Augmented reality and perception of analogue and digital images and maps

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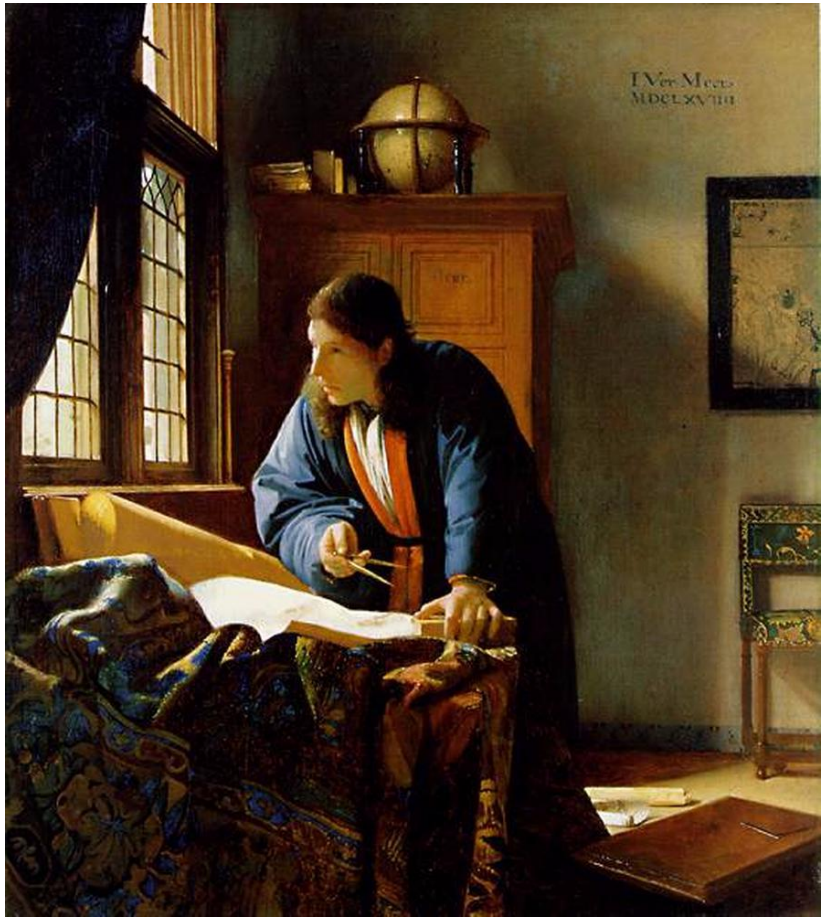
UNIVERSITY OF WARSAW

Augmented reality metaphor



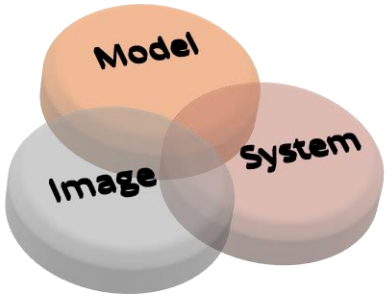
„Roger Downs, professor of geography (…) uses Johannes Vermeer's famous painting (…) *The Geographer* to make an important point about virtual realities. On the table in front of the figure is a map, taken to represent the geographer's window on a part of the world that happens to be of interest. But the subject figure is shown looking out of the window, at the real world, perhaps because he needs the information he derives from his senses to understand the world as shown on the map."

Geographic Information Systems and Science, by Paul A. Longley, Mike Goodchild, David J. Maguire, David W. Rhind pp. 286-287, 2005

Printed map is yet important but there is rising challenge of growing use of mobile (digital) maps.

Courtesy, students of University of Warsaw, May 2016

Facebook, courtesy, B.Murgante, November 2015



Definition of map is changing

Discussion about digital map and its usefulness in information society

(Commission of Geoinformatics, Polish Academy of Arts and Sciences)

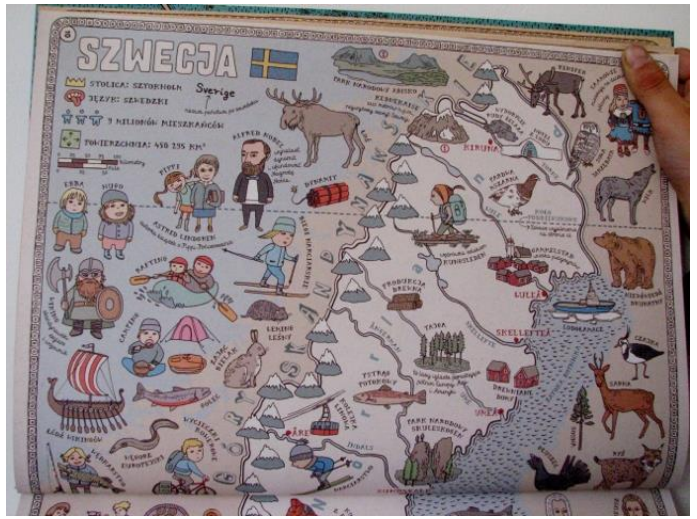
- Maps, as spatial notations of the reality surrounded us, are linked to the process of civilization changes since the earliest times…
- … the question of map ontogenesis is the question of human-milieu relation. Optimal solution of this issue results from integrated human structures: somatic, psychological and mental, revealing during the actions in the environment, including also the creative and useful role of vision of the map.
- (…) map (…) is oriented information entity based on unity of three concepts: system (target), model (information) and image (transmission) → *tria iuncta in uno.*

