In Situ with Bystanders of Augmented Reality Glasses:

Perspectives on Recording and Privacy-Mediating Technologies

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Augmented Reality: The Vision

- Sensing
- Real-Time Context
- Information Overlay

Augmented Reality: Productization

- Coming to market
  - Glass
  - SpaceGlasses
  - castAR
  - …

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Incorporates wearable camera

Augmented Reality & Privacy

Congress of the United States
Washington, DC 20515

Mr. Larry Page
Chief Executive Officer
Google
1600 Amphitheatre Parkway
Mountain View, CA 94043

Dear Mr. Page:

In April 2012, Google announced "Project Glass" on Google+.[1] The company indicated that it wanted to build a technology that "helps you explore and share your world."[2] The creation of Google Glass is said to allow you to take pictures, record and share what you see hands free, obtain directions, send messages, and basically ask whatever is on your mind right before your eyes.[3]

Since the announcement of this initiative, there have been a number of articles written discussing not only the vast innovation of this technology, but also the privacy implications. For example, a recent article in the *Wall Street Journal* states, "It will only be a matter of time until you'll be able to aim the lens of your device at his or her face, and using face reco
the individual's address, work history, marital status, measurements and
an article in *Forbes* indicated that a bar in Seattle has already declared th
advance from the establishment due to privacy concerns.[5]

As members of the Congressional Bi-Partisan Privacy Caucus, we are cu
technology could infringe on the privacy of the average American. Beca
not yet been released and we are uncertain of Google's plans to incorpor
into the device, there are still a number of unanswered questions that we share. Accordingly, we would appreciate the answers to the questions that follow:

1. In 2010, it was discovered that Google was collecting information across the globe from unencrypted wireless networks.[6] This practice caused multiple investigations into the company along with consumers left perplexed.[7] Google just recently agreed to pay $7 million to settle charges with 38 states for the collection of data from unprotected Wi-Fi

[1] Parviz, B., Lee, S.,& Thrun, S. (2012, April 4). Project Glass [Msg 1]. Message posted to https://plus.google.com/+projectglass/posts
[2] *Id.*
[3] Glass. (n.d.). *Google*. Retrieved May 2, 2013, from http://www.google.com/glass/start/what-it-does/.
[4] Gardner, G., Jr. (2013 March 20). Too much, too soon? *Wall Street Journal*. Retrieved May 1, 2013, from http://online.wsj.com/article/SB10001424127887323419104578372580870846420.html
[5] Olson, P. (2013 March 10). The banning of google glass begins (and they aren't even available yet). *Forbes*.

72% of Americans Refuse **Google Glass** Over **Privacy** Concerns ...
Mashable - Apr 7, 2014
A recent poll, conducted by market-research firm Toluna, found 72% of Americans cited **privacy** concerns as the biggest reason for not wanting ...

Google Glass users facing street violence from muggers and privacy campaigners
Indo Asian News Service, April 21, 2014

Privacy Issues and Recording Devices

- Multimedia Spaces, e.g.:
  - [Bellotti 1992]
  - [Adams 2000]
- Infrastructure Cameras, e.g.:
  - [Friedman 2006]
  - [Massimi 2010]
  - [Nguyen 2011]
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Investigating underlying issues of augmented reality and privacy…

Investigating underlying issues of augmented reality and privacy… via in-situ interviews

Talk Agenda

1. Augmented Reality and Privacy
2. **In Situ with Bystanders: Study Design and Results**
3. Towards Privacy-Mediating Technologies

In-Situ Interviews with Bystanders

- Observation & semi-structured interviews in cafes
  - 12 field sessions
  - 8 cafes
  - Spring & Summer 2013
  - 31 participants

Field Sessions

- Researcher pair (F/M):
  A. Researcher observing and interviewing
  B. Researcher wearing mock AR device

AR Interview Results: Bystander Reactions

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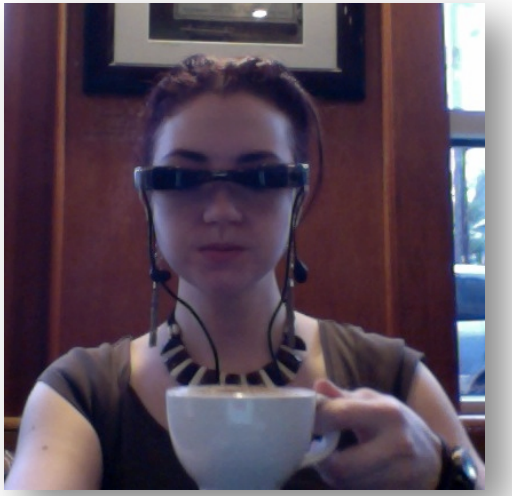
- 1/3 of participants did not notice glasses



AR Interview Results: AR vs. Other devices

- Participants were split as to whether recording with an AR device is similar or different to recording with cell phones

AR Interview Results: AR vs. Other devices

What's Similar

- No legal differences
- Recording is already expected (cell phones, CCTVs, cameras)

What's Different

"I'm fully aware that I'm being photographed all the time. Look at the tracking activities of the police in Boston. That was "fantastic," in the literal sense of the word, not necessarily the positive sense."

