THE METAVERSE, AR AND USER PRIVACY

ADDING SUBSTANCE TO THE HYPE

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Guest Lecture Mobile Business 2

Goethe University Frankfurt am Main

Dr. David Harborth

AGENDA OF TODAY'S GUEST LECTURE

01 Introduction

02 Definitions

03 The dark side of augmented reality

04 Practical implications and outlook

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Curriculum Vitae Dr. David Harborth

Employment

Since 06/2022	Senior Consultant Capgemini Invent, Digital Trust and Security
07/2021 – 05/2022	Postdoctoral researcher Chair of Mobile Business & Multilateral Security, Goethe University Frankfurt
01/2020 – 03/2022	Visiting researcher International Computer Science Institute (ICSI) and Berkeley Laboratory for Usable and Experimental Security (BLUES) University of California, Berkeley, US
12/2015 - 07/2021	Research assistant Chair of Mobile Business & Multilateral Security, Goethe University Frankfurt
10/2015 - 11/2015	Senior Associate KPMG AG, Advisory, Financial Services
12/2013 - 09/2015	Working Student KPMG AG, Advisory, Financial Services

Education (all from Goethe University Frankfurt)

12/2015 - 07/2021	Dr. rer. pol (PhD in Economics)
10/2013 - 09/2015	Master of Science in Management
10/2010 - 09/2013	Bachelor of Science in Economics and Business Adm.

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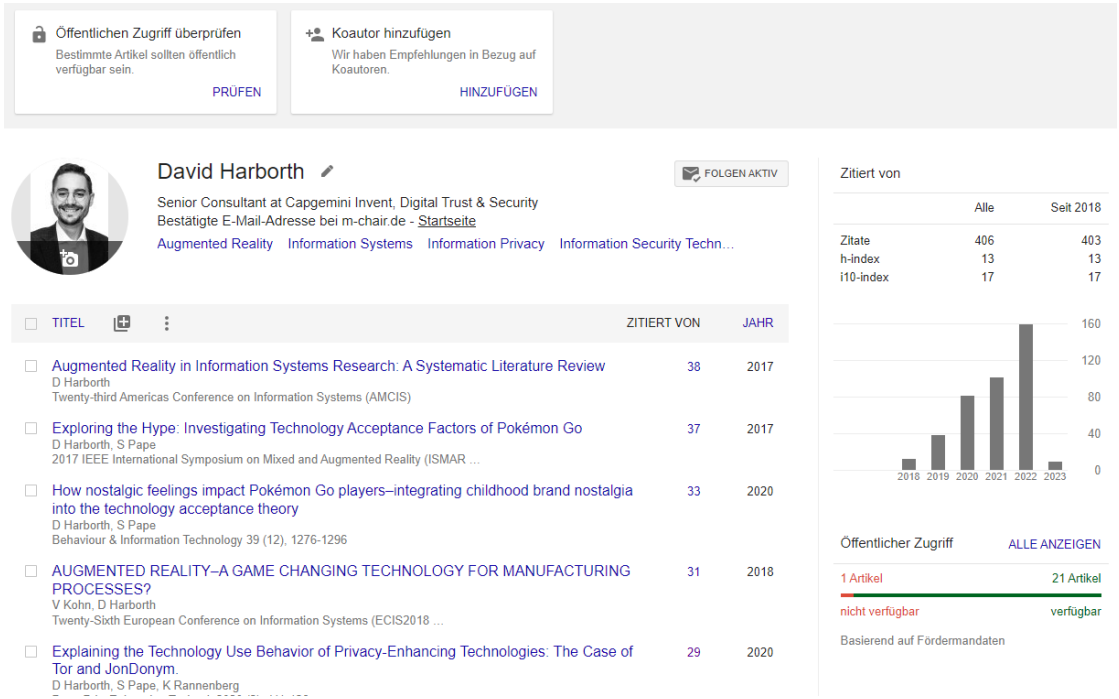
Research Profile Dr. David Harborth