Source: T.Chrobak, December 2015

Definition of geographical map

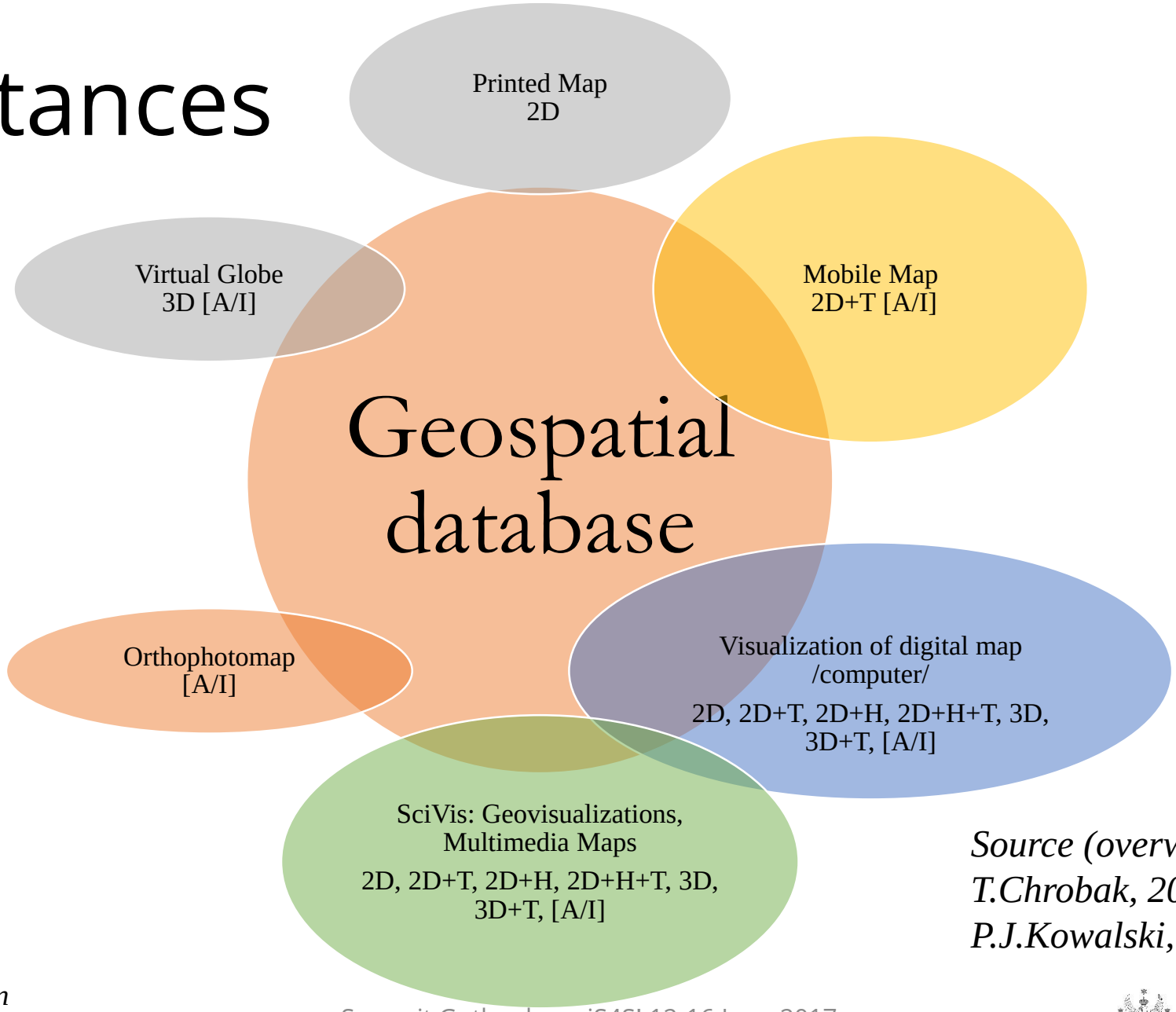
- Taking into account that the relation between map and human action is causal, the content of definition of map according to A.Makowski (2005) is as following:

„ Geographic map is a systemic model-image information entity, mapping space-time situations in context of human intentional action in adopted georeferenced system coordinates.”



source: http://pozarozkladem.blogspot.com/2012/10/juz-sa-mapy.html

Map instances



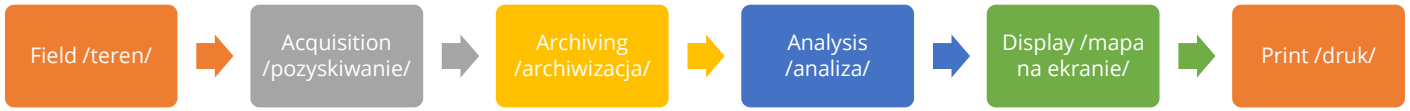
Legend:
2D, 3D: spatial dimensions
T: time
H: height/depth
A: animation
I: interaction
SciVis: scientific visualization

Source (overworked & changed):
T.Chrobak, 2015
P.J.Kowalski, 2014

Analogue map (hardcopy - printed paper map)

- Almost all map instances characterize interaction and feedbacks to geospatial database.
  - They make possible update of the digital maps, but only hardcopy i.e. printout of map is finished product and seems completely separated from mother, geospatial database.
    - Update of hardcopy needs restart of the whole production process, and the feedback with geospatial database is limited or does not exist.
- Interaction of hardcopy with digital devices is minimal…

Classic processing of spatial data in Geographic Information Systems



Hardcopy (printed paper map)