AR Interview Results: AR vs. Other devices

What's Similar

- No legal differences
- Recording is already expected (cell phones, CCTVs, cameras)

What's Different

- Subtleness
- Ease of recording
- Lack of prevalence

"It's slightly more clandestine, but if it gets popular people would be clued in.

AR Interview Results: Perspectives on Recording

What makes being recorded more or less impactful?

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- Place
- Bystander Behavior
- Sharing Context
- Social Norms
- Perception of Recorder
- Identification
- Vexation

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Design defenses leveraging these properties…

AR Interview Results: Perspectives on Recording

What makes being recorded more or less impactful?

- **Place**
- Bystander Behavior
- Sharing Context
- Social Norms
- Perception of Recorder
- Identification
- Vexation

Can we design mitigating strategies that take place as a **social context** into account?

[Harrison 1996]

AR Interview Results: Permission & Notification

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- Over 1/2 of participants would want to be asked permission
  - Focus of recording
  - Feasibility
  - Helplessness

AR Interview Results: Permission & Notification

- Over 1/2 of participants would want to be asked permission
  - Focus of recording
  - Feasibility
  - Helplessness
- Some participants expressed interest in blocking technologies

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1. Augmented Reality and Privacy
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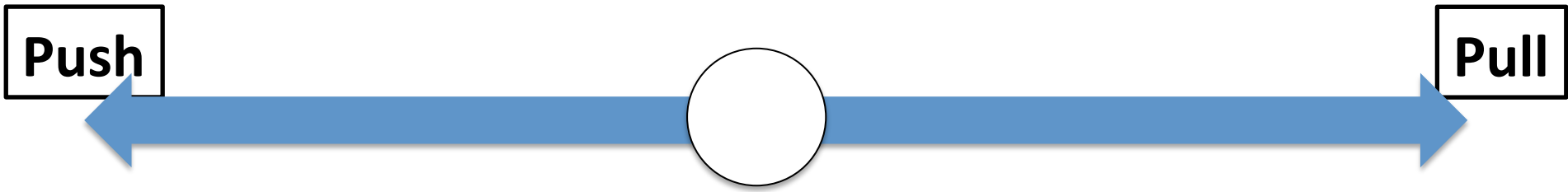
3. **Towards Privacy-Mediating Technologies**

Privacy Systems for AV Recording

- Broadcasting privacy preferences
  - [Brassil 2009]
- Opt-out markers
  - [Schiff 2009]
- Blurring video
  - [Barhm 2011]
- Recognizing private spaces
  - [Templeman 2014]
- Cryptographic enforcement
  - [Halderman 2004]
- Active distortion via pulsed light
  - [Patel 2009]

Design Axes for Privacy-Mediating Technologies

e.g. [Brassil 2009]



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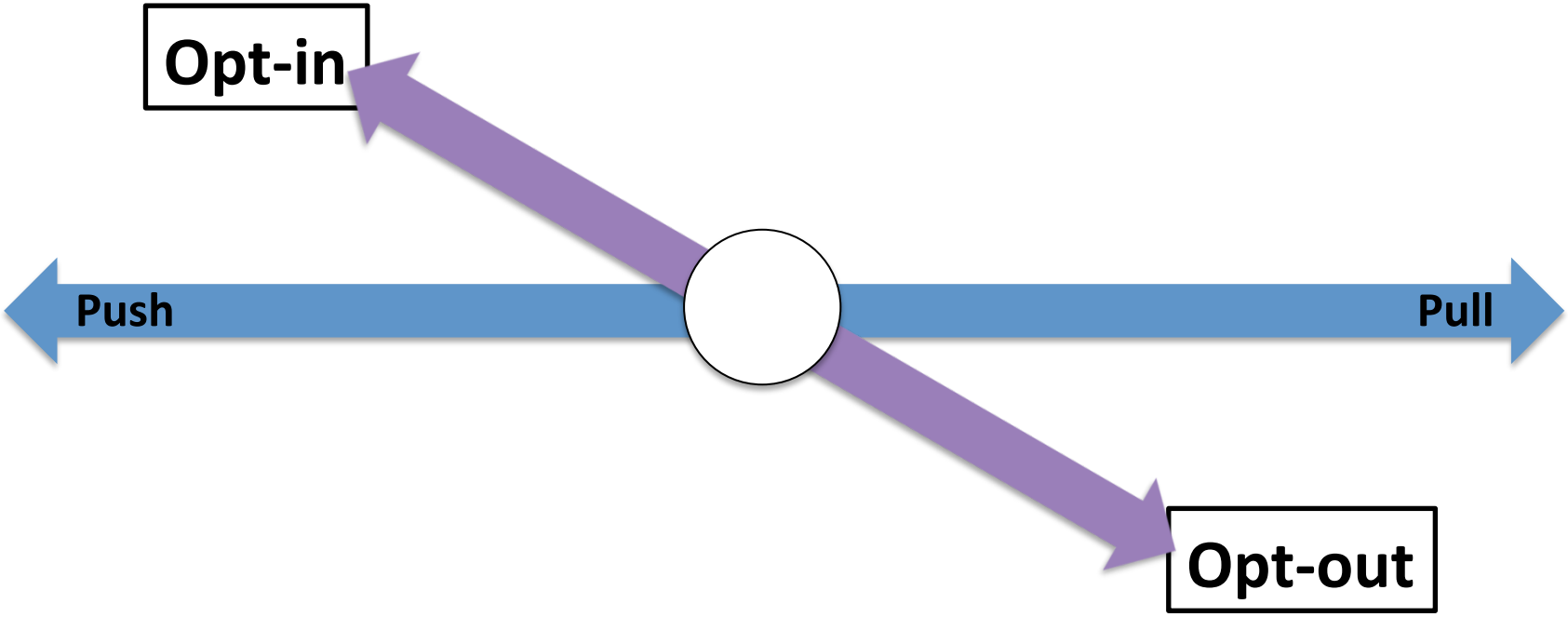

e.g. [Schiff 2009]