Research profile

- Research topics and interests
  - User perceptions and concerns related to immersive systems and technology acceptance research, especially Augmented Reality (AR)
  - Investigation of informational self-determination of individuals through privacy-enhancing technologies (PETs) and user adoption
  - Privacy of individuals in the digital sphere, including analyses of privacy concerns and their ramifications with regard to technology use
  - Artificial Intelligence (AI) and Intelligence Augmentation (IA) and possible effects on the work life
  - Human aspects of information security
  - Research methods for investigating human aspects in the information systems and computer science domain

- Publication profile
  - Publication of more than 30 peer-reviewed conference and journal articles on the topics above
  - Supervision of more than 25 seminar papers, bachelor and master theses



AGENDA OF TODAY'S GUEST LECTURE

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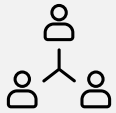
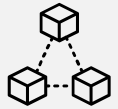
The actual concept of the “Metaverse“ is currently not existing yet since important features are still missing

The metaverse is “a fully immersed three-dimensional society-like environment that can integrate both physical and virtual worlds and can be accessed via XR (VR and AR) devices” with three characteristics:

- Experienced via immersive XR technologies, such as AR and VR
- 3D environments experienced on a computer or smartphone screen are not metaverse environments.
- XR technologies are “the gateway” to the metaverse.



- Sharing similarities with physical societies
  - Socializing
  - Presence of individuals, potentially through avatars
  - A to be defined legal structure (e.g., ownership and community rules)
  - Transactions through alternative exchange forms (e.g., cryptocurrencies)



- It must be decentralized.
  - Traditional Internet-based applications (including social media) and current VR worlds (e.g., Decentraland, Fortnite, Roblox, and Sandbox) are not constituting metaverse environments.

Source: https://www.linkedin.com/pulse/clarification-metaverse-xr-20-philipp-a-rauschnabel/

Some more key differentiators of the metaverse according to the literature

	Traditional Internet (incl. Social media)	Current VR worlds (e.g., Decentraland, Fortnite, Roblox, and Sandbox	"True" Metaverse
Hardware	Monitor, mobile device screen	Monitor, mobile device screen, VR	Simultaneous access through **XR (AR and VR)**
Transactions	Traditional currencies, established (e.g., credit card) or alternative (e.g., PayPal) payment methods	Cryptocurrencies, digital wallets	Cryptocurrencies, digital wallets
Goods	Physical and digital fungible goods	Non-fungible tokens (NFTs)	Non-fungible tokens (NFTs)
Identity	Several user profiles	One avatar within each platform	One avatar **across** platforms
Ownership and copyright	Copyright on virtual content (e.g., digital rights management – DRM)	Property identification based on blockchain, NFTs	Property identification based on blockchain, NFTs

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Further information on the Metaverse

- There are several slightly different definitions of the Metaverse and many predictions regarding use cases.

- In case you are interested in the topic, you can read about the metaverse in articles and reports by different companies and experts:
  - https://www2.deloitte.com/ca/en/pages/technology-media-and-telecommunications/articles/welcome-to-the-metaverse.html
  - https://medium.com/blockchain-biz/delivering-the-entire-metaverse-db4c2afcb6e5
  - https://www.linkedin.com/pulse/clarification-metaverse-xr-20-philipp-a-rauschnabel/