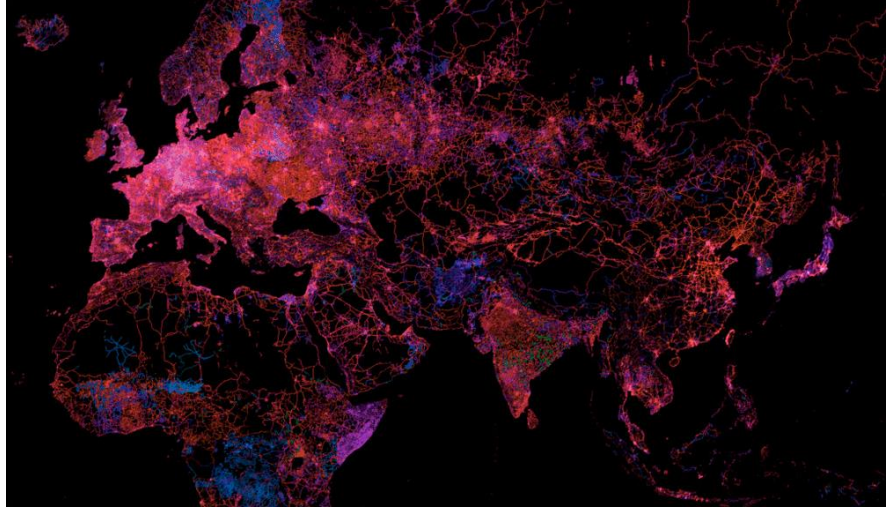
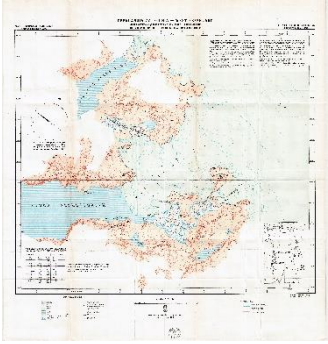


Image: MapBox/OpenStreetMap contributors
The million-plus amateur cartographers who volunteer their time to plot roads, streets, and even shrubbery…

- People still buy and use printed (paper) maps, despite of the digital technologies expansion. They still buy and read newspapers, books or display their scans on digital devices.
  - „the separate problem is fact, that during the travel using GPS device, the large number of users come to conclusion, that paper map may (and absolutely should in any case), calmly lie in a backpack. The GPS information completely support orientation in the hardest terrain. Even if the digital map is not very detailed in the device or presents only the waypoints.”

source: http://www.gpsmaniak.com/new/mapy-papier.htm

Analogue map (hardcopy, printed map)



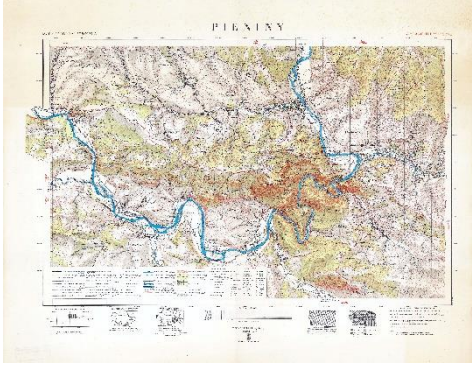
West Greenland – the marginal zone of the inland-ice near Arfersiorfikfiord
First Polish Greenland expedition 1937 of the Geographical Society in Lviv (Lwów)

If paper map yet is not the niche product, one should at least attempt to diagnose the several reasons of this situation:

- First → habits, shaped during the curricular and extracurricular education i.e. formal and tacit knowledge of printed maps, atlases and guidebooks…
- Second → lack of WiFi or GPS signal (regardless of reason)…
- Third → lack of knowledge and skills which make possible *a vista* generation of digital (professional) map by the users from accessible sources in net and ever more widely available software and geolocation tools.

Analogue map (hardcopy, printed map) /continued/

Pieniny Mountains – tourist map
Polish Military Geographical Institute, 1937



If paper map yet is not the niche product, one should at least attempt to diagnose the several reasons of this situation:

- Fourth → psychological human mechanism → belief in „durability" of printed image, which is available any time without additional equipment…
- Fifth → hardcopy, printout map documents the state of real world in defined point of time and may be the proof (according to law) to any public or individual decisions, actions, projects and claims…

  …
- N-th → one can enumerate the several other reasons (I have, for sure, omitted them), e.g.
  - Historical documentation…
  - Aesthetical values of map as the work of art.
  - etc…

Augmented reality /definition/

- Ronald T. Azuma (1997): To avoid limiting AR to specific technologies, AR is defined as systems that have the following three characteristics:
  - Combines real & virtual
  - Interactive in real time
  - Registered in 3D

Azuma, R. T. (1997). A Survey of Augmented Reality. Presence: Teleoperators and Virtual Environments, 6(4), 355–385. https://doi.org/10.1162/pres.1997.6.4.355

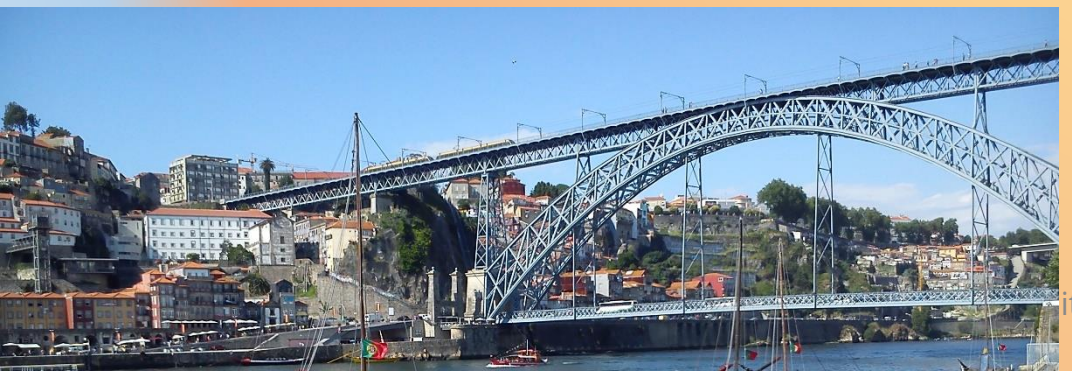
Augmented Reality AR

- AR is dynamic overlay of digital, virtual images and information concerning real environment, which is observed.
    - Images and virtual information change constantly while observer is moving.
- AR means to integrate synthetic information into the real environment.
- The overlay of spatially-registered computer graphics over a live image of the real-world