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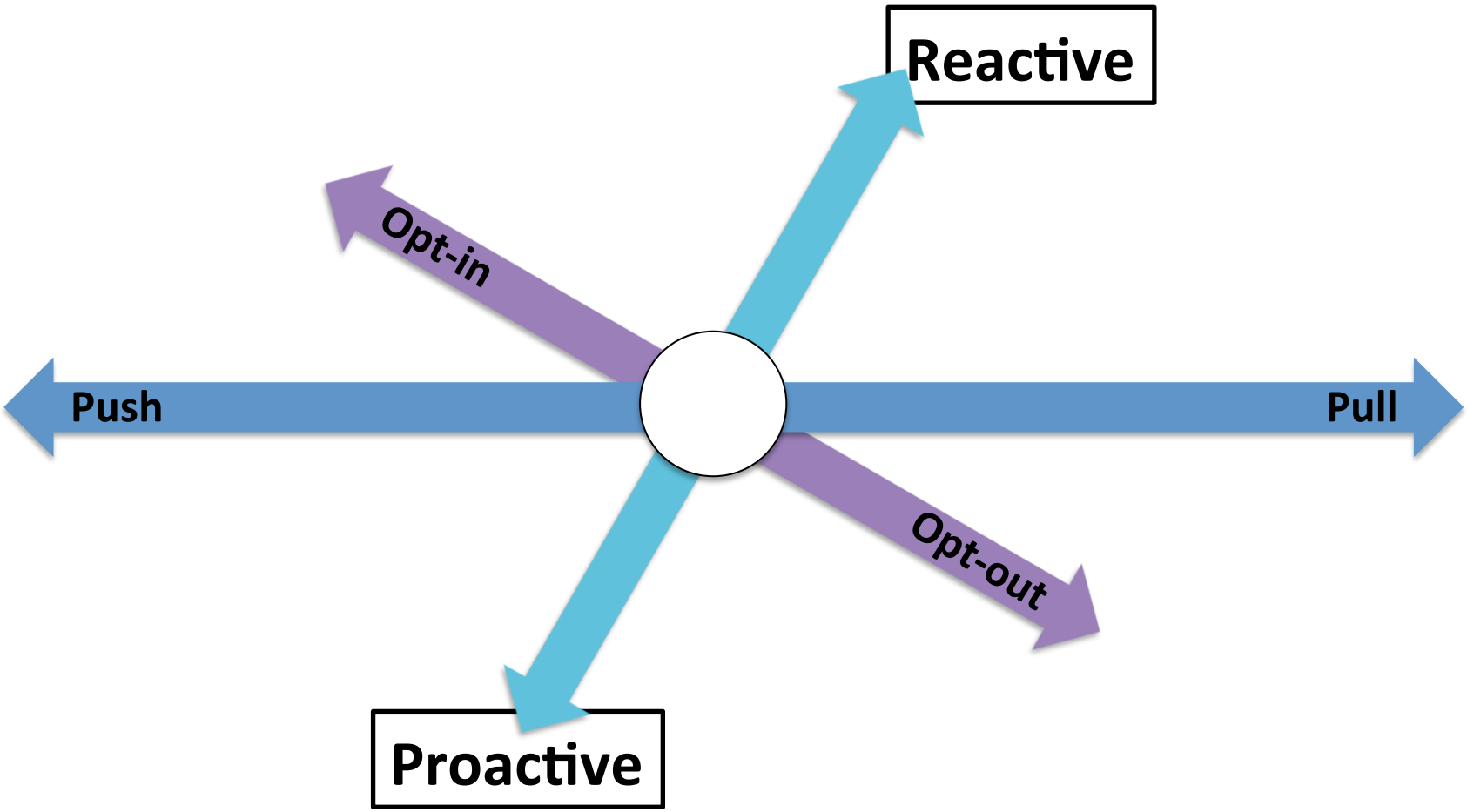

[Templeman 2014]