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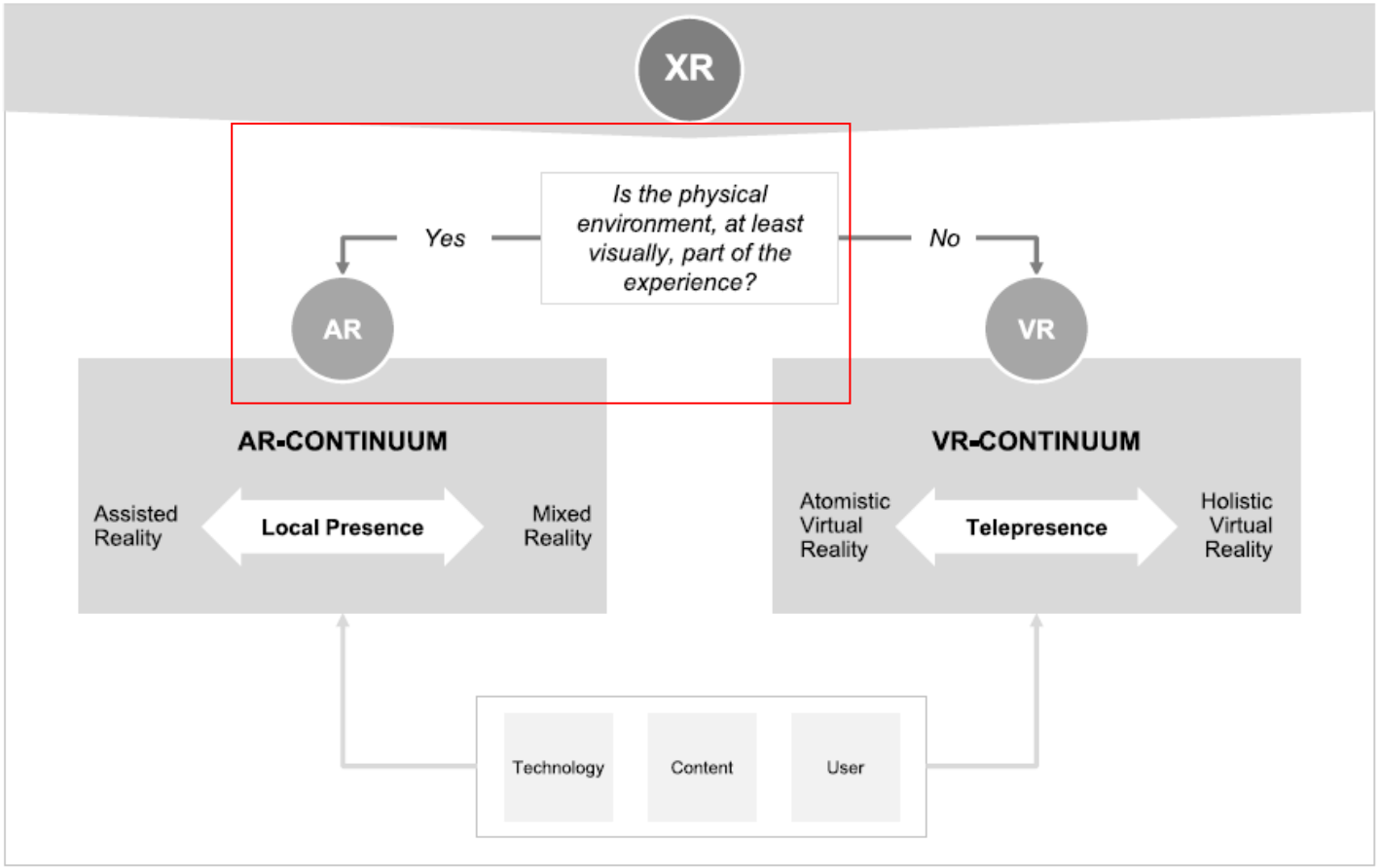
Definition of Augmented Reality (AR) and its different forms

- AR “[...] combines **real** and virtual objects in **a real environment**; runs interactively, and in real time; and registers (aligns) real and virtual objects with each other" (Azuma et al., 2001, p. 34).
- Need to delineate **mobile** and **portable** augmented reality (Craig, 2013)
  - Portable can include several devices like laptops or head-mounted displays (HMDs)
  - HMD worn only because of AR and otherwise not in everyday life (portable system)
  - Mobile systems differ in that way that they are easy to take with and are also usually used in the everyday life independent from the AR application
  - Tablets and smartphones are Mobile Augmented Reality (MAR) devices

- **Scope of this presentation:** Mobile Augmented Reality (MAR) from an end user perspective since it is currently the most widely used and accessible form of AR for the end user.

Source picture: https://img.buzzfeed.com/buzzfeed-static/static/2017-12/19/18/asset/buzzfeed-prod-fastlane-03/sub-buzz-10739-1513727900-2.jpg

AR is part of the XR technologies and a clear delineation is required to understand the importance and promise



Source figure: Rauschnabel et al., 2022

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Having a clear understanding of privacy is important due to the importance and threats to information privacy in today's world

Commonly used definitions of privacy

- **Control** as a dominant concept for defining privacy in the literature (Bélanger and Crossler, 2011; Bélanger et al., 2002)
- Exemplary definition from the literature:
  "[…] privacy is the ability of an individual to control the access others have to personal information" (Culnan, 1993, p.344).