Traugutta St. in Warsaw, Poland: now and before 1915

AR application (according to Pardel,2009)

- Geolocation – GPS: Geographic Information Systems, Location Based Services ←→ marine & air traffic,
- Security and military applications,
- Interactive maps: display & interactive analysis of terrain, interactive 3D maps, landscape visualizations,
- Building Information Modeling (BIM): visualization & modeling of buildings and urban fabric,
- Support for visitors: displaying tags & labels of observed objects,
- Simulations: flight & drive simulators,
- Virtualization of conferences,
- Entertainment & education,
- **Newest: Google graphics → geolocation using images of terrain objects → search by images**



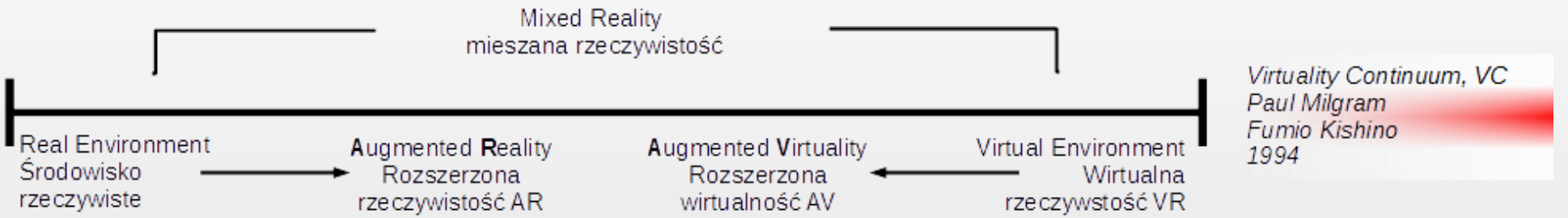
Ponte Luís I, Porto, Portugal

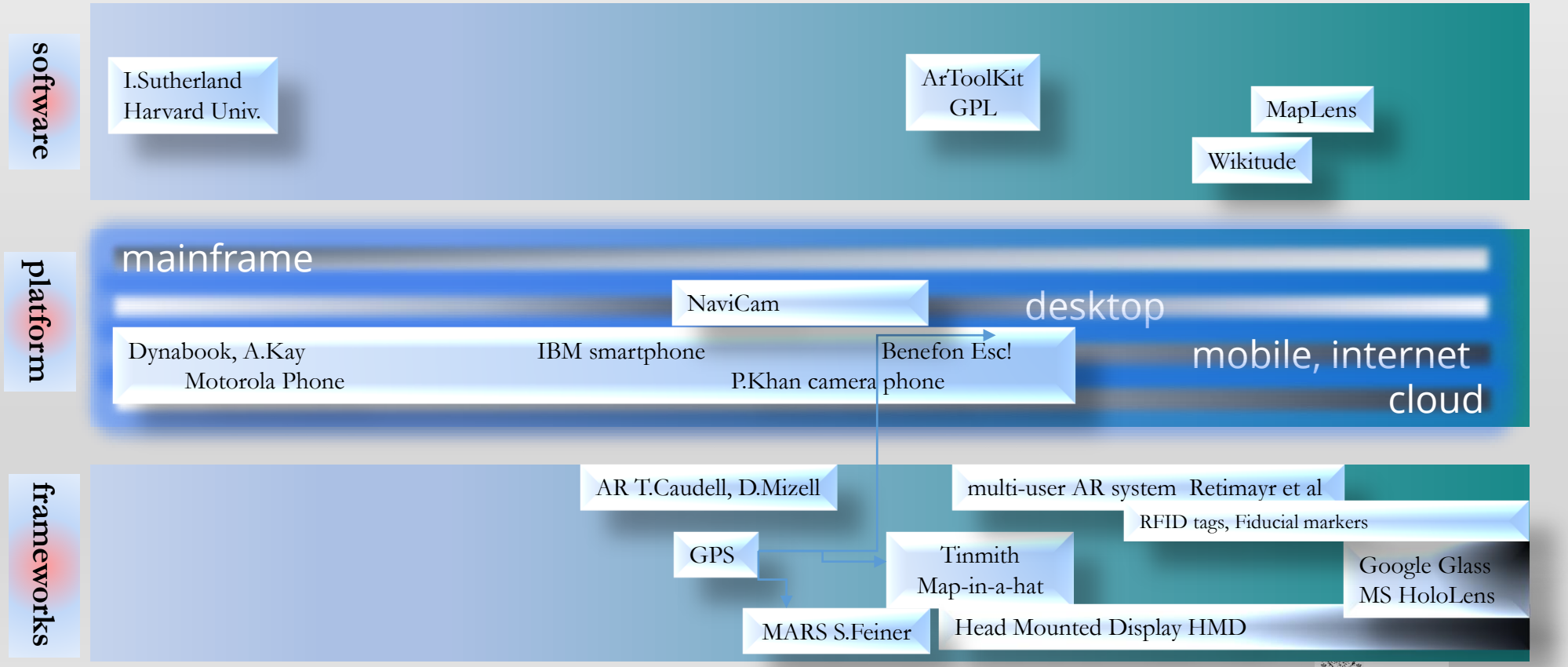
AR classification

- Two different augmented reality display concepts exist to superimpose graphics onto the user's view of the real world:
  - **Video see-through** and **optical see-through** head-mounted displays (HMD) have been the traditional output technologies for augmented reality applications for almost forty years.
- SAR → spatial augmented reality approach
  - New display paradigms exploit large spatially-aligned optical elements, such as mirror beam combiners, transparent screens, or holograms, as well as video projectors.
- In many situations, SAR displays are able to overcome technological and ergonomic limitations of conventional AR systems

Bimber, O., & Raskar, R. (2005). Spatial augmented reality merging real and virtual worlds. Norwood Mass.