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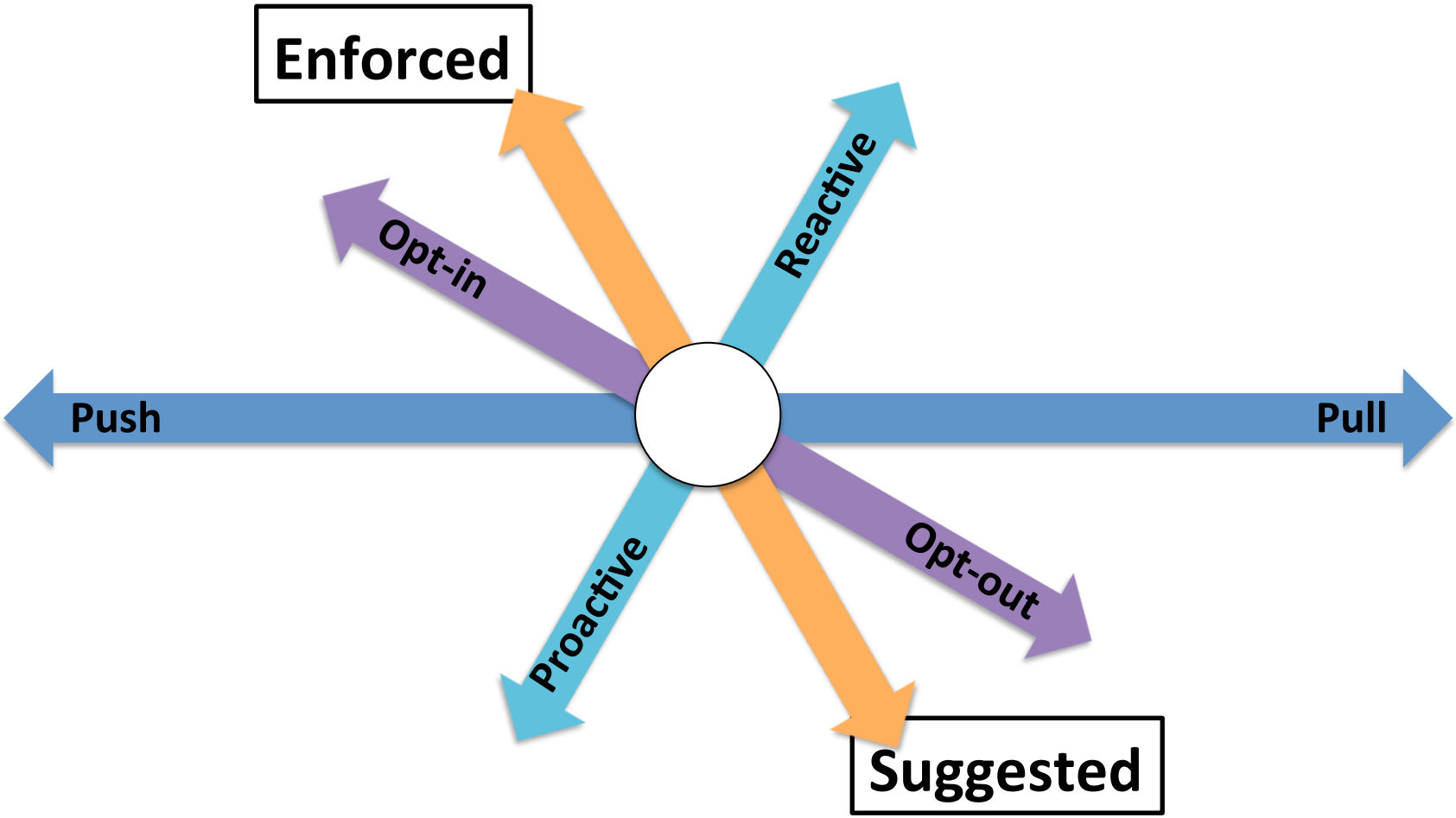

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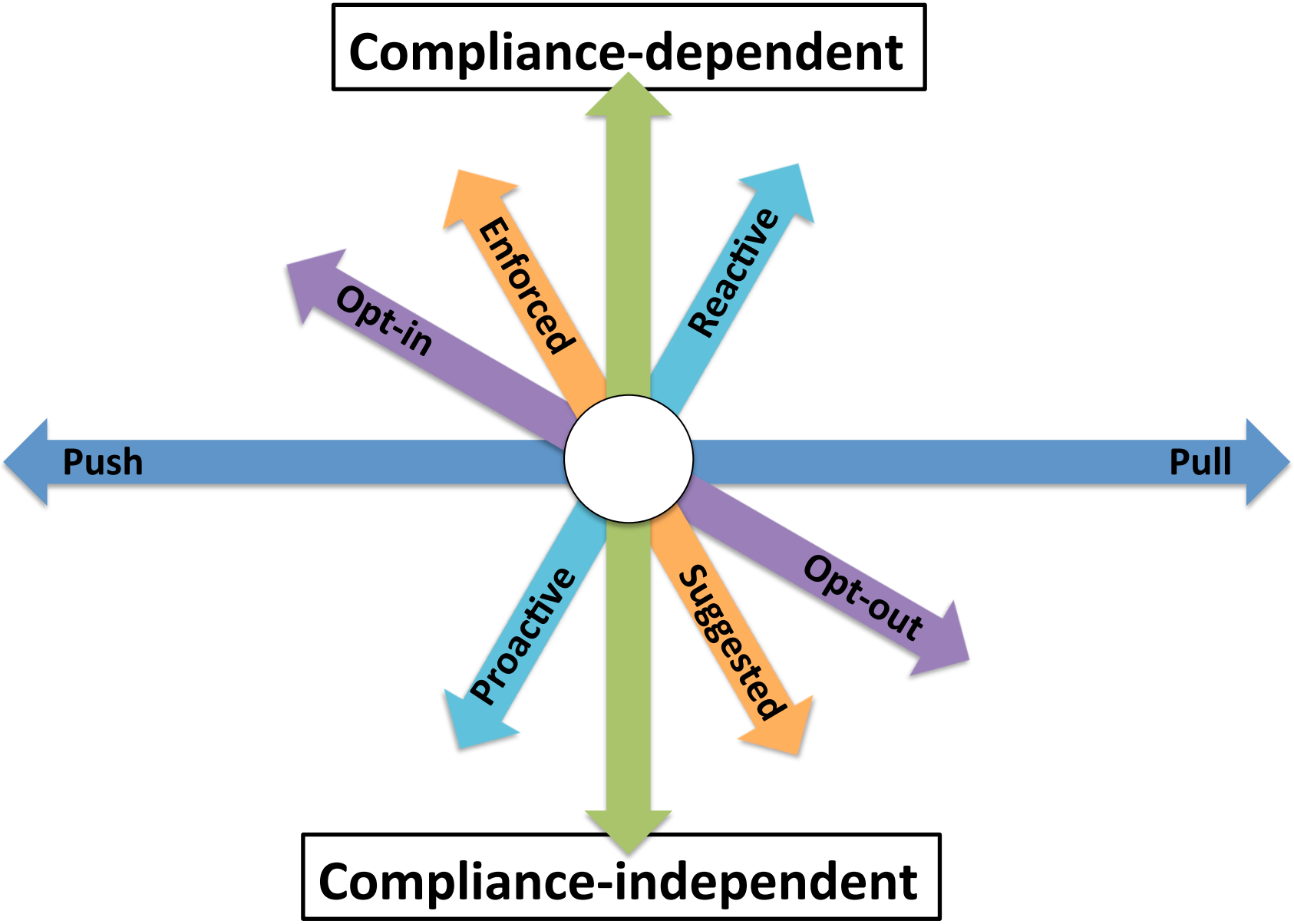

