Privacy Tools and Techniques for Developers

-Amber Welch

bit.ly/2x1UXWX

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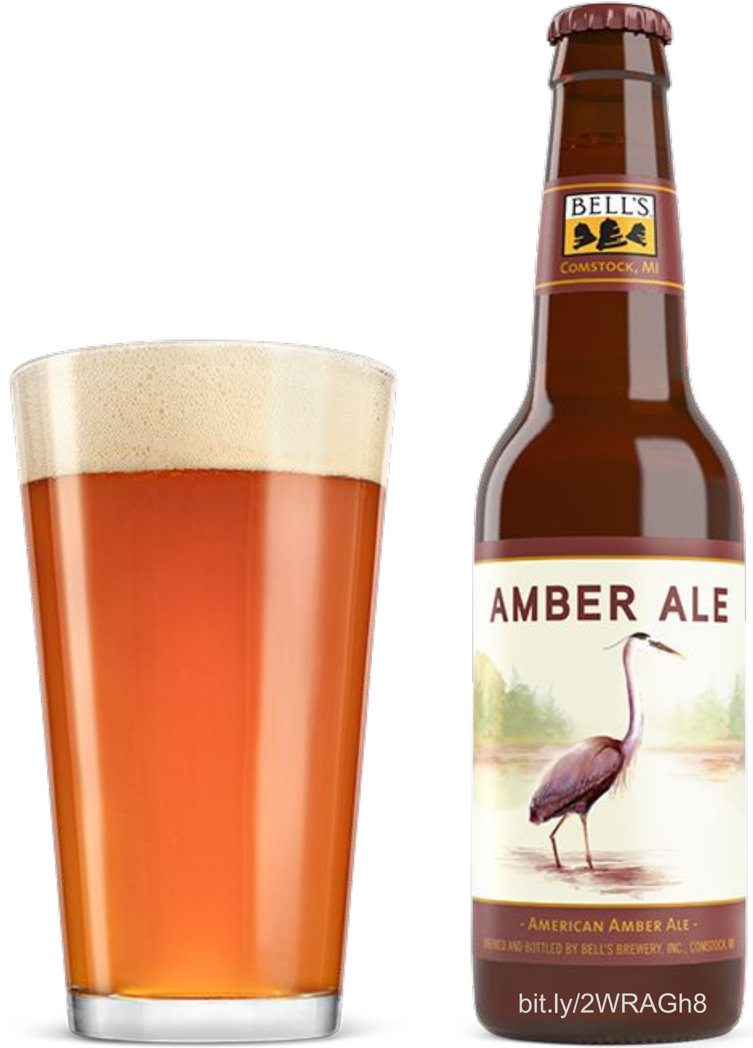

bit.ly/2WRAGh8

Menu

- Privacy Engineering Intro
- Privacy by Design
- Privacy Enhancing Technologies

bit.ly/2WXJTcR


First, an apology.
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Legal teams have often kept tech out of privacy.

Developers don’t know privacy concepts. Privacy teams haven’t taught them.