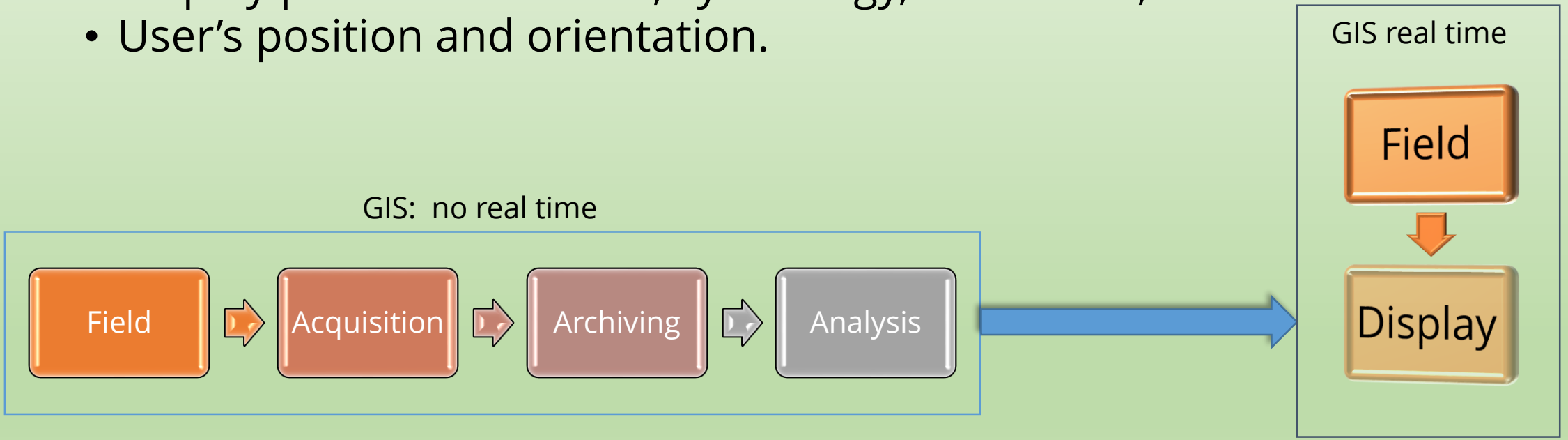
AR Milestones





GIS / AR processing chain

- Input parameters:
  - User request,
  - Display parameters /scale, symbology, metadata/,
  - User's position and orientation.



Combination of GIS & AR

- Indoor/Outdoor exploration of geographical data.
  - **Augmented Map (AM)** → Exploration of geospatial data directly from real or virtual (digital) world → **Augmented Virtuality**.
  - **Augmented Territory (AT)** → additional information during exploration of natural (or anthropogenic) environment → **Augmented Reality**

These types are designed and implemented into applications (e.g. GPS navigation).

Bimber, O., & Raskar, R. (2005). Spatial augmented reality merging real and virtual worlds. Norwood Mass

How to include hardcopies (printed paper maps) into to chain of digital world?

- So far AR predominantly is related with mobile (digital) maps and there are „few practical applications” (except navigation)
- Ann Morrison (2011) experimented with augmented reality (AR) using a magic lens over a paper map using smartphones.
- *„Maps are one of the main application categories for mobile AR. The focus is in augmentation of physical maps with useful and interesting real-time information. Paper maps have a large static surface and AR can provide a see-through lens without forcing the user to watch map data only through the small `keyhole` of the display”*

Morrison, A. et al. (2011). Collaborative use of mobile augmented reality with paper maps. Computers & Graphics, 35(4), 789–799. http://doi.org/10.1016/j.cag.2011.04.009

Some findings…

- … points out, that type and layout of physical map undergone augmented reality operation (augmented map) affect its efficiency while using mobile devices (through spatial pattern analysis and ways of users' interaction).
- *„…technical difficulties have mostly prevented (…) studies of outdoor AR use in uncontrolled environments."*
- *„The maps act as mediation objects for multimodal discourses providing resources such as a context and facilitation for embodied communication."*

