CSE190/291
How The Web Tracks You / Targeted Advertising

Online Advertising, Part 2

UC San Diego

Housekeeping

General course things to know

- PA1 part 4 is due **11/3, in one week!**
  - Everything that you have built so far will converge
  - You will be building an SSP that talks to several DSPs and makes pricing decisions, trying to make money for Boogle using advertising
    - Along the way, you'll deal with complaints, fraud, etc.…

Housekeeping

General course things to know

- Pete Snyder, Principal Privacy Researcher at *Brave*, (a privacy oriented browser company) will be visiting us on **11/3,** in the CSE190 section
- The talk will (hopefully) be in-person, which will be great!
  - Come prepared with lots of questions about how Brave works and the online tracking ecosystem!



Brave

Housekeeping

General course things to know

- The midterm is coming: in class on **11/5**
- Basic structure:
  - Multiple choice — penalties for guessing
  - Short answer — write things
  - PA-style questions — **very** similar to your PAs!
- *We will release some sample questions this week!*
- **You must attend the section you are enrolled in. No exceptions.**

Previously on CSE190/CSE291…

- The online ad ecosystem, supply side, demand side, and the intermediaries that make a lot of money in this ecosystem
- Rapid-fire recap:
  - What is supply in the ad exchange ecosystem?
  - What is demand in the ad exchange ecosystem?

Previously on CSE190/CSE291…

- The online ad ecosystem, supply side, demand side, and the intermediaries that make a lot of money in this ecosystem
- Rapid-fire recap:
  - What is supply in the ad exchange ecosystem?
  - What is demand in the ad exchange ecosystem?
- Left with open question: **How do we implement this in practice?**

Today's lecture — Online Advertising, Part 2

Learning Objectives

- Understand the fundamentals, the spec, and how requests + responses work in OpenRTB
- Detail how tracking is implemented in OpenRTB!
- Learn some ways that the ecosystem has had to adapt in response to fraud and abuse
- Understand the idea of an *auction*, how auctions are embedded in online advertising, and the distinction between a first-price and second-price auction