1. Are these generic definitions applicable to each new innovation?
2. Do individuals really care about controlling their personal data in every situation?
3. To what extent are individuals able to differentiate information types?
4. Who are "others"?

A more recent definition of user privacy considers the **importance of context**

- The framework of contextual integrity provides **contextual factors** for understanding users' privacy concerns, expectations, and privacy violations (Nissenbaum, 2010).
- Violation occurs if information practice does not correspond to users' expectations in a given **context:**
  1. Subject(s)
  2. Sender(s)
  3. Receiver(s)
  4. Information type(s)
  5. Transmission principle(s)

Sustainability is not only about firms‘ carbon footprints, but it also includes social responsibility regarding their customers

Two colliding concepts create an area of tension which need to be addressed in the future

“Data is the new oil” (Clive Humby)

- “Data is the new oil” became the prevalent guiding principle for firms’ data strategy
  - Most companies gather **too much data without a clear purpose** and strategy to leverage the value
  - Some companies leverage their data to **modify the behavior of users**

Protection of user privacy and autonomy

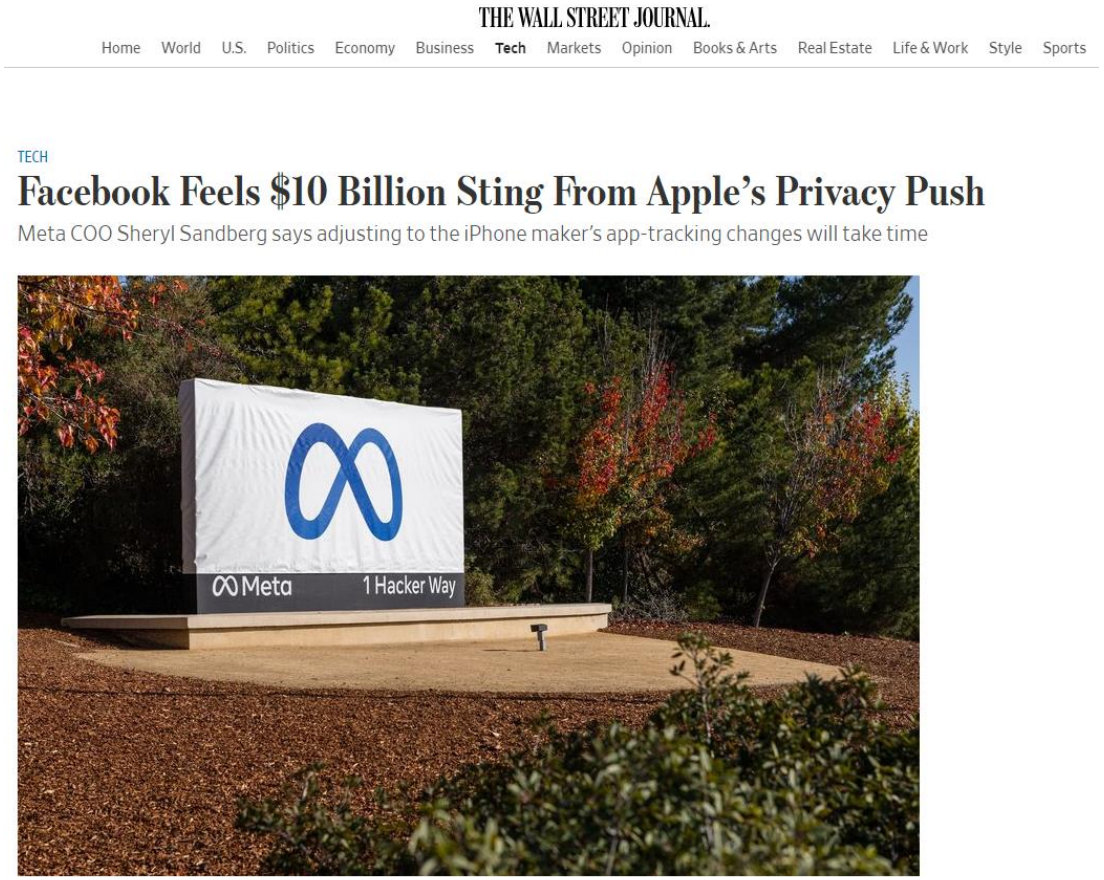
- **Privacy as a fundamental human right** needs to play an integral part in firms’ strategies for offering new services and technologies
- Protecting user privacy is part of the overarching concept of **human autonomy**
  - Given if a person can pursue her or his life based on her or his **own ideas, causes, and motivations**