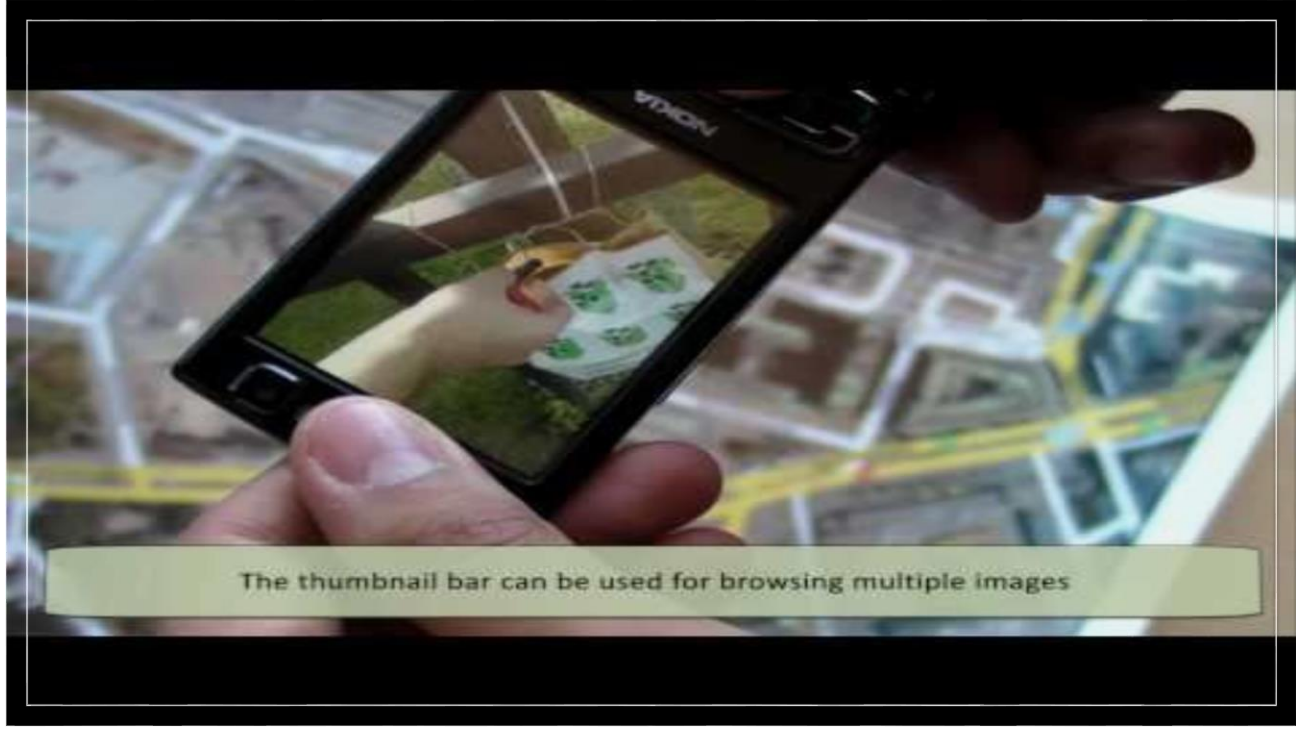
source: Morrison, A. et al. (2011) Collaborative use of mobile augmented reality with paper maps. Computers & Graphics, 35(4), 789–799. http://doi.org/10.1016/j.cag.2011.04.009

MapLens in action

- „A unique characteristic of mobile AR is the *dual-presence* of information: aspects of the physical background (at which the camera is pointed) are represented simultaneously with extra information on the viewfinder.”
- „Also traditionally, optical markers (e.g. dotted maps) have been used for tracking, which require specifically modified printed maps”

(source: Morrison, A. et all 2011)

However Symbian is past, but the idea of augmented map is vital.

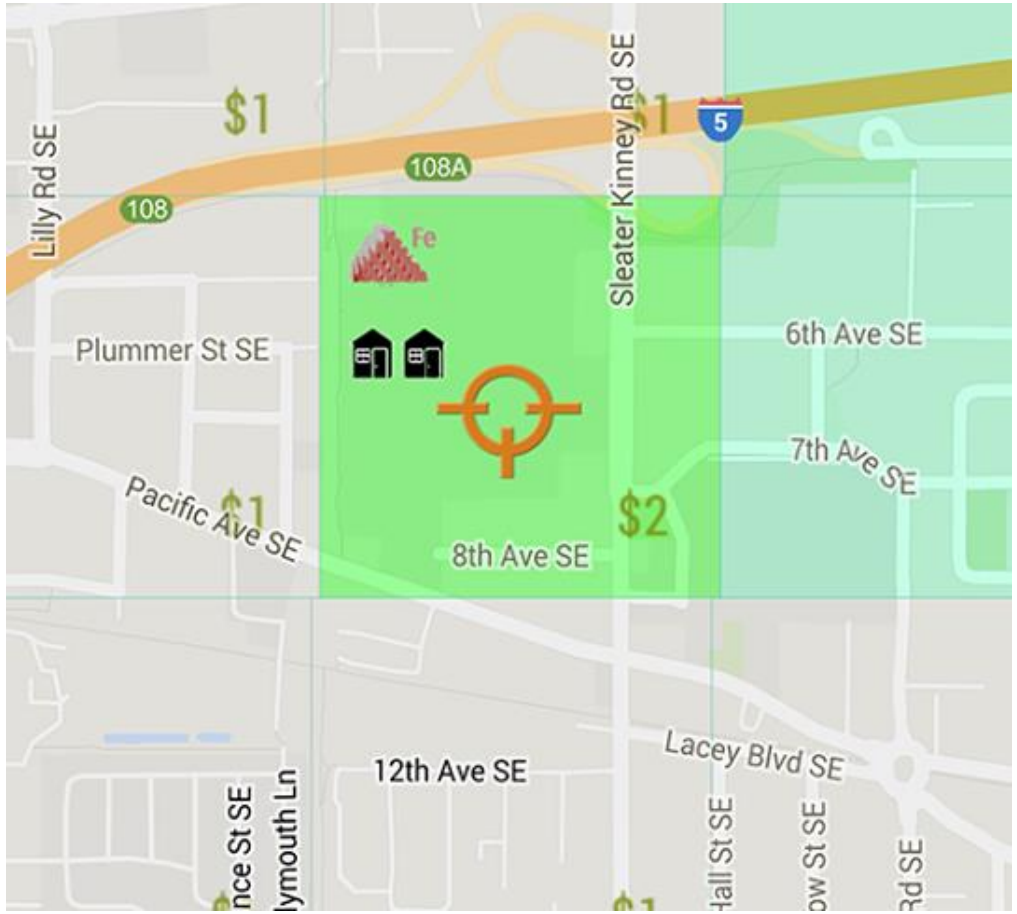


„When a markerless paper map is viewed through the phone camera, the system analyses and identifies the GPS coordinates of the map area visible on the phone screen. Based on these coordinates, location based media (photos and their metadata) is fetched from HyperMedia Database (HMDB).
Markers to access the media by clicking the selected marker showing the thumbnail of the photo are then provided on top of the map image on the display”