e.g. [Patel 2009]

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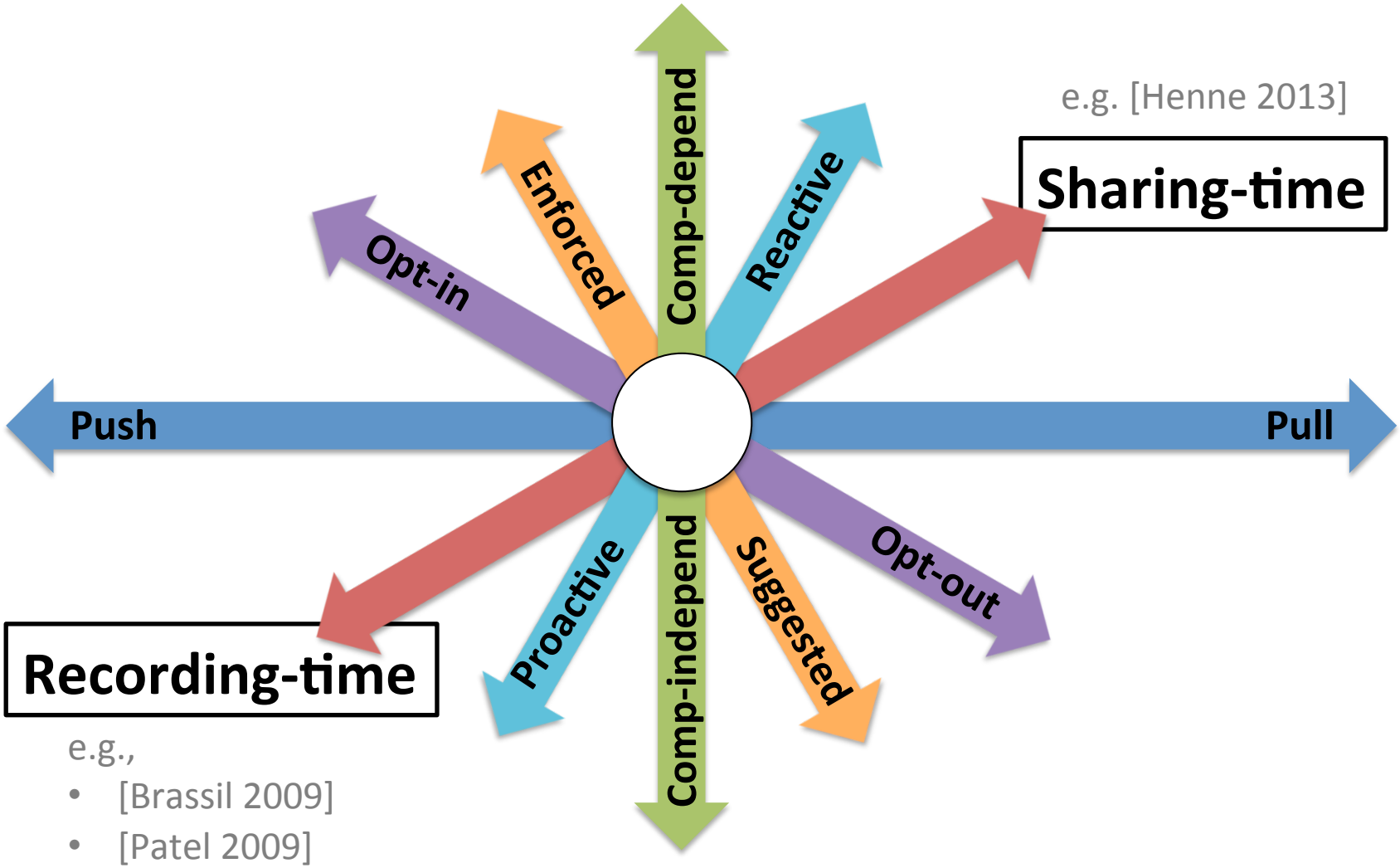


e.g. [Henne 2013]