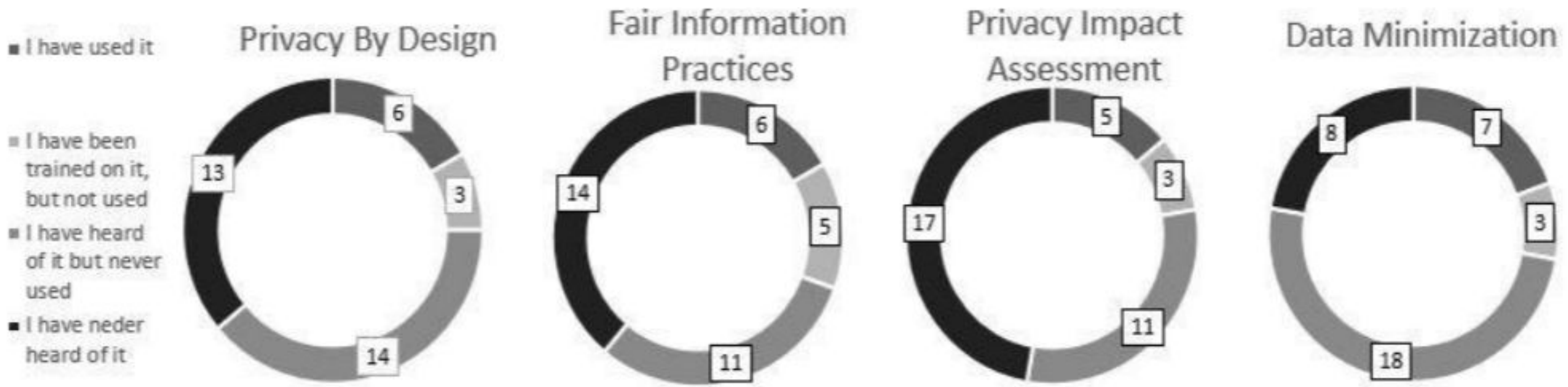

Figure 1: Participants’ Formal Knowledge on Privacy Concepts

bit.ly/2J3yEWn

Privacy Impact Assessment

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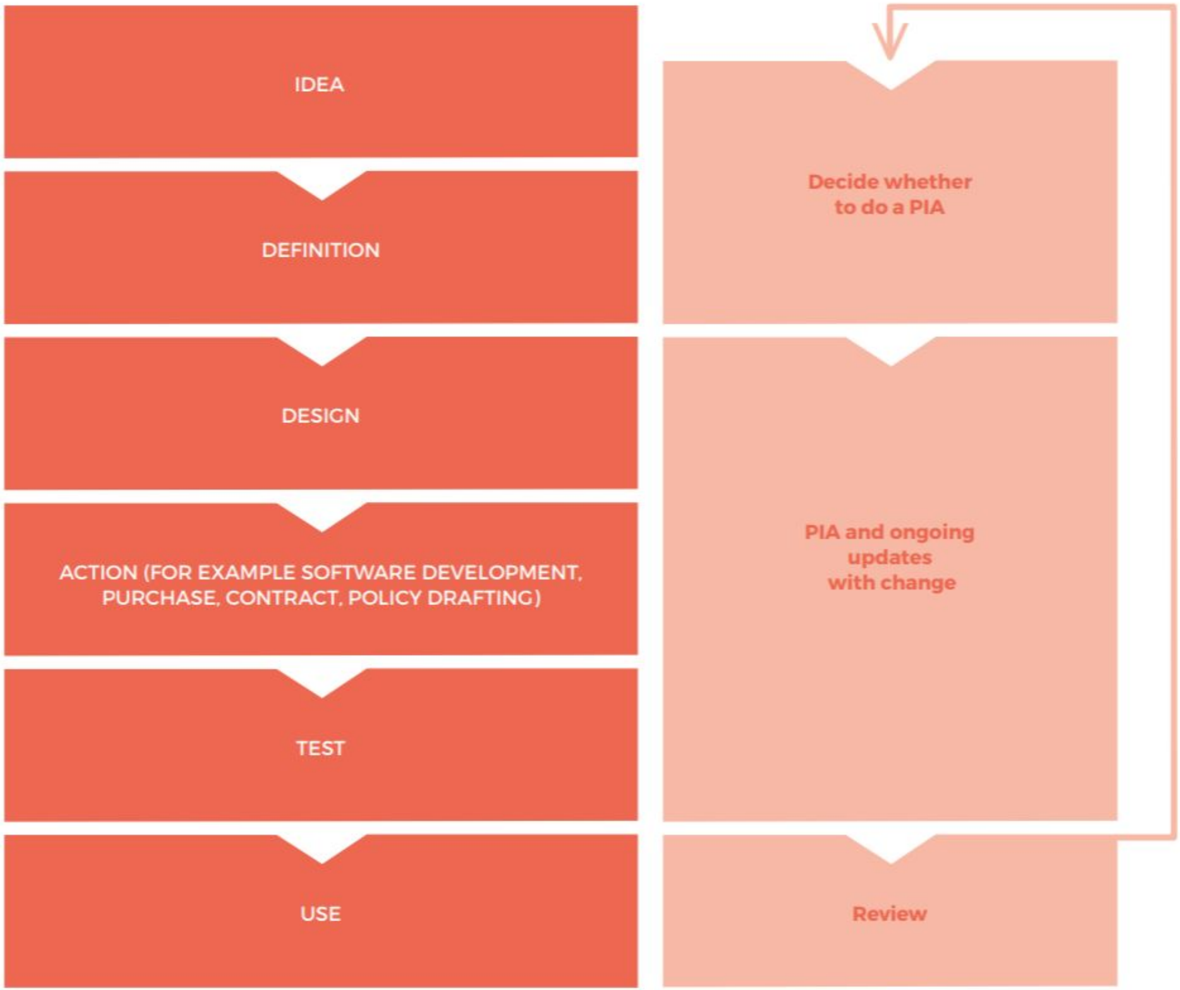
Description

A Privacy Impact Assessment (PIA) is a method to:

- Identify privacy risk
- Map personal data flows
- Document privacy risk mitigations
- Fulfill regulatory requirements

Privacy Impact Assessment throughout an initiative



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Use Cases

- New applications
- Adding functions and features
- Collecting new sensitive personal data
- Annual reviews or audits

Tasting Notes

Benefits

- Legal compliance
- Identify and reduce privacy risks
- Catch privacy errors

bit.ly/2qbrnu5

Tasting Notes

Benefits

- Legal compliance
- Identify and reduce privacy risks
- Catch privacy errors

Limitations

- High time investment
- Ineffective if not completed well
- Not a security risk assessment

Data Minimization and Retention

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Description

Data minimization is:

- Collecting only necessary data
- Maintaining and updating data
- Deleting old data that isn't needed

Use Cases

- New applications
- API integrations
- Adding functions and features
- Collecting new personal data
- Customer termination

Tasting Notes

Benefits

- Legal compliance
- Minimize volume of data to be breached
- Improve data quality

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Tasting Notes

Benefits

- Legal compliance
- Minimize volume of data to be breached
- Improve data quality

Limitations

- Users may be frustrated
- Companies like to keep all the data

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Default Settings
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Description

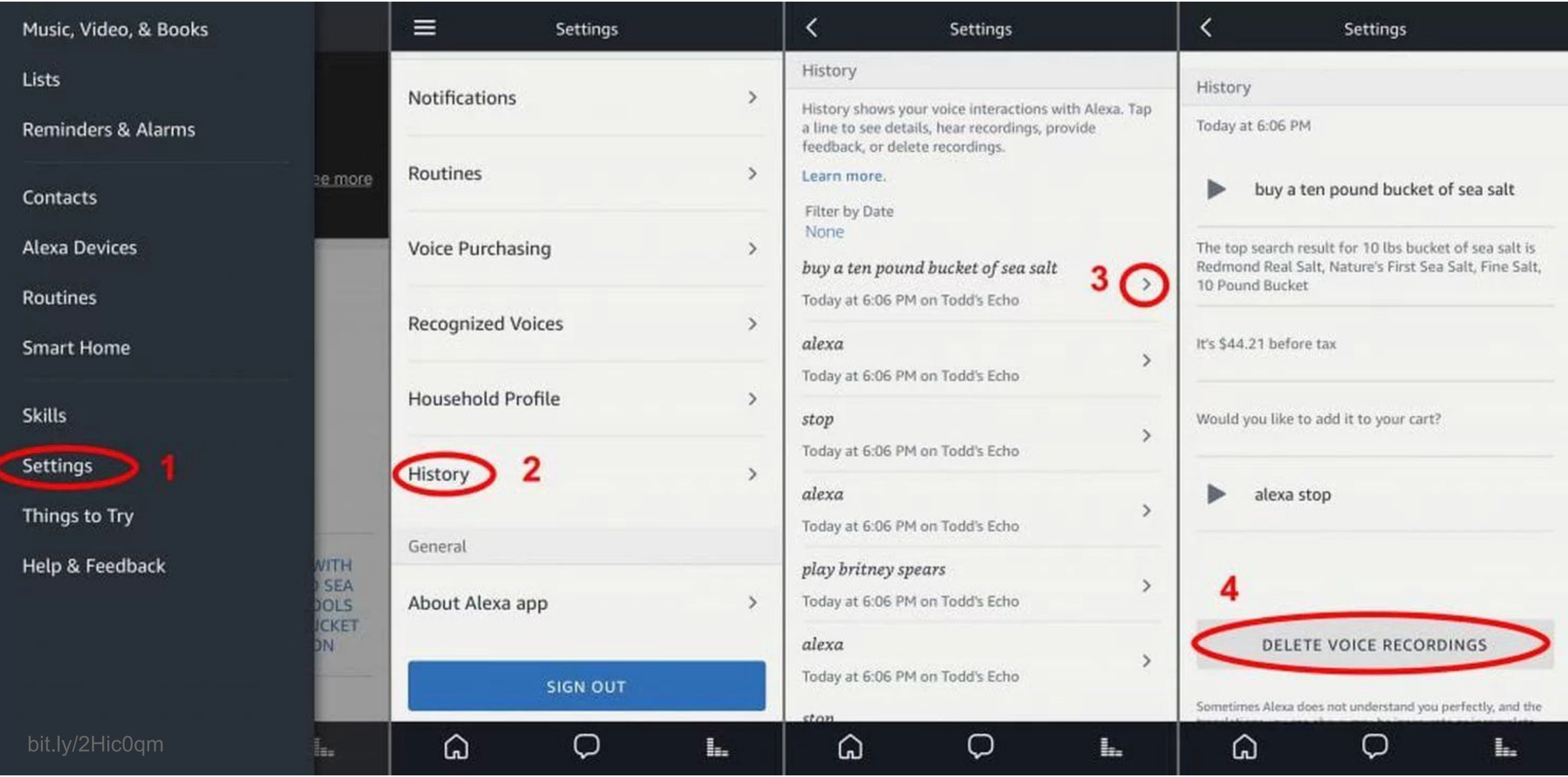
Default settings for privacy should:

- Minimize personal data collected
- Prevent default data sharing
- Require enabling of intrusive settings
- Avoid making data public by default


bit.ly/2KmuLyl

Less than 5% of general users change any default settings, while programmers change 40% of settings.

bit.ly/2UmLXEP



Music, Video, & Books
Lists
Reminders & Alarms
Contacts
Alexa Devices
Routines
Smart Home
Skills
Settings
1
Things to Try
Help & Feedback
bit.ly/2Hic0qm
Settings
Notifications
Routines
Voice Purchasing
Recognized Voices
Household Profile
History
2
General
About Alexa app
SIGN OUT
Settings
History
History shows your voice interactions with Alexa. Tap a line to see details, hear recordings, provide feedback, or delete recordings.
Learn more.
Filter by Date
None
buy a ten pound bucket of sea salt
3
Today at 6:06 PM on Todd's Echo
alexa
Today at 6:06 PM on Todd's Echo
stop
Today at 6:06 PM on Todd's Echo
alexa
Today at 6:06 PM on Todd's Echo
play britney spears
Today at 6:06 PM on Todd's Echo
alexa
Today at 6:06 PM on Todd's Echo
Settings
History
Today at 6:06 PM
buy a ten pound bucket of sea salt
The top search result for 10 lbs bucket of sea salt is Redmond Real Salt, Nature's First Sea Salt, Fine Salt, 10 Pound Bucket
It's $44.21 before tax
Would you like to add it to your cart?
alexa stop
4
DELETE VOICE RECORDINGS
Sometimes Alexa does not understand you perfectly, and the

Manage your privacy and automated messaging choices

Read our privacy policy

How AT&T Communicates with Customers

Automated Messages

How AT&T Uses Customer Data

External Marketing & Analytics Reports

DNS Error Assist

Relevant Advertising

Enhanced Relevant Advertising

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Please note, your choice for Relevant Advertising is separate.

Service	**Allow use of information?**
Wireless number:	No
Wireless number:	No

bit.ly/2Yg4i9D

Tasting Notes

Benefits

- Reputation for privacy
- Reduce user frustration
- Protect less educated users

Tasting Notes

Benefits

- Legal compliance
- Reputation for privacy
- Reduce user frustration
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Limitations

- Companies may want to monetize intrusive apps
- Requires privacy awareness at design

Encryption

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Encrypt these:

- TLS
- Email and messaging
- Databases
- Cloud storage
- Backups
- Password management
- Endpoint devices

Don’t:

- Make your own crypto
- Use deprecated crypto (i.e., SHA1)
- Hard code keys
- Store keys on the same server as the data
- Use one key for everything
- Skip password hash and salt
- Forget to restore certificates after testing
- Use old crypto libraries

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Differential Privacy

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Description

Differential privacy:

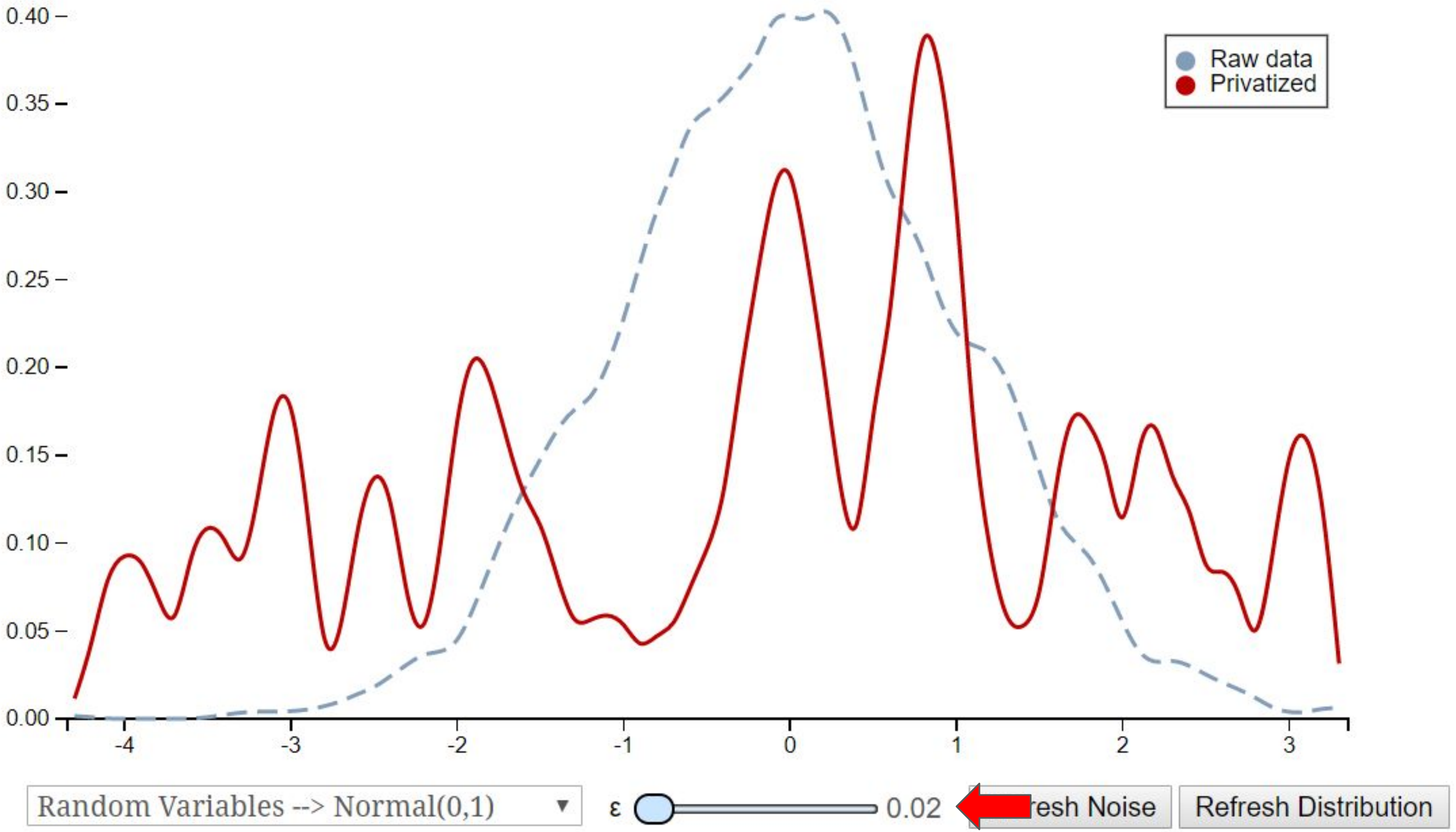
- Adds statistical noise to a data set
- Prevents identification of one individual's record
- Provides the same results as the raw data would, with or without one record

Table I. Privacy Models

Privacy Model	Attack Model			
	Record Linkage	Attribute Linkage	Table Linkage	Probabilistic Attack
k-Anonymity	✓			
MultiR k-Anonymity	✓			
ℓ-Diversity	✓	✓		
Confidence Bounding		✓		
(α, k)-Anonymity	✓	✓		
(X, Y)-Privacy	✓	✓		
(k, e)-Anonymity		✓		
(ϵ, m)-Anonymity		✓		
Personalized Privacy		✓		
t-Closeness		✓		✓
δ-Presence			✓	
(c, t)-Isolation	✓			✓
ϵ-Differential Privacy			✓	✓
(d, γ)-Privacy			✓	✓
Distributional Privacy			✓	✓

bit.ly/2IwDufR

bit.ly/2Pk7fEG



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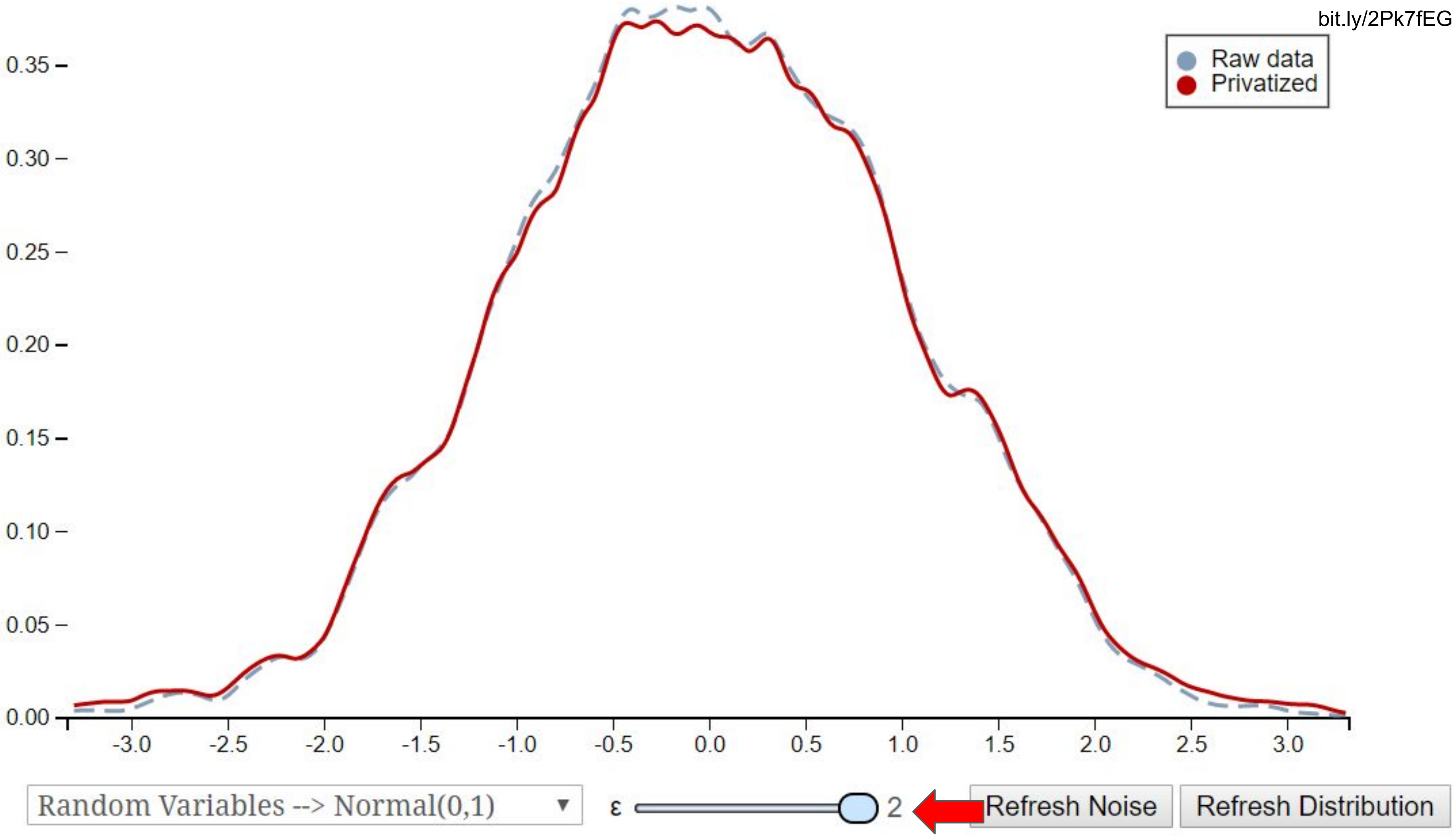