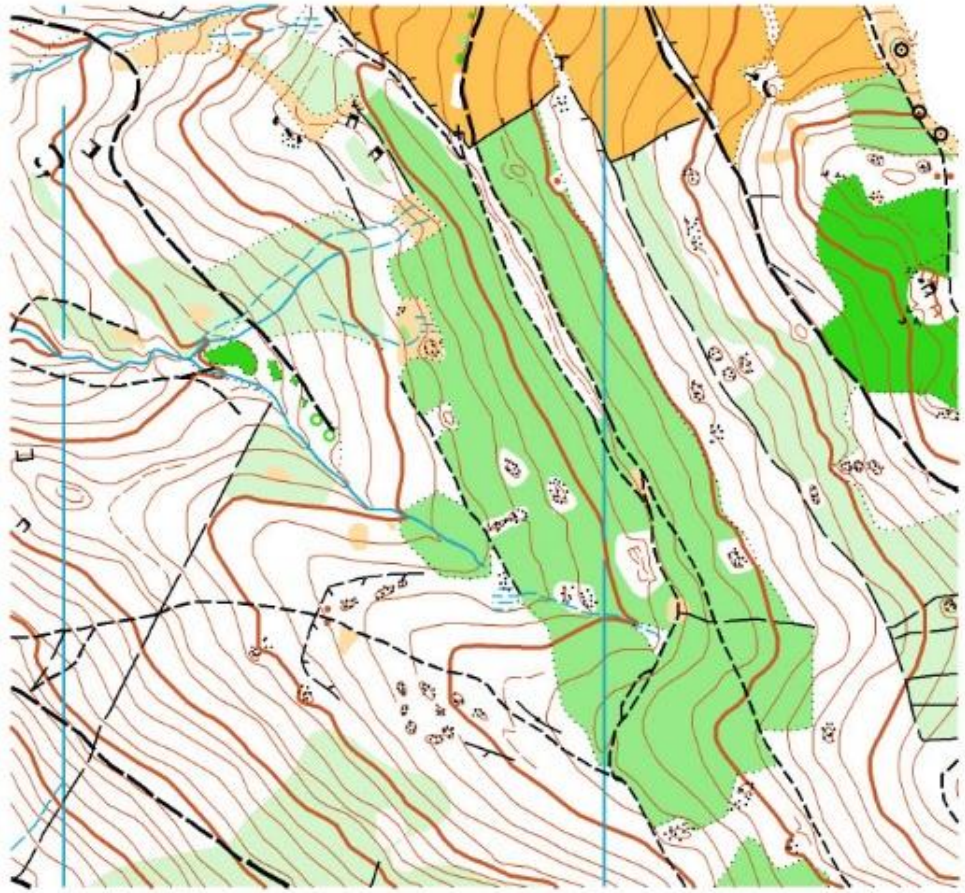
Other examples...

LBS games ≡ geocaching ≡ orienteering?

Instruments:
smartphone, GPS, application;



map, compass /source: Wikipedia/



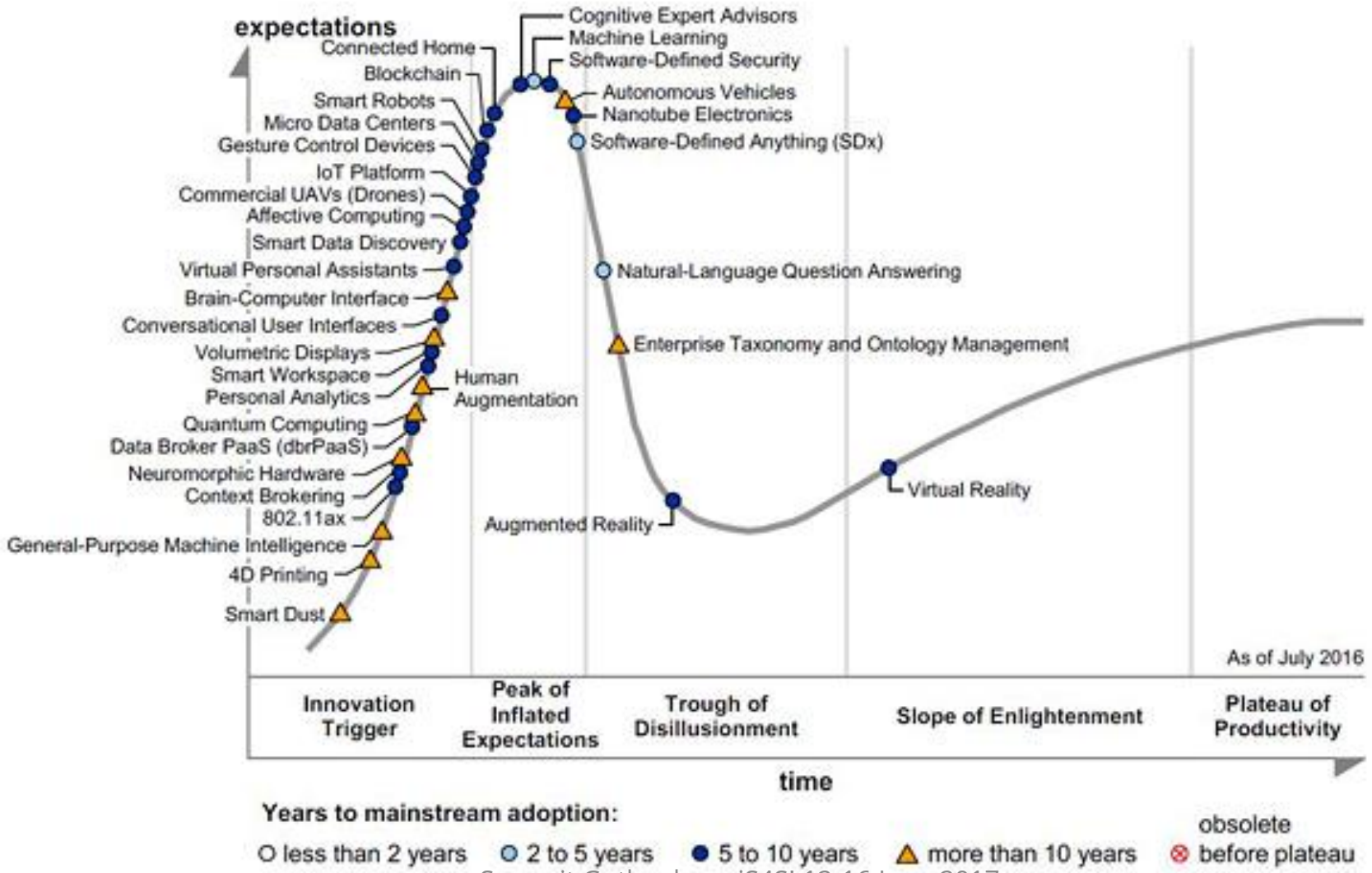
Yet another example…
not exactly but almost paper…

