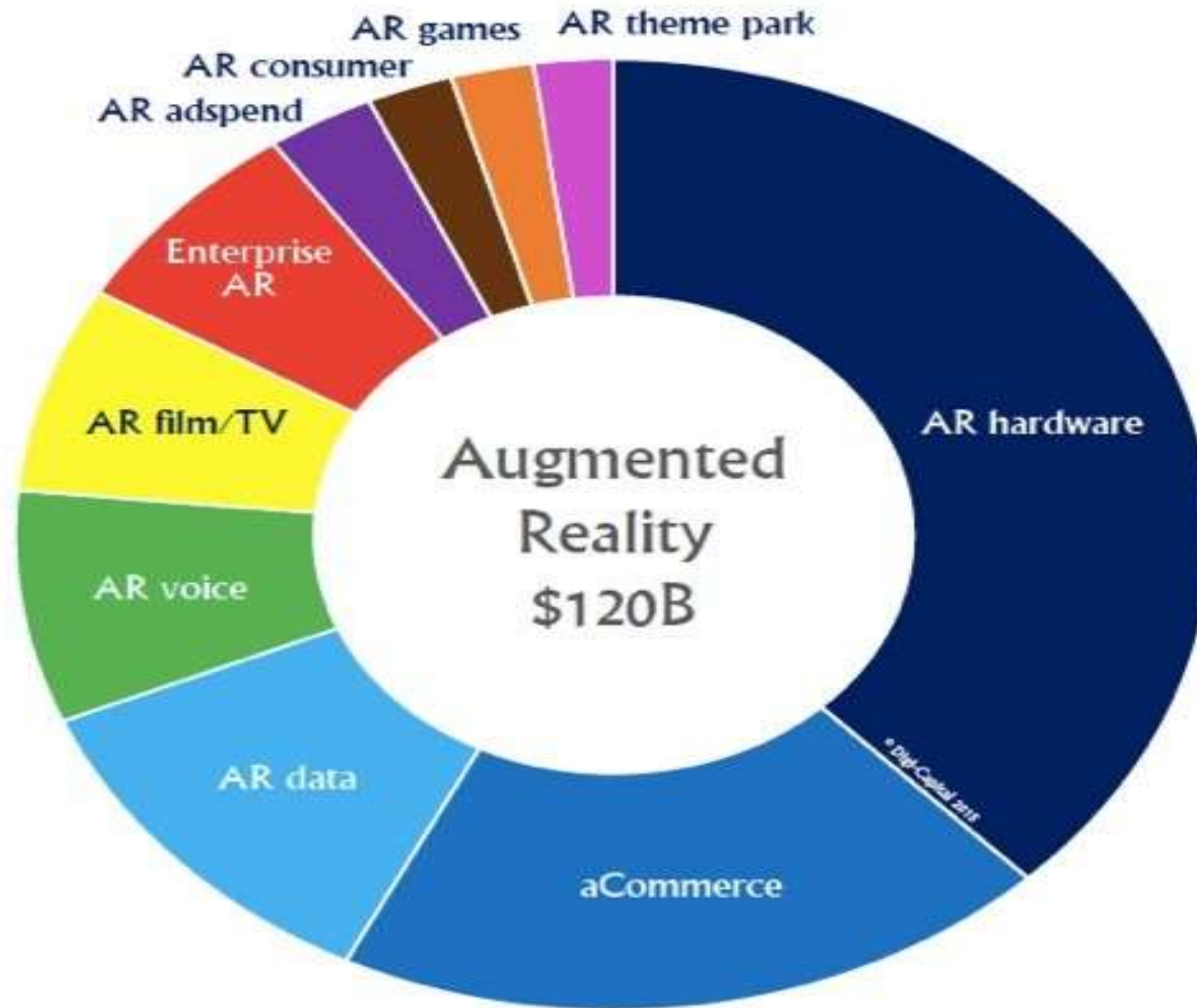
Market Forecast



Up to \$120B by 2020 - 5 x VR market



Digi-Capital™ Augmented/Virtual Reality revenue share 2020





What Markets will AR/VR Cannibalize and Grow?

VR



Tens of millions of users



AR



Hundreds of millions of users



The Addressable Markets

VR



AR





Mobile AR Apps



Wikitude
(Mobile)



Funda
(Mobile)



Yelp
(Mobile)



ScanSearch



From GeoInfo/Tagging To Entertainment
Richer 3D Graphics
More Accurate Tracking
(With Computer Vision)



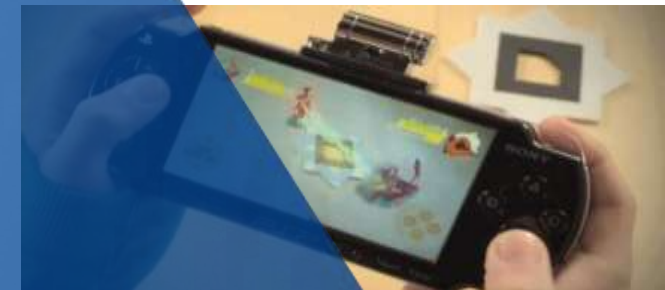
Layar
(SPRX Mobile)



junaio
(Metaio)



Firefighter360
(Presselite)



Invisimals
(Sony)



Kweekies
(Int'l)



ARf
(Georgia Tech)



Summary

- Augmented Reality has a long history going back to the 1960's
- Interest in AR has exploded over the last few years and is being commercialized quickly
 - Smart Phones with sensors/cameras
- Mobile AR is growing in a number of areas
 - Gaming, Tourism, Marketing experiences