OpenRTB

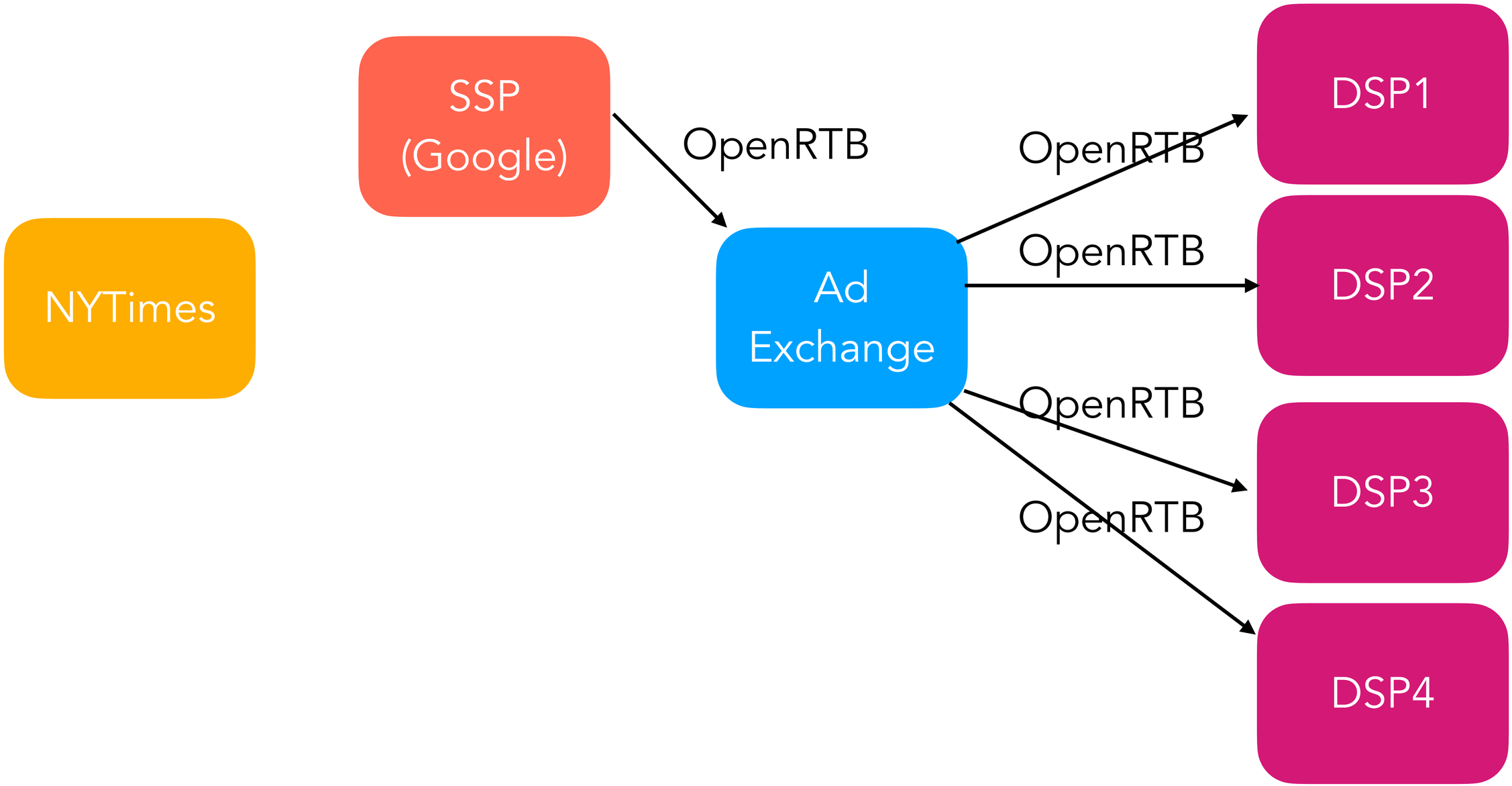
Recap — OpenRTB

- OpenRTB is a real-time bidding (RTB) protocol that enables suppliers, exchanges, and advertisers to communicate with one another
- Largely implemented by **SSPs, Ad Exchanges, and DSPs** to send structured data to one another
  - What is the protocol + data format that OpenRTB uses?

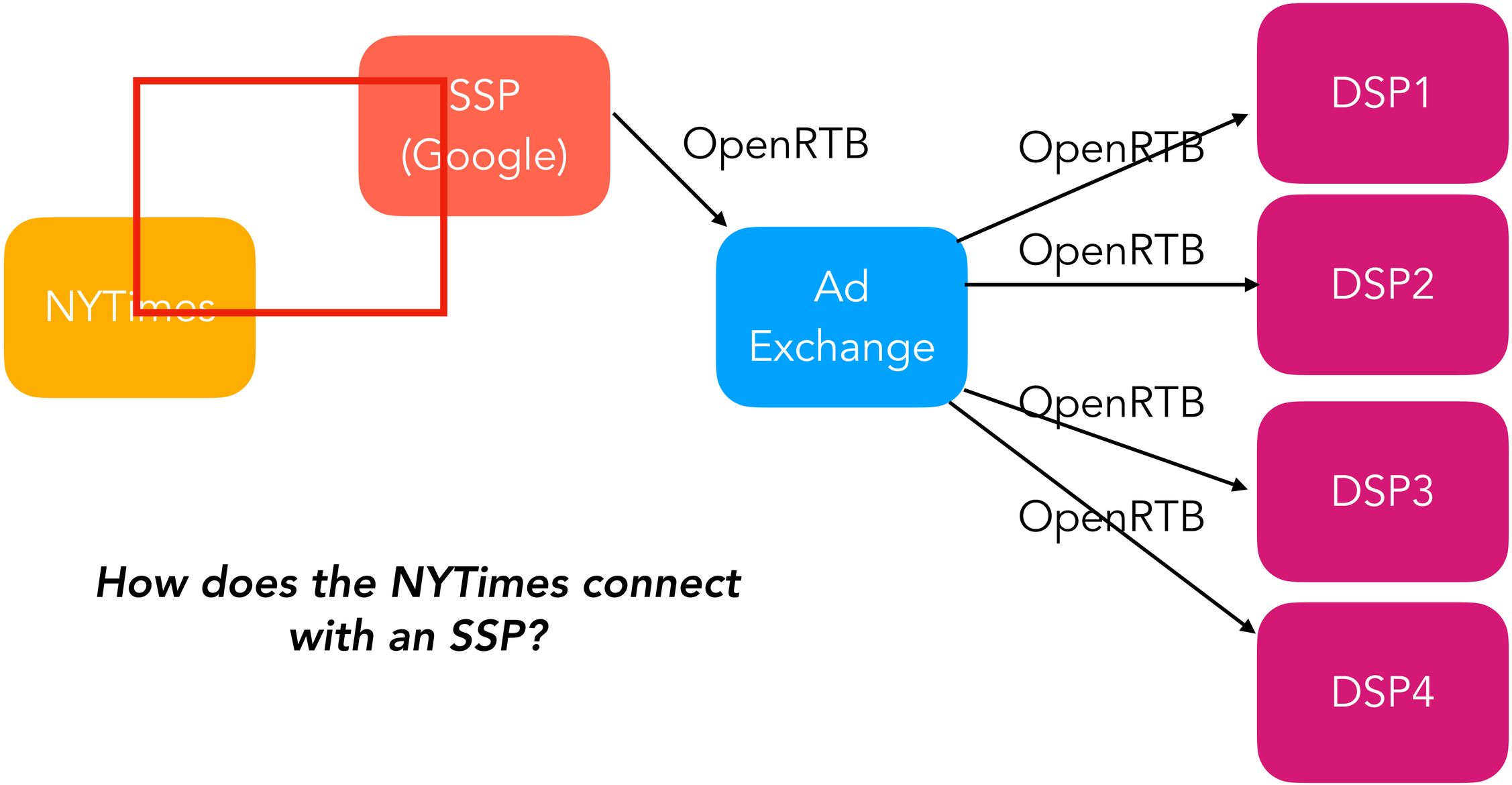
Recap — OpenRTB

- OpenRTB is a real-time bidding (RTB) protocol that enables suppliers, exchanges, and advertisers to communicate with one another
- Largely implemented by **SSPs, Ad Exchanges, and DSPs** to send structured data to one another
  - What is the protocol + data format that OpenRTB uses? **HTTP + JSON!**
- The goal is to have an easy-to-use and easy-to-implement protocol that enables interoperability between parties