Tasting Notes

Benefits

- Limit insider threats
- Increase data usability
- Allows for collaboration without exposing data

Tasting Notes

Benefits

- Legal compliance
- Limit exposure from security incidents
- Limit insider threats

Limitations

- Works best on large databases
- Must be tuned well

Privacy Preserving Ad Click Attribution

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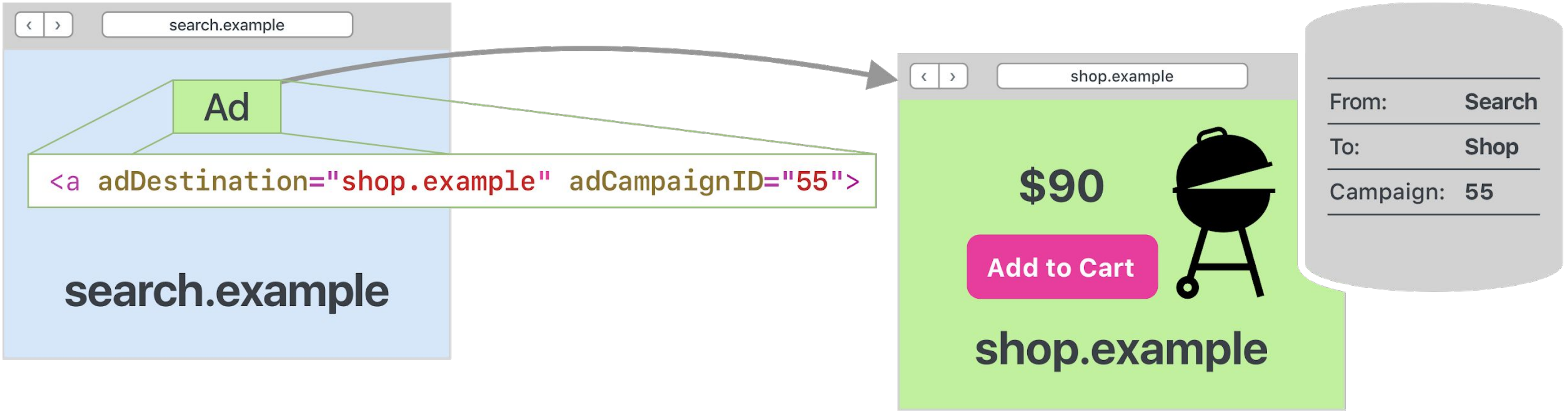
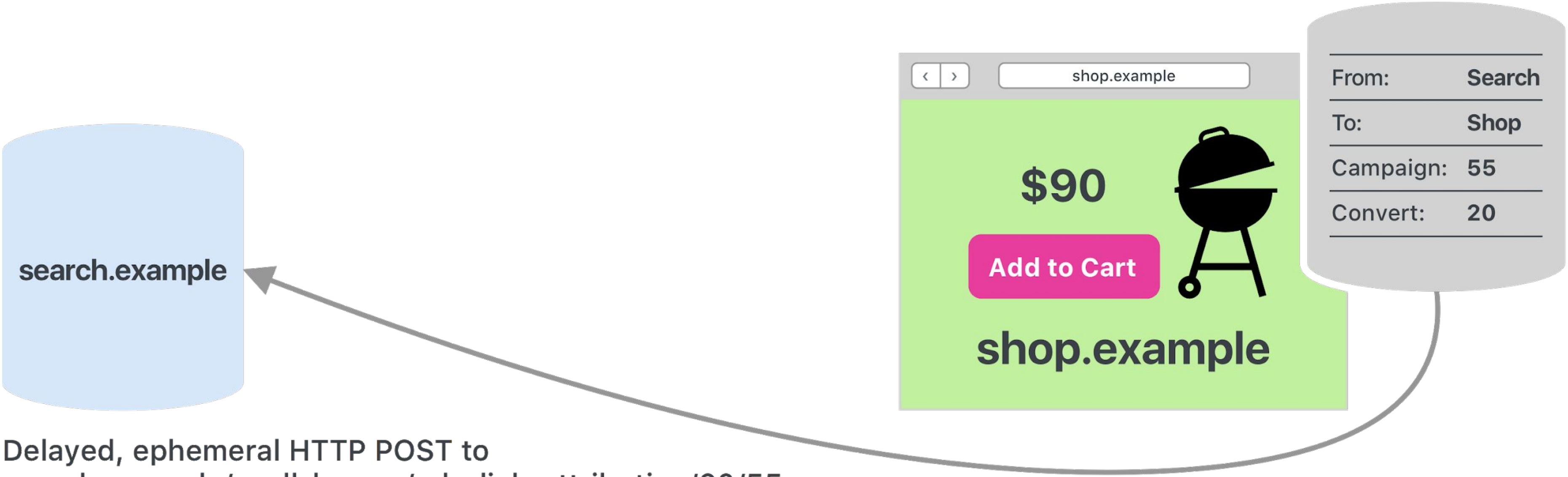
Description

Privacy preserving ad click attribution:

- Allows ad attribution monetization
- Prevents user ad click tracking
- Uses the browser to mediate ad clicks



