PPM for ads measurement on the web

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Problem: web privacy

- Third party cookies are bad for users’ cross site privacy
- But, critical infrastructure that powers online ads depends on them
- Could we build a third party cookie alternative that gives good user privacy while still supporting ads use-cases?
  - In principle, many ads use-cases are totally fine with aggregate data!
Attribution Measurement: with cookies

- A third party cookie allows joining events from two sites
  - An impression (on a publisher site)
  - A conversion (on an advertiser site)
- This allows building a graph of user browsing activity.
- The cookie becomes a sort of mega-identity that allows your activity to be seen wherever the cookie is read

![Diagram of Ad-tech and cookies connecting news.example and shoes.example](image-url)
Attribution Measurement: with PPM

- Browser internally joins two events, and generates contributions to some aggregate measure (e.g. a histogram)
  - x-axis: ad campaign
  - y-axis: number of conversions
- Browser splits contributions into shares, and submits them to the PPM system
- PPM securely aggregates and shares with ad-tech
More use-cases to consider

- Guaranteeing differential privacy on PPM output
- Reporting under very large, sparse, domains
- Training machine learning models
  - e.g. compute pConversion given an impression
- Supporting infrastructure for ads targeting use-cases
  - e.g. github.com/WICG/turtledove
  - k-anonymity checks, ad serving measurement, etc.
- Reach measurement (how many users saw my ads?)
- Generic cross site measurement on the web
Formal privacy guarantees: Differential privacy

Take two neighboring databases $d$ and $d'$ that differ on a single user’s contributions. Run the two databases through a randomized algorithm $M$.

$M$ is $\epsilon$ differentially private if: $P(M(d) = O) \leq e^{\epsilon} P(M(d') = O)$ For all possible outputs $O$.

In other words, the output of $M$ looks “basically the same” whether that single user is in the database or not, via noise introduced by $M$.

PPM can guarantee that output is differentially private, even if one party is dishonest.
- Each aggregator can add independent noise
- Clients can add noise