OpenRTB runs the entire ecosystem* (almost)

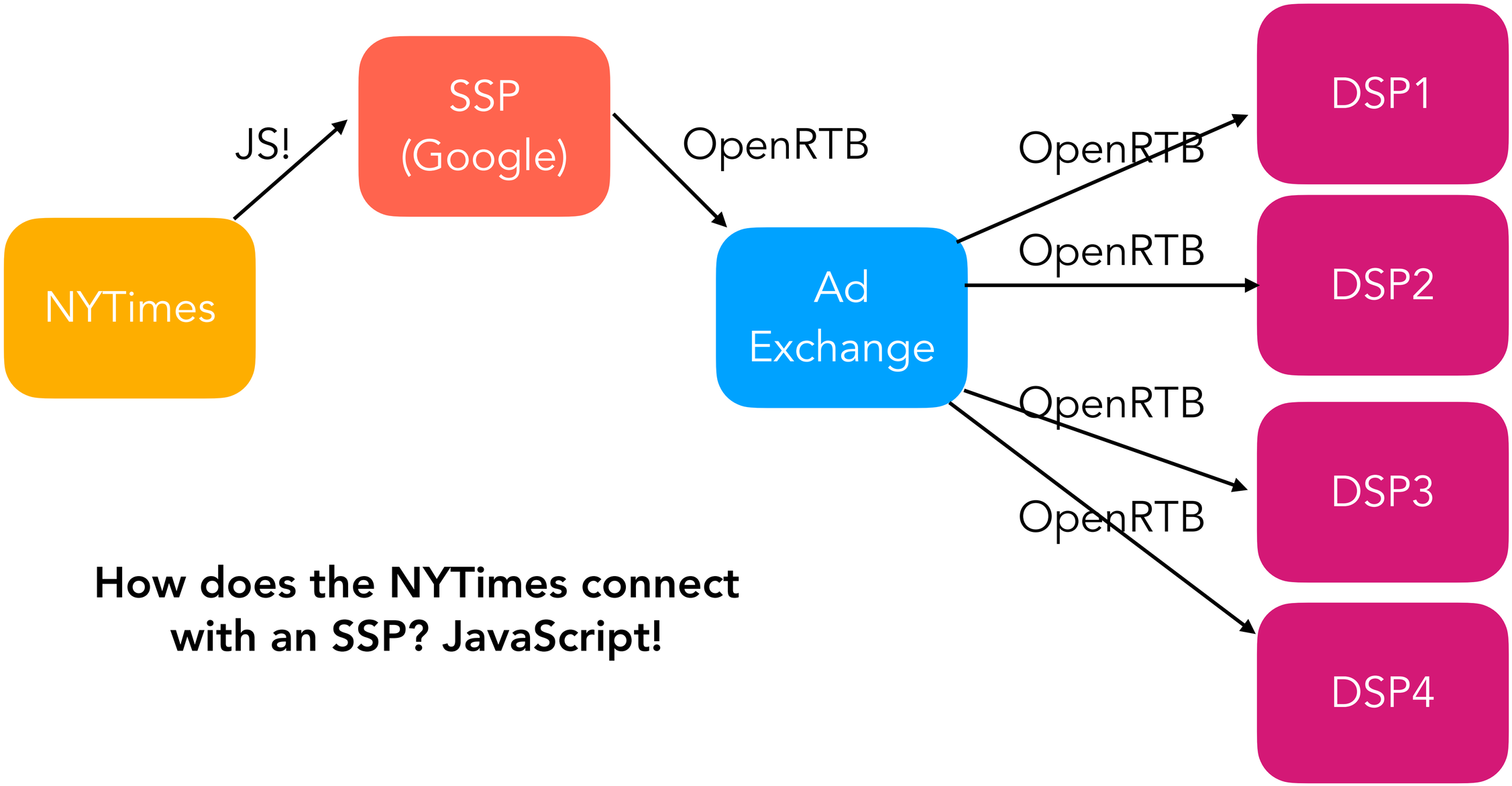


OpenRTB runs the entire ecosystem* (almost)