➢ Firms which are being clueless and violate user privacy OR doing it deliberately are equally critical from a **social responsibility** point of view

➢ Facebook and Cambridge Analytica scandal good example for both

Firms need to acknowledge this tension and develop a privacy strategy when developing new services and technologies

We can already observe a market shift from a “Wild West Notion” towards a more pronounced privacy strategy



Source pictures:
Left: https://www.engadget.com/2019-01-05-apple-ces-2019-privacy-advertising.html
Right: https://www.wsj.com/articles/facebook-feels-10-billion-sting-from-apples-privacy-push-11643898139

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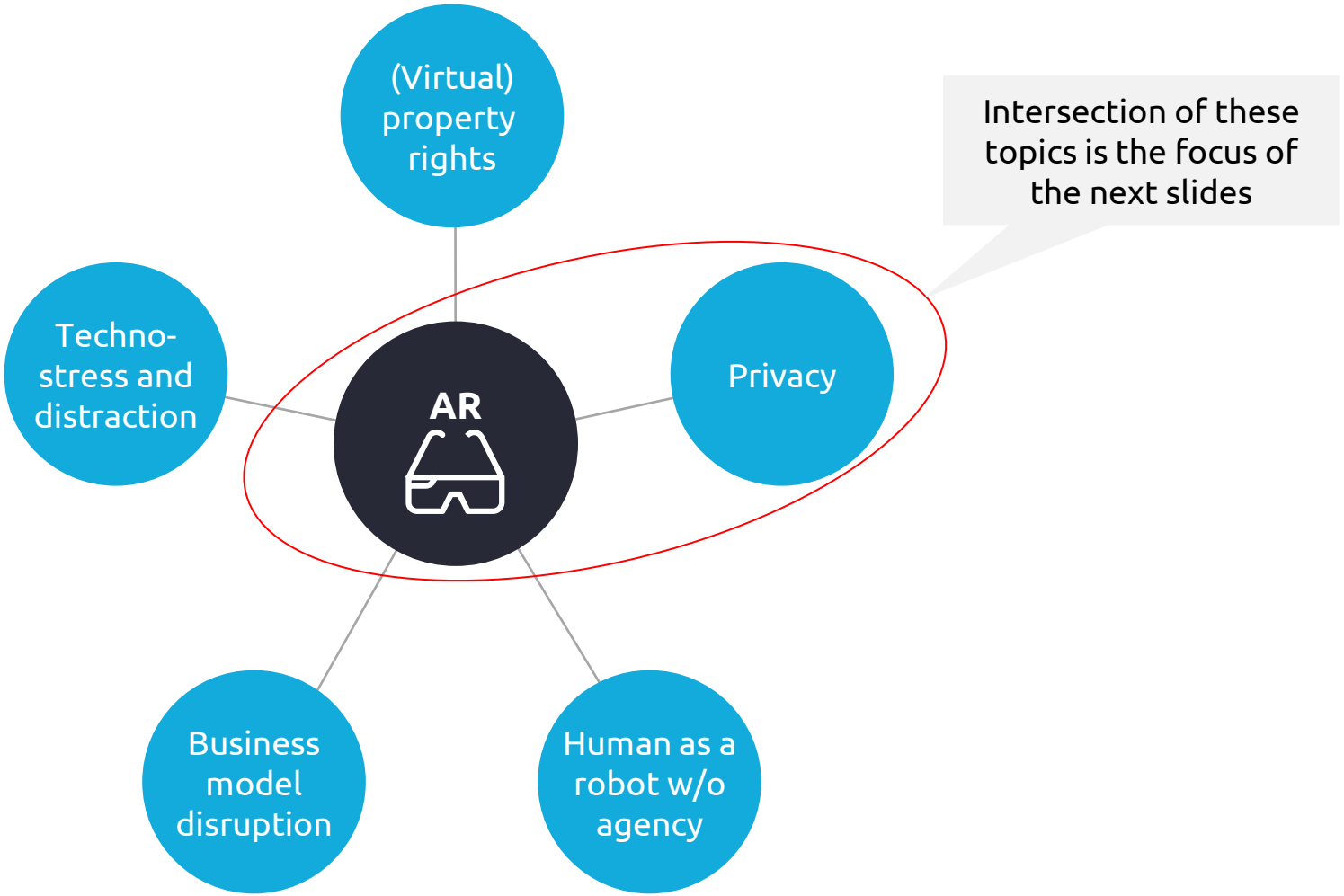
Several issues with AR (“Dark Side of AR“) must be considered and weighed up against its immense benefits