- Avenza PDF map (http://www.pdf-maps.com)

Gartner Identifies the Top Strategic Technology Trends

Gartner 2012	Gartner 2016	Gartner 2017
connected world	merging the physical and virtual worlds	Artificial Intelligence and Advanced Machine Learning
		Intelligent Apps
interface trends	emergence of the digital mesh	**Intelligent Things**
		Virtual Reality and Augmented Reality
		Digital Twins
analytical advances	algorithmic business	Blockchains and Distributed Ledgers
		Conversational Systems
new digital frontiers	new IT reality, the new architecture and platform	Mesh App and Service Architecture
		Digital Technology Platforms
		Adaptive Security Architecture

Gartner's 2016 Hype Cycle for Emerging Technologies



Source: Gartner (July 2016)

Types of Mobile Augmented Reality

source: Khan, A. et al. (2015). Rebirth of Augmented Reality-Enhancing Reality via Smartphones. Bahria University Journal of Information & Communication Technology, 8(1), 110.

Marker based AR

Indoor applications

- Template markers
- 2D barcode

This reality type uses visual marker known as fiducial or AR card to determine center, orientation and range of coordinate system.

The system detect marker, identify and calculate pose of the object with help of computer vision techniques

Marker-less/Gravimetric AR

Outdoor applications

- Marker-less AR utilizes GPS (geopositioning), compass and other related sensors
- Augmented reality browsers help users to navigate between POIs (Point of Interests) appear on camera view for exploring AR contents based on location and context.

Challenges of mobile augmented reality

source: Khan, A. et al. (2015). Rebirth of Augmented Reality-Enhancing Reality via Smartphones. Bahria University Journal of Information & Communication Technology, 8(1), 110

- **Image capturing capabilities** of smartphones camera are dependent on lighting conditions.
- **Energy consumption** remained an open challenge for smartphones.
- AR applications **access a large amount of data** over networks for locating/navigating point of interests, any downtime of network access may harm instant response to users.
- **Accuracy of sensor information** is a vital component for indoor and outdoor navigation.
- **Lighting Conditions →** technologies are struggling to remain readable in bright outdoor conditions
- **Technology Adoption Life Cycle →** people resists change to adopt new operating mechanism for handling devices and learning new methods of interactivity and realism.

Does the digital era herald the end of history?

source: http://www.bbc.com/news/technology-32315449 [Accessed 27 April 2015]

- The loss of this data could plunge the world into a **"digital dark age"**, warns "father of the internet" Vint Cerf - one of the inventors of the net's language and architecture.
- Most of our photos, videos, conversations, research and writings are now stored as strings of ones and noughts - distributed throughout the world. [**And after all → maps!!!** *Auth.*]
- **An electromagnetic pulse (EMP)** ..., could easily wipe out entire electricity networks and effectively bring civilisation to a crashing halt.

- **We're only just beginning to understand how important this data is and what the consequences might be if we lost it**

Target: inclusion of paper map or analogue image into the chain of digital devices use

- If there is no mobile operator coverage …
- If there is no wireless coverage …
- If for any reason there is no GPS signal on the smartphone …

- But, the battery is still charged; and in the pocket a paper (augmented) map; and maybe a compass (analogue) on the watch strap ¡

How to include the paper map into the digital world using AR?

- **Mix of different known technologies**
  - **Digital and classic steganography,**
  - **AR – augmented reality,**
  - **Fiducial markers,**
  - **Mobile device with different sensors, GPS, etc…**
  - **Access to GPS and WiFi signal,**
  - **(last but not least) analogue (printed) paper map (or image)**

The idea… (after hours)

- to include a set of tags into the symbology of map,
- without disturbing traditional, human perception,
- to expand the volume of information contained in the printed paper map …

- i.e. steganographic information layer, overlaid on paper map, calibrated with markers which make possible its augmenting.
- Let's make augmented paper (printed) map (more) intelligent thing (the same can be done with printed images – photos)

→ *I have even tried but up to now without success*

Thank You for patience and audience