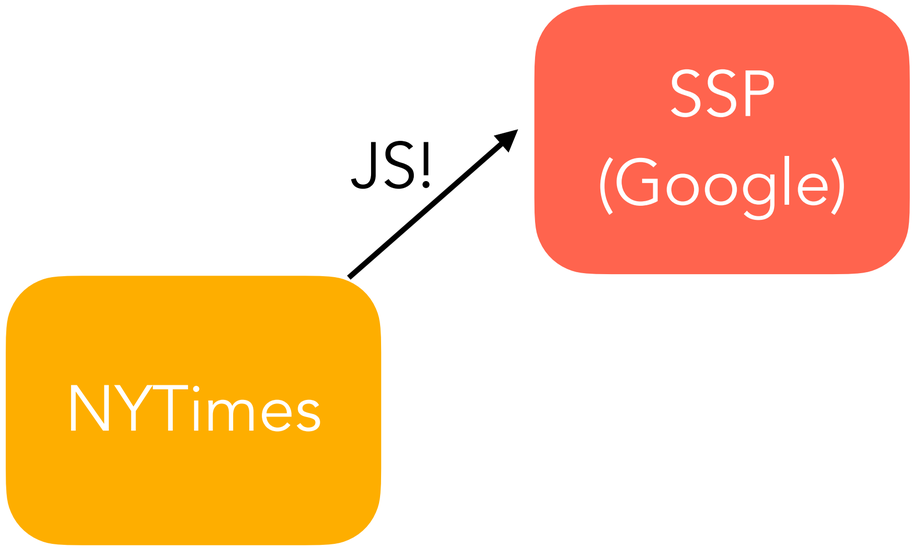
How does the NYTimes connect with an SSP?

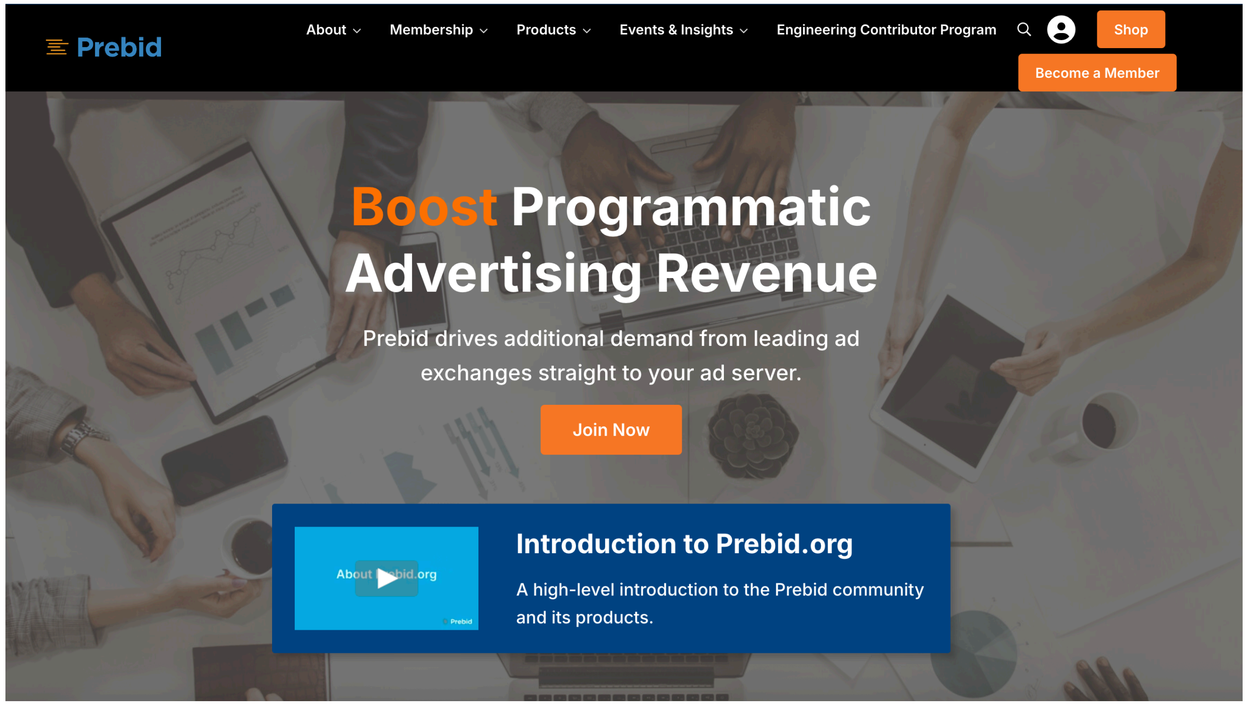
OpenRTB runs the entire ecosystem* (almost)



How does the NYTimes connect with an SSP? JavaScript!