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AR has the potential to subsitute the smartphone in the near future and plays an important role as a gateway to the Metaverse

- AR as the next **“big technology”** (Business Insider Intelligence, 2016; Cook, 2016)
  - 83.1 million users in the US in 2020 with the potential to **substitute the smartphone** (Bitkom, 2021; Petrock, 2020)

- AR **more intrusive** than existing technologies (de Guzman et al., 2018; Hafner, 2016; Harborth et al., 2019; Koelle et al., 2015; Niemöller et al., 2016)

- Threats to personal information privacy **negatively impact trust in new technologies** (Mazey, 2018)

- “[...] now is the time to consider AR security and privacy issues, while the technologies are **still young and malleable**” (Roesner et al., 2014, p.93)

- Compared to technical research, few user studies on AR technologies and **almost no research on privacy** in IS and CS (Dey et al., 2018; Harborth, 2017)

Source picture: https://www.techrepublic.com/blog/google-in-the-enterprise/five-ways-to-make-google-glass-appeal-to-businesses/

Privacy risks related to AR are manifold and endanger individual privacy and autonomy even more than other technologies

- Example of MAR apps: **five major risks distinguish MAR apps from non-MAR apps** (de Guzman et al., 2018; Harborth et al., 2019)

1. **Limited feedback regarding what data is captured** by the app's camera (MAR app input)
2. Malicious MAR app **altering digital objects/information** (MAR app output).
3. **Increasing data aggregation capabilities** due to simultaneous employment of multiple privacy-sensitive sensors
4. Privacy breaches in **collaborative and shared AR environments** (Lebeck et al., 2018)
5. **Bystanders of AR** systems could get filmed without awareness or possibility to control (Denning et al., 2014) (bystander privacy not covered in my work).

An empirical example of actual MAR apps' access behaviors to smartphone resources shows the immense privacy risks

Table 1. Identified permissions accessed by examined MAR apps.

Permission	Description
READ_STORAGE	*Allows an app to read from external storage.*
CAMERA	*Required to be able to access the camera device.*
BODY_SENSOR	*Allows an app to access data from sensors that the user uses to measure what is happening inside his/her body, such as heart rate.*
READ_CONTACTS	*Allows an app to read the user's contacts data.*
LOCATION	*Allows an app to access location.*
PHONE_STATE	*Allows an app to access the phone state, including phone number of the device, current cellular network information, the status of any ongoing calls, the list of any phone accounts registered on the device and a verification of the user/phone with IMEI information*
RECORD_AUDIO	*Allows an app to record audio.*

Table 2. MAR application behaviors (active phase versus inactive phase)