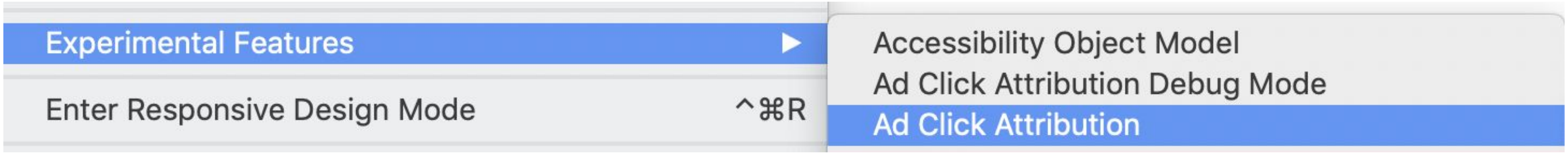
bit.ly/30FFBoj



Delayed, ephemeral HTTP POST to
search.example/.well-known/ad-click-attribution/20/55
with referrer set to shop.example

bit.ly/30FFBoj

Available now as an experimental feature



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Tasting Notes

Benefits

- Allows websites to still monetize content
- Could become a W3C web standard

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- Allows websites to still monetize content
- Could become a W3C web standard

Limitations

- Needs widespread adoption to be effective
- Users may not believe any ads respect privacy

Federated Learning

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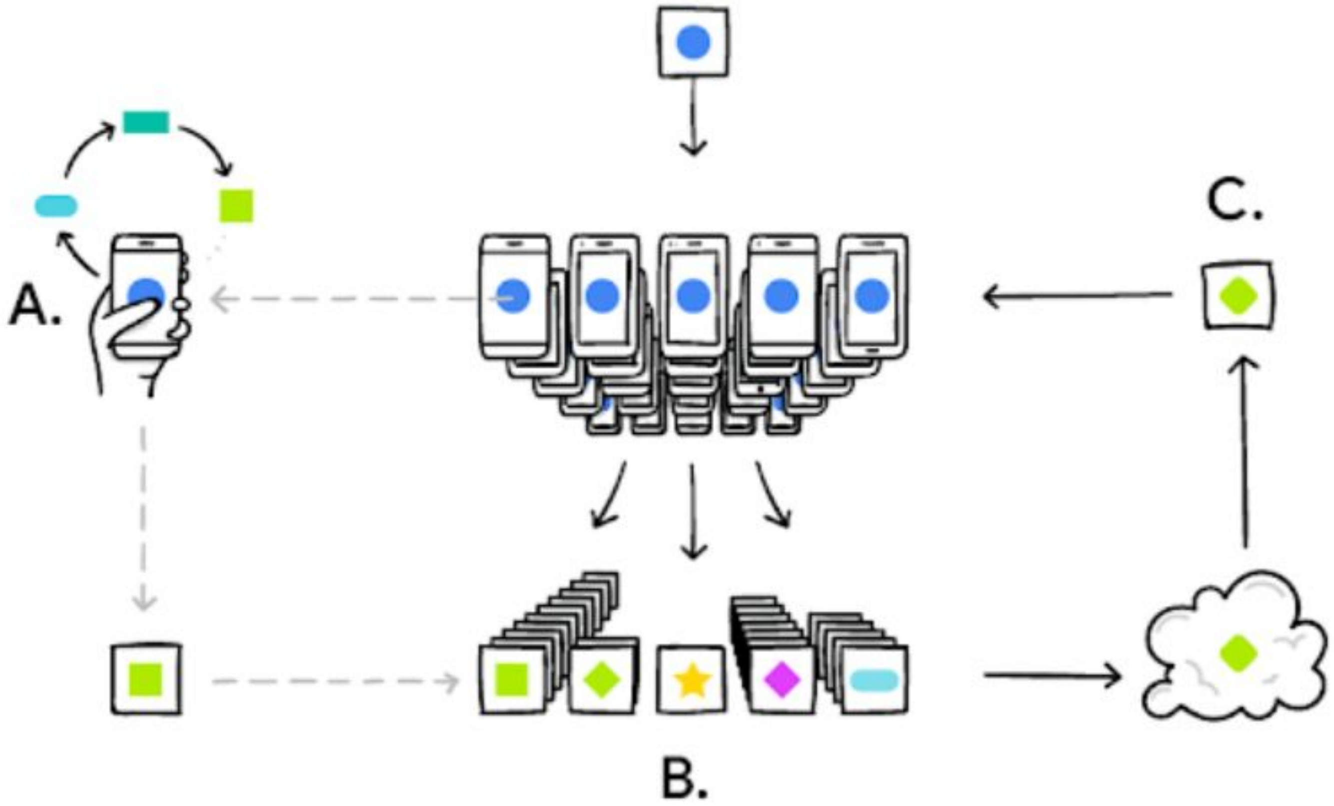
Description