Sharing-time

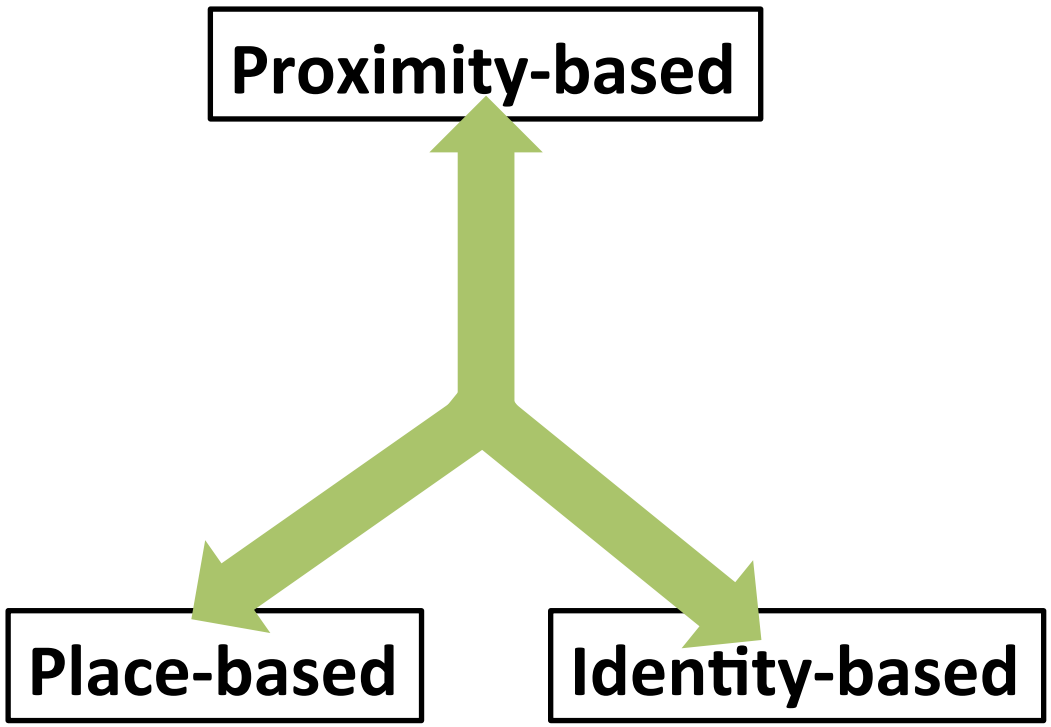
Recording-time

e.g.,

- [Brassil 2009]
- [Patel 2009]
- [Schiff 2009]
- [Templeman 2014]

Design Axes for Privacy-Mediating Technologies

e.g., [Manweiler 2009]



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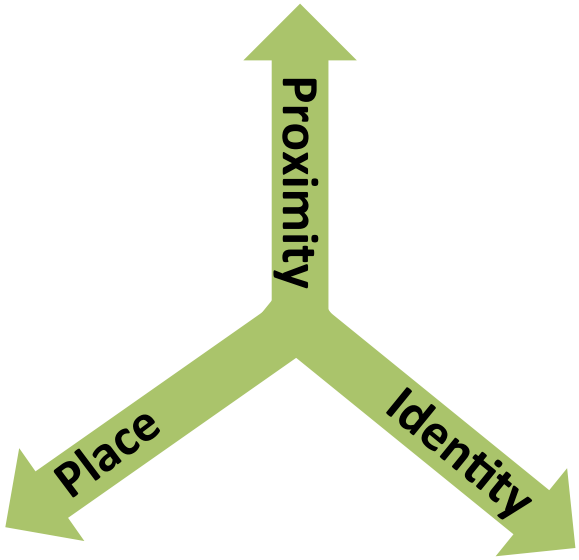