	Resource Accesses Phase 1 – Phase 2						
App #	READ_ STORAGE	CAMERA	BODY_ SENSOR	READ_ CONTACTS	LOCATION	PHONE_ STATE	RECORD_ AUDIO
1	17 – 2	18 – 0	0 – 0	0 – 0	0 – 0	**12 – 2**	0 – 0
2	18 – 6	10 – 0	0 – 0	0 – 0	0 – 0	**2 – 0**	0 – 0
3	14 – 4	10 – 0	0 – 0	0 – 0	0 – 0	0 – 0	0 – 0
4	10 – 1	**10 – 2**	0 – 0	0 – 0	0 – 0	**3 – 0**	0 – 0
5	17 – 2	14 – 0	0 – 0	0 – 0	0 – 0	0 – 0	0 – 0
6	10 – 11	**11 – 2**	0 – 0	0 – 0	0 – 0	0 – 0	0 – 0
7	12 – 8	14 – 0	0 – 0	0 – 0	0 – 0	**3 – 0**	0 – 0
8	11 – 4	8 – 0	0 – 0	0 – 0	0 – 0	**9 – 0**	0 – 0
9	7 – 11	10 – 0	1 – 0	0 – 0	0 – 0	0 – 0	0 – 0
10	10 – 3	8 – 0	0 – 0	0 – 0	0 – 0	0 – 0	0 – 0
11	19 – 11	12 – 0	0 – 0	0 – 0	**21 – 4**	0 – 0	0 – 0
12	8 – 10	10 – 0	0 – 0	0 – 0	0 – 0	0 – 0	0 – 0
13	13 – 9	14 – 0	0 – 0	**3 – 0**	0 – 0	0 – 0	**4 – 0**
14	8 – 5	**6 – 2**	0 – 0	0 – 0	0 – 0	**2 – 0**	0 – 0
15	15 – 3	10 – 0	0 – 0	0 – 0	0 – 0	0 – 0	0 – 0
16	7 – 7	10 – 0	0 – 0	0 – 0	0 – 0	0 – 0	0 – 0
17	9 – 3	10 – 0	0 – 0	0 – 0	0 – 0	0 – 0	0 – 0
18	11 – 8	12 – 0	0 – 0	0 – 0	0 – 0	0 – 0	**1 – 0**
19	14 – 6	10 – 0	0 – 0	0 – 0	0 – 0	**9 – 0**	0 – 0

Source: Harborth et al., 2019

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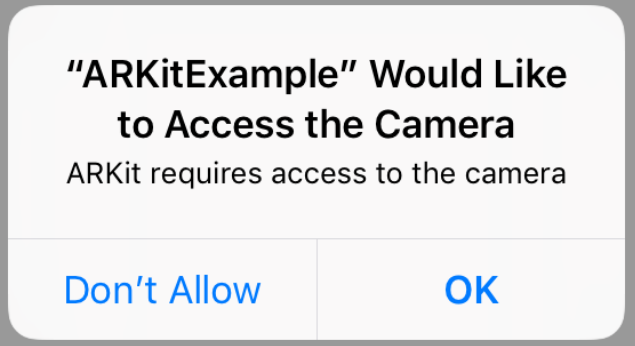
There are diverse theoretical contributions and implications for future developments

General implications which affect AR

- Trust cues (e.g., download numbers) in app stores can **mislead** users.
- Lack of accurate **privacy policies** and principle of **least privilege** (Harborth et al., 2019)
- General privacy concerns **do not impact use behavior**, still users take privacy protecting measures (e.g., reset ad ID) (Harborth & Pape, 2018).

AR-specific implications

- Need to redefine permissions for (M)AR in order to provide **transparency** and more detailed information on **apps' data practices**.
- Understand **what new information** about users can be derived by **which combination** of data types gathered by AR
- **Educate** users on the specific risks of AR to enable informational self-determination.



Source picture : https://medium.com/the-reading-room/getting-started-building-augmented-reality-apps-in-xamarin-46ee19b86ec8

A dystopian outlook for the end

- AR in general can be a critical technology regarding its impact on the individual autonomy.
  - Freedom of choice must be ensured based on informed decisions.
  - *"[...] could the products that they're [the users] using **cause them** to walk a different path, drive a different path, divert from the trajectory that they're normally going to go on.*
    *If you could do that through information services that you're offering to people, there's tremendous opportunity there for businesses that might want to **change the behavior of people, to get them to go places they wouldn't otherwise go**"* (Hanke, 2017).
  - Research: provide insights stimulating the ethical debate and make recommendations to MAR app developers and operators as well as regulators
- If not addressed properly, these privacy issues can **pose significant risks** for humans and our society in the context of AR alone but also as a gateway technology for the **Metaverse**

Source picture: https://mixed.de/pokemon-go-erfinder-virtual-reality-koennte-gesellschaftliches-problem-werden/

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