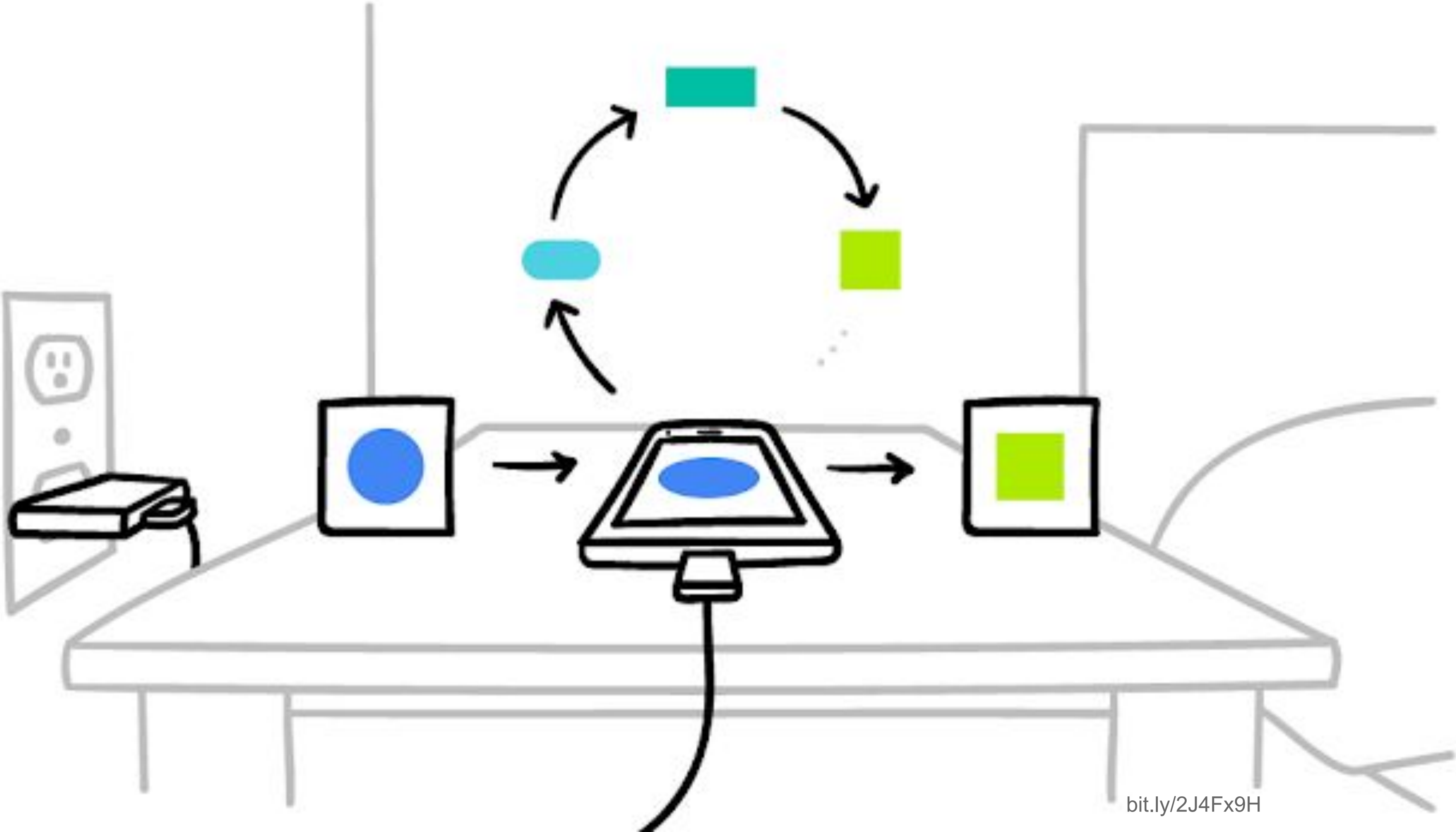
Federated learning:

- Trains a central model on decentralized data
- Never transmits device data
- Sends iterative model updates to devices which return new results
- Uses secure aggregation to decrypt only the aggregate and no user data



Your phone personalizes the model locally, based on your usage (A). Many users' updates are aggregated (B) to form a consensus change (C) to the shared model, after which the procedure is repeated.

bit.ly/2J4Fx9H



bit.ly/2J4Fx9H

Use Cases

- Android’s Gboard prediction model
- Health diagnostics
- Behavioral preference learning
- Driver behavior

Tasting Notes

Benefits

- Speeds up modeling and testing
- Minimally intrusive
- Individual data is not accessible to the central model