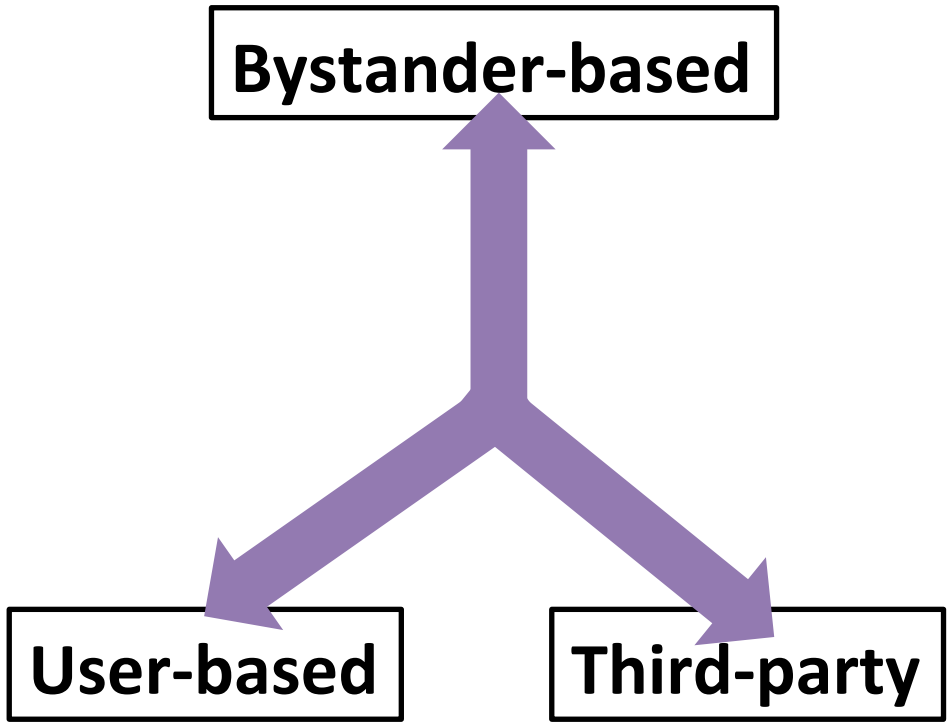

e.g. [Bell 2012]

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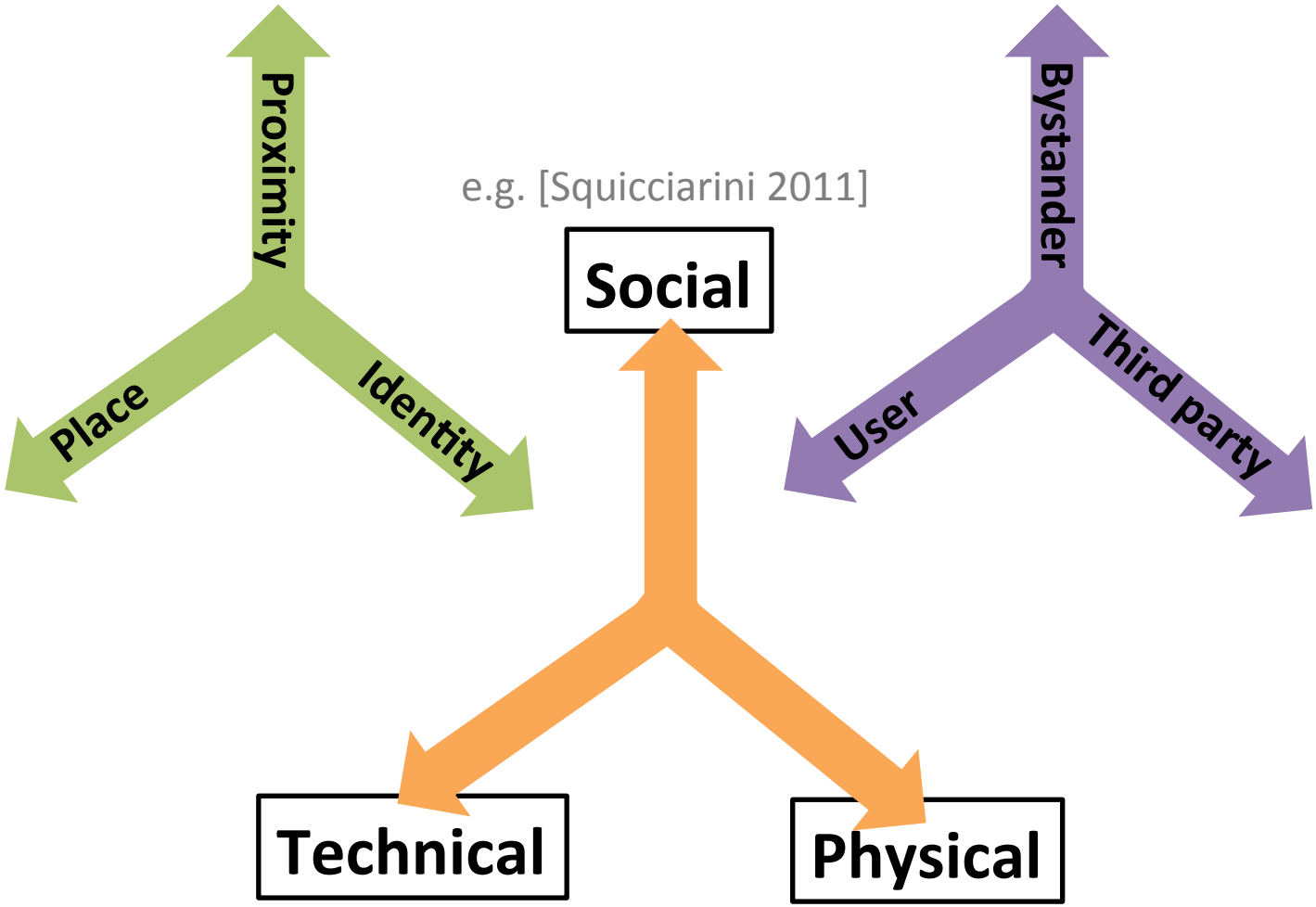

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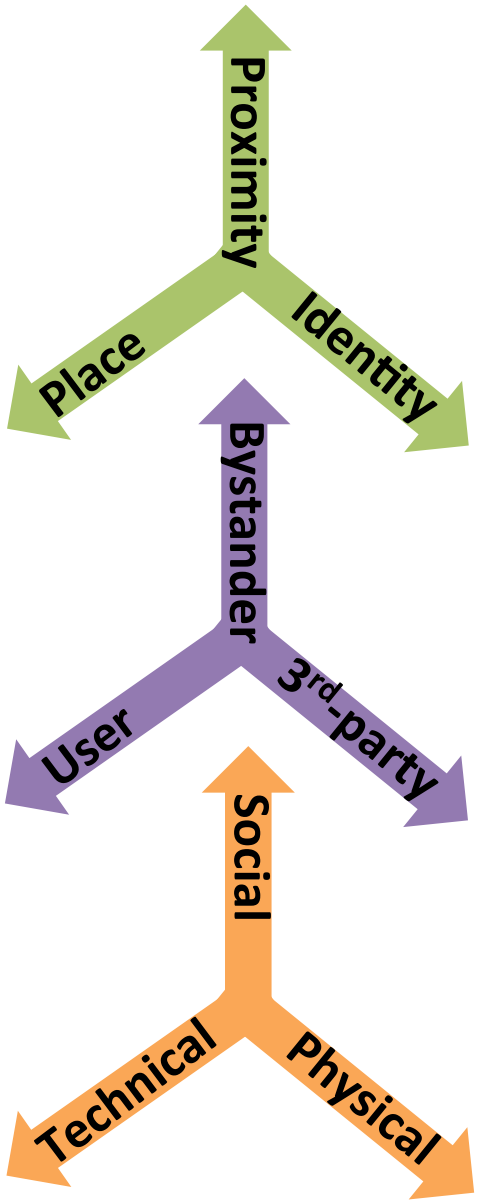

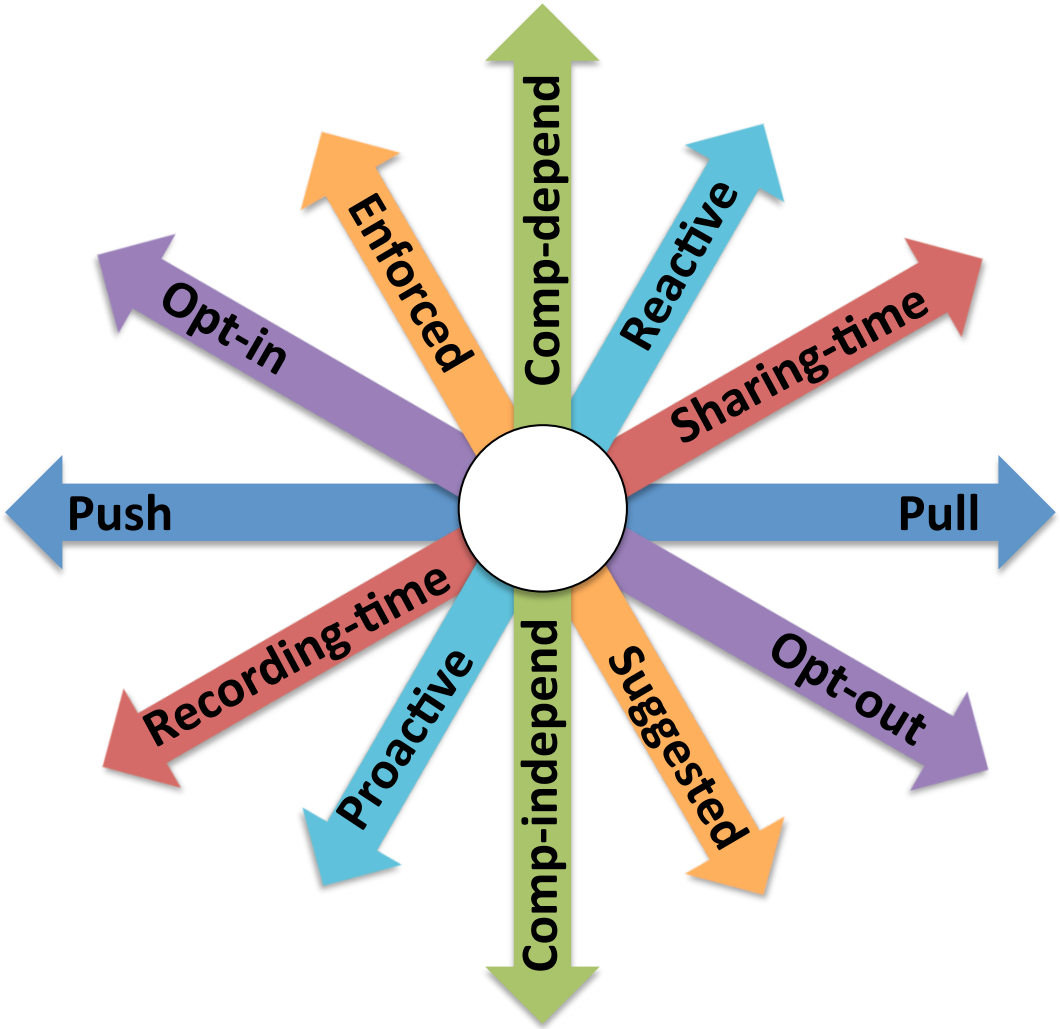

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- In-situ interviews with bystanders to AR devices
- Interview data indicates factors that affect acceptability of recording
- Participants expressed interest in privacy mediation
- Design axes for privacy-mediating technologies direct system research