Publishers often connect using prebid.js






```
<script async src="//cdn.jsdelivr.net/npm/prebid.js@latest/dist/not-for-prod/prebid.js"></script>
```

Prebid gets a shout out in a recent DoJ

Remedies for Google's Unlawful Monopolization to Help Restore Competition in Online Advertising Technology Markets

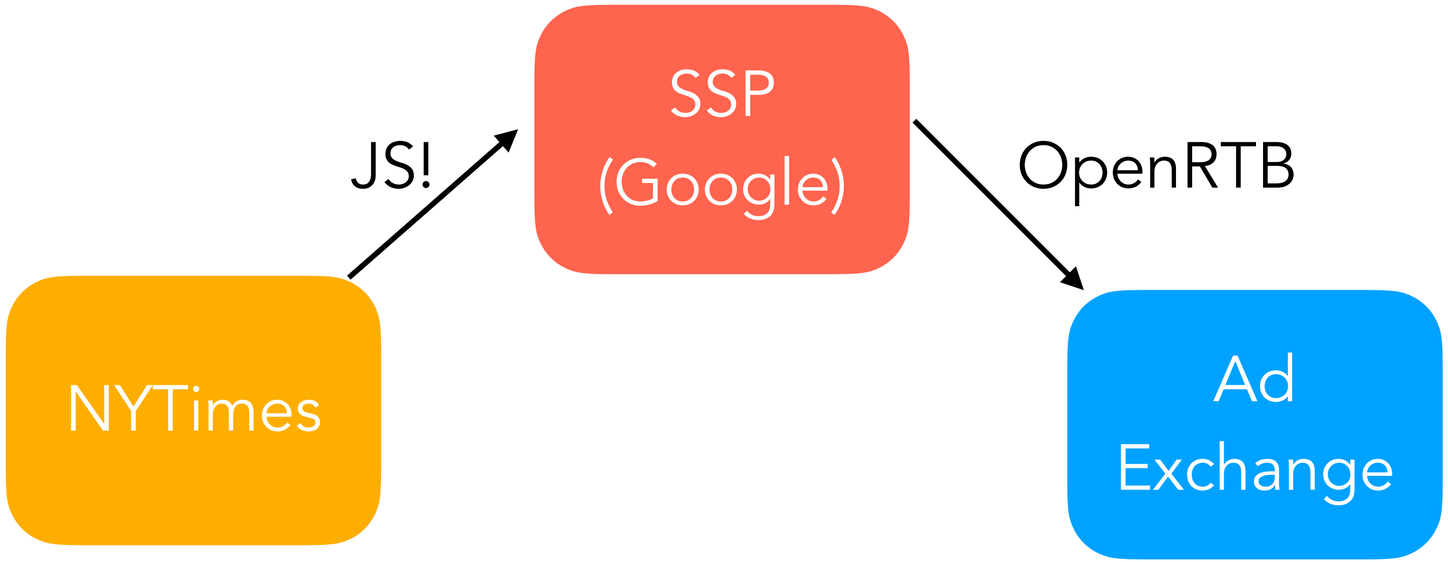
The Justice Department's Antitrust Division won substantial relief in its monopolization case against Google in advertising technology markets. In *United States et al. v. Google LLC*, the U.S. District Court for the Eastern District of Virginia ordered significant behavioral relief, including requiring close integration between Google's products and products offered by rivals, including the open-source solutions offered by Prebid. The court ordered further relief that will help to pry open these markets to competit

- **Required Integrations with Prebid and Competing Publisher Ad Servers.** The court recognized the importance of injecting new competition and breaking Google's unlawful tie between AdX and DFP. Google must create and support integrations between AdX and Prebid, and DFP and Prebid. Prebid is an open-source industry standard for real-time bidding. In addition, AdX will be required to submit real-time bids to other publisher ad servers. These integrations will give publishers more control over the sale of their inventory and offer access to important, unique demand without publishers being forced to use both DFP and AdX.

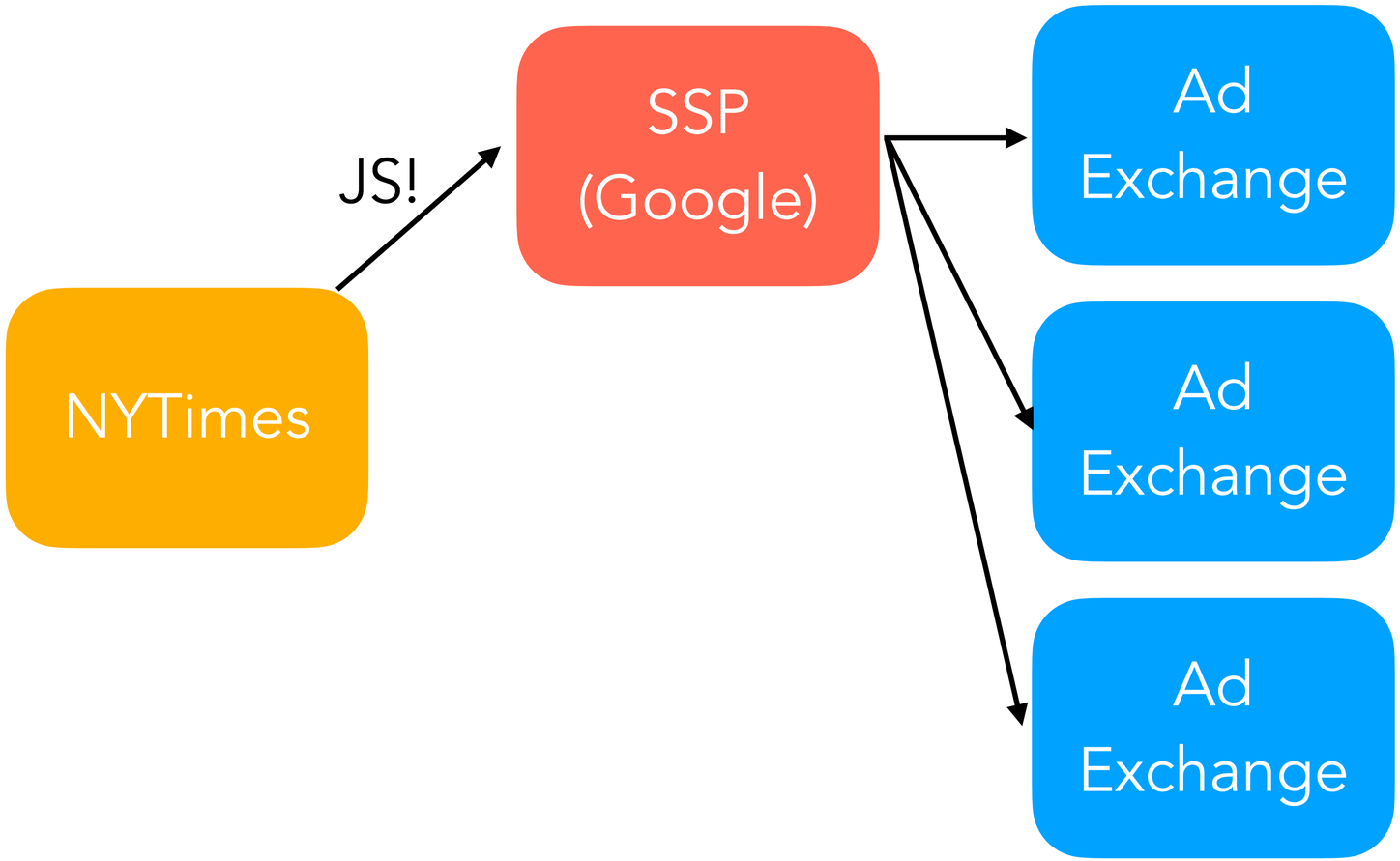
Prebid gets a shout out in a recent DoJ

- **Required Integrations with Prebid and Competing Publisher Ad Servers.** The court recognized the importance of injecting new competition and breaking Google's unlawful tie between AdX and DFP. Google must create and support integrations between AdX and Prebid, and DFP and Prebid. Prebid is an open-source industry standard for real-time bidding. In addition, AdX will be required to submit real-time bids to other publisher ad servers. These integrations will give publishers more control over the sale of their inventory and offer access to important, unique demand without publishers being forced to use both DFP and AdX.

OpenRTB runs the entire ecosystem* (almost)



OpenRTB runs the entire ecosystem* (almost)



Your SSP will contact all ad exchanges at once… in practice, SSPs and exchanges are somewhat interchangable.

A simple OpenRTB Request

```
{
  "id": "req-123", "at": 1, "tmax": 150,
  "imp": [{ "id": "1", "banner": { "w": 300, "h": 250 }, "bidfloor": 0.50 }],
  "site": { "domain": "news.example", "page": "https://news.example/sports/
game" },
  "device": { "ua": "Mozilla/5.0 ...", "ip": "203.0.113.0" },
  "user": { "buyeruid": "dsp-u-77f1" }
}
```

What do we know about this slot?

A simple OpenRTB Request

```
{
  "id": "req-123", "at": 1, "tmax": 150,
  "imp": [{ "id": "1", "banner": { "w": 300, "h": 250 }, "bidfloor": 0.50 }],
  "site": { "domain": "news.example", "page": "https://news.example/sports/
game" },
  "device": { "ua": "Mozilla/5.0 ...", "ip": "203.0.113.0" },
  "user": { "buyeruid": "dsp-u-77f1" }
}
```

This is a banner ad, with size 250x300px

A simple OpenRTB Request

```
{
  "id": "req-123", "at": 1, "tmax": 150,
  "imp": [{ "id": "1", "banner": { "w": 300, "h": 250 }, "bidfloor": 0.50 }],
  "site": { "domain": "news.example", "page": "https://news.example/sports/
game" },
  "device": { "ua": "Mozilla/5.0 ...", "ip": "203.0.113.0" },
  "user": { "buyeruid": "dsp-u-77f1" }
}
```

The minimum amount the seller is willing to accept is a CPM of $0.5

A simple OpenRTB Request

```
{
  "id": "req-123", "at": 1, "tmax": 150,
  "imp": [{ "id": "1", "banner": { "w": 300, "h": 250 }, "bidfloor": 0.50 }],
  "site": { "domain": "news.example", "page": "https://news.example/sports/
game" },
  "device": { "ua": "Mozilla/5.0 ...", "ip": "203.0.113.0" },
  "user": { "buyeruid": "dsp-u-77f1" }
}
```

The seller is selling on news.example, specifically the sports section

A simple OpenRTB Request

```
{
  "id": "req-123", "at": 1, "tmax": 150,
  "imp": [{ "id": "1", "banner": { "w": 300, "h": 250 }, "bidfloor": 0.50 }],
  "site": { "domain": "news.example", "page": "https://news.example/sports/
game" },
  "device": { "ua": "Mozilla/5.0 ...", "ip": "203.0.113.0" },
  "user": { "buyeruid": "dsp-u-77f1" }
}
```

The user has an identifier (likely, a cookie) and device information (including IP addresses!)

A simple OpenRTB Request

```
{
  "id": "req-123", "at": 1, "tmax": 150,
  "imp": [{ "id": "1", "banner": { "w": 300, "h": 250 }, "bidfloor": 0.50 }],
  "site": { "domain": "news.example", "page": "https://news.example/sports/
game" },
  "device": { "ua": "Mozilla/5.0 ...", "ip": "203.0.113.0" },
  "user": { "buyeruid": "dsp-u-77f1" }
}
```

Question: why send this cookie value along?

A simple OpenRTB Request

```
{
  "id": "req-123", "at": 1, "tmax": 150,
  "imp": [{ "id": "1", "banner": { "w": 300, "h": 250 }, "bidfloor": 0.50 }],
  "site": { "domain": "news.example", "page": "https://news.example/sports/
game" },
  "device": { "ua": "Mozilla/5.0 ...", "ip": "203.0.113.0" },
  "user": { "buyeruid": "dsp-u-77f1" }
}
```

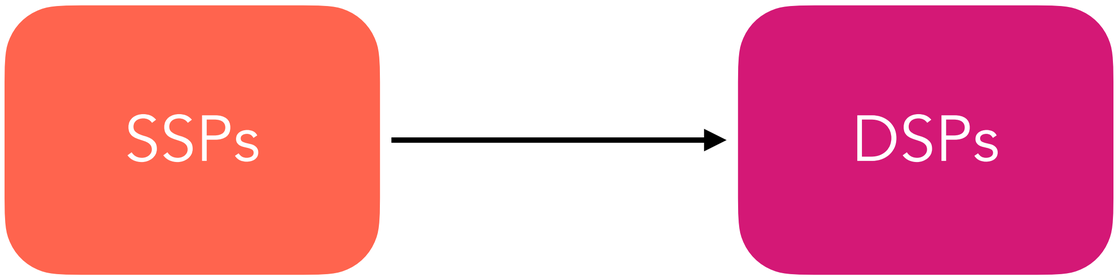
Question: why send this cookie value along?

Advertisers that this supplier has *cookie sync'd* with can send an even more specific targeted advertisement!

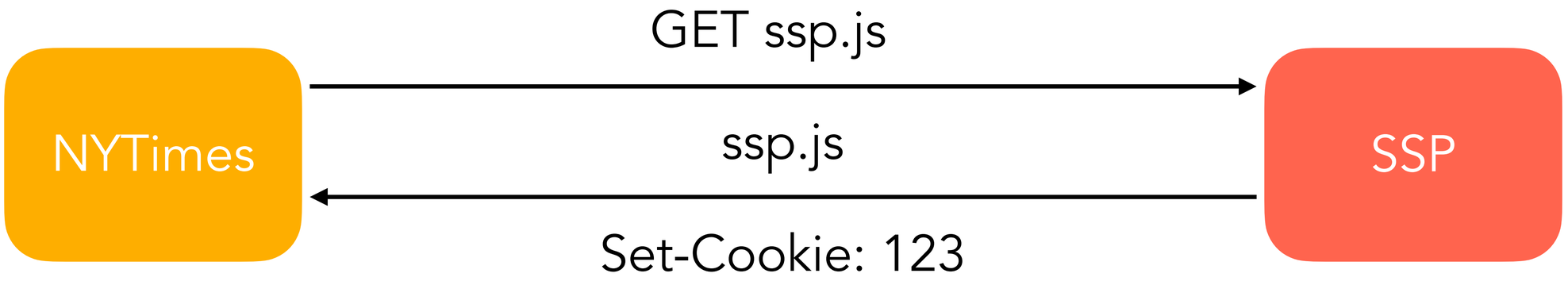
Implementing cookie syncing for advertising

- SSPs are sending a user ID via OpenRTB in the “user field.” In order for it to be useful, there must be some kind of cookie syncing going on.

- With a group, take five minutes to design a cookie syncing strategy an SSP can use to ensure all parties are targeting the same user. Include how the sharing is initiated, where the cookies are set, and where the mappings are stored.

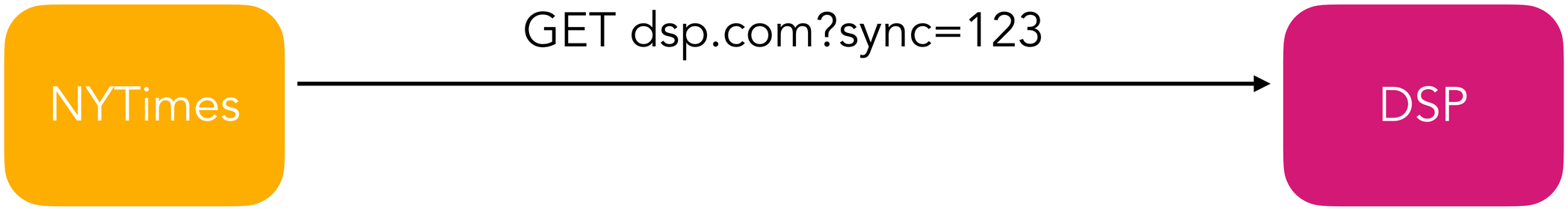


A common cookie syncing protocol



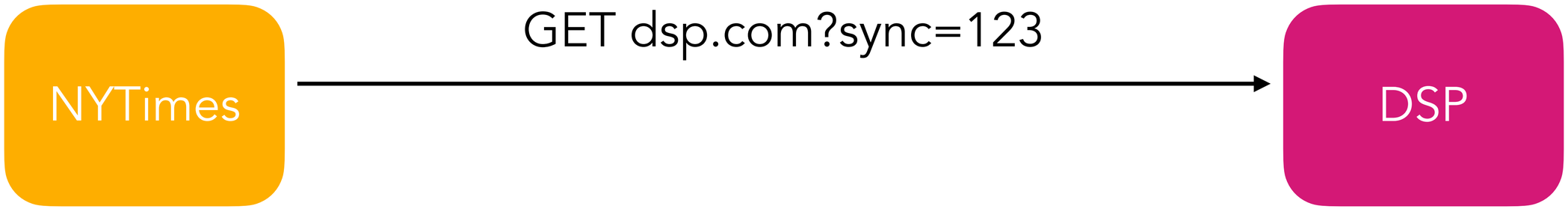
NYTimes loads some JavaScript into the page, which can do anything

One strategy: The JS makes a request



ssp.js makes a GET request from the browser with its sync ID.
What else is sent along to DSP?

One strategy: The JS makes a request



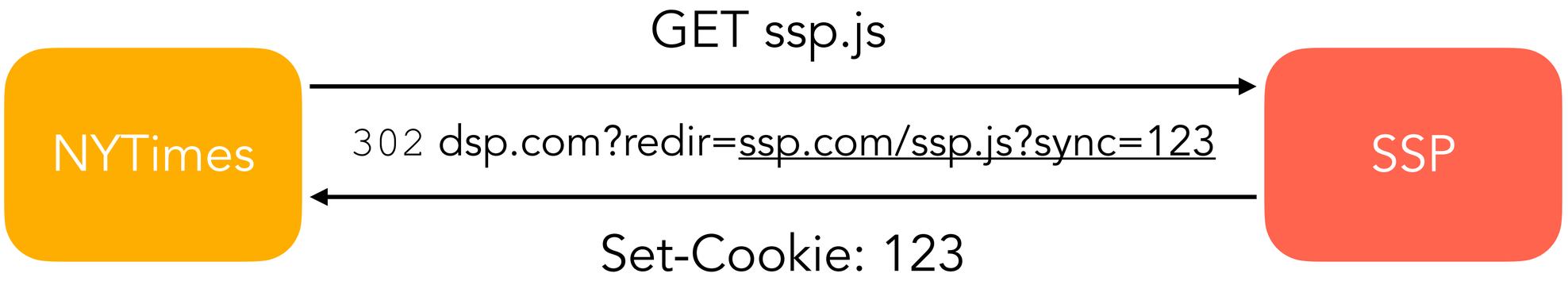
ssp.js makes a GET request from the browser with its sync ID.
What else is sent along to DSP? DSPs cookies, **if they are set.**
How can the SSP instead ensure DSP has a cookie set?

A common cookie syncing protocol



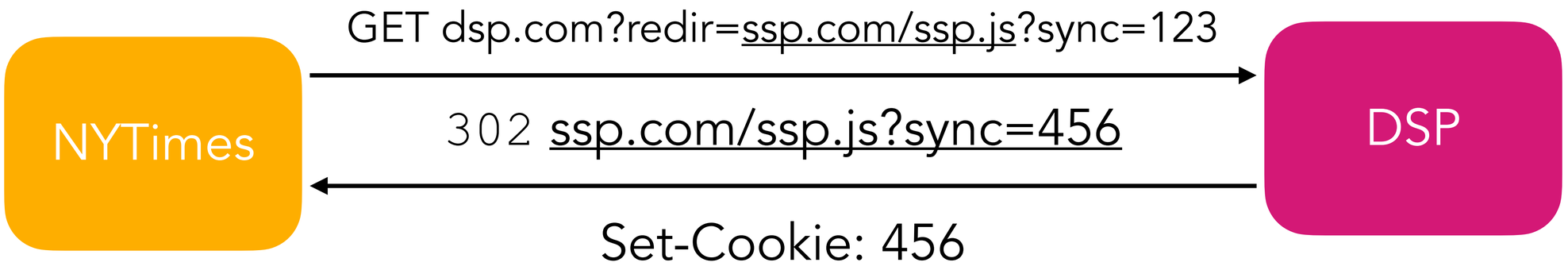
Redirects!

A common cookie syncing protocol