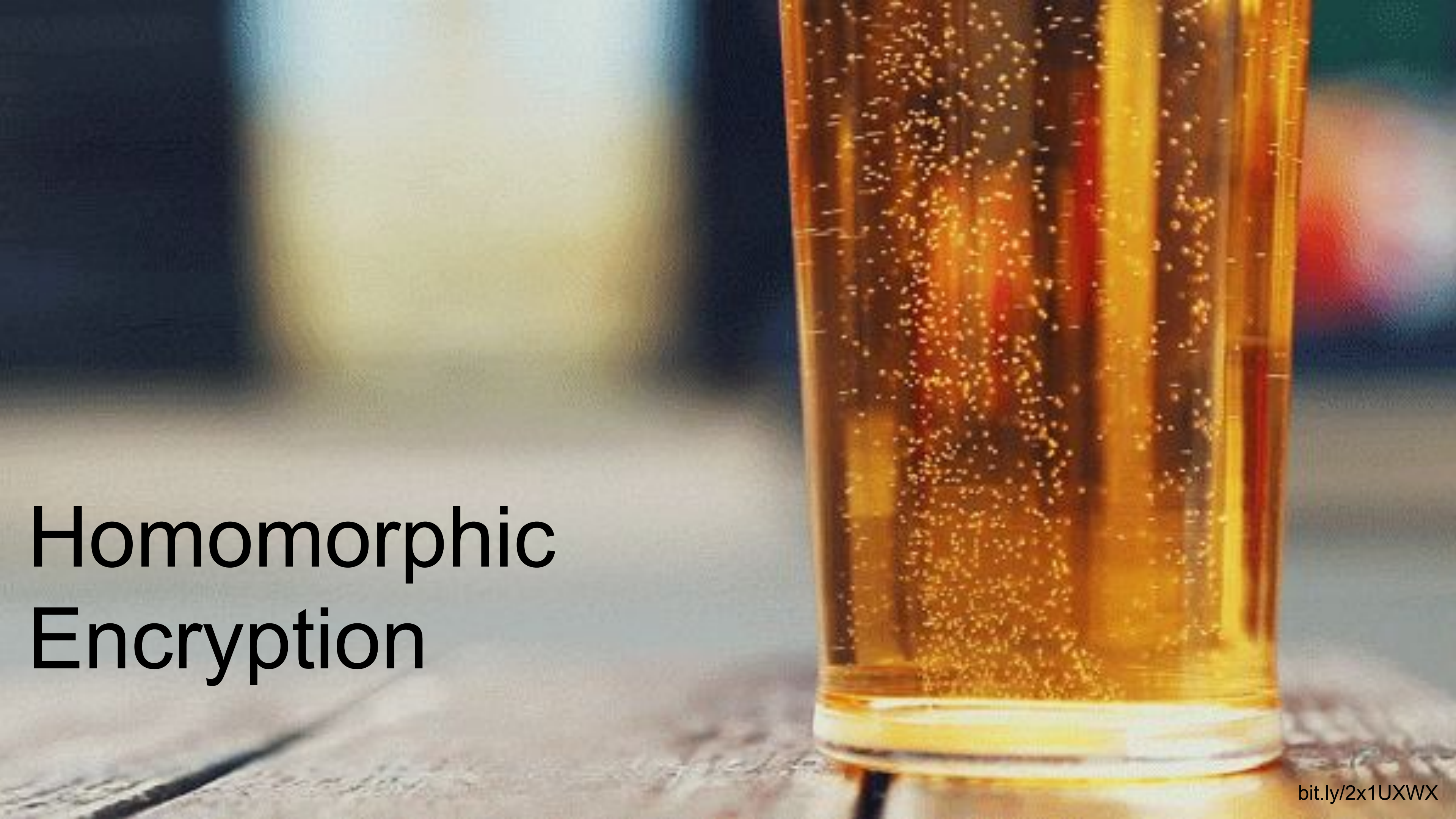
Tasting Notes

Benefits

- Speeds up modeling and testing
- Minimally intrusive
- Individual data is not accessible to the central model

Limitations

- Errors could cause private data leakage
- Requires a large user base



Homomorphic Encryption

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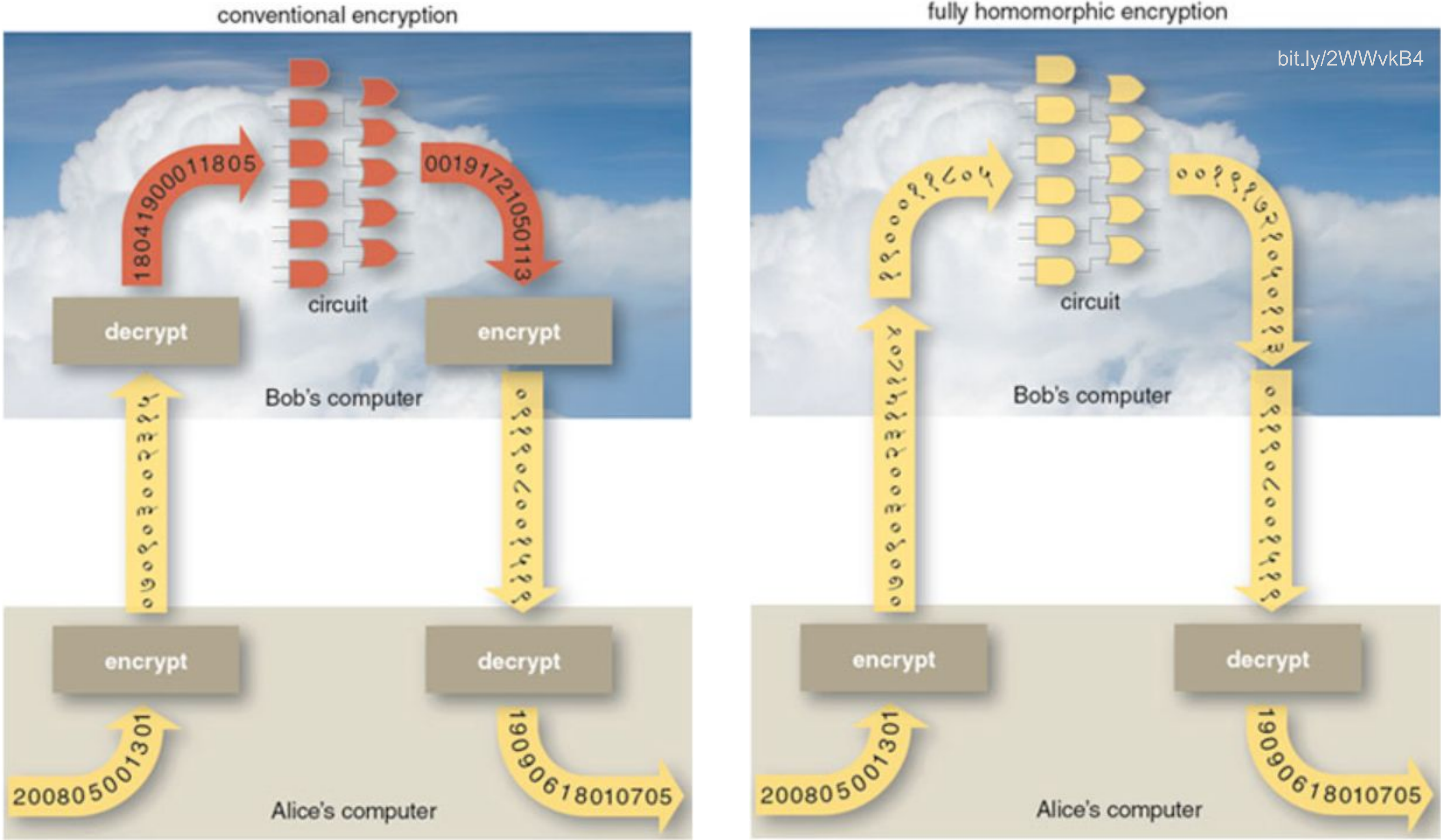
Description

Homomorphic encryption:

- Allows computation on ciphertext
- Enables collaboration without disclosing confidential data
- Only the calculation results can be decrypted



conventional encryption
fully homomorphic encryption
bit.ly/2WWvkB4
180419000011805
0019172105011З
circuit
decrypt
encrypt
Bob's computer
encrypt
decrypt
200805001301
19090618010705
Alice's computer
circuit
Bob's computer
encrypt
decrypt
200805001301
19090618010705
Alice's computer

Use Cases

- Computations on data shared across organizations
- Research using highly sensitive records
- Processing by employees with a lower clearance
- Google’s open source Private Join and Compute

Tasting Notes

Benefits

- Reduces insider threat
- Increases collaboration
- Increases data usability

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Tasting Notes

Benefits

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- Increases collaboration
- Increases data usability

Limitations

- Resource-intensive
- Limited functions
- No fully homomorphic encryption available yet

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Becoming a Privacy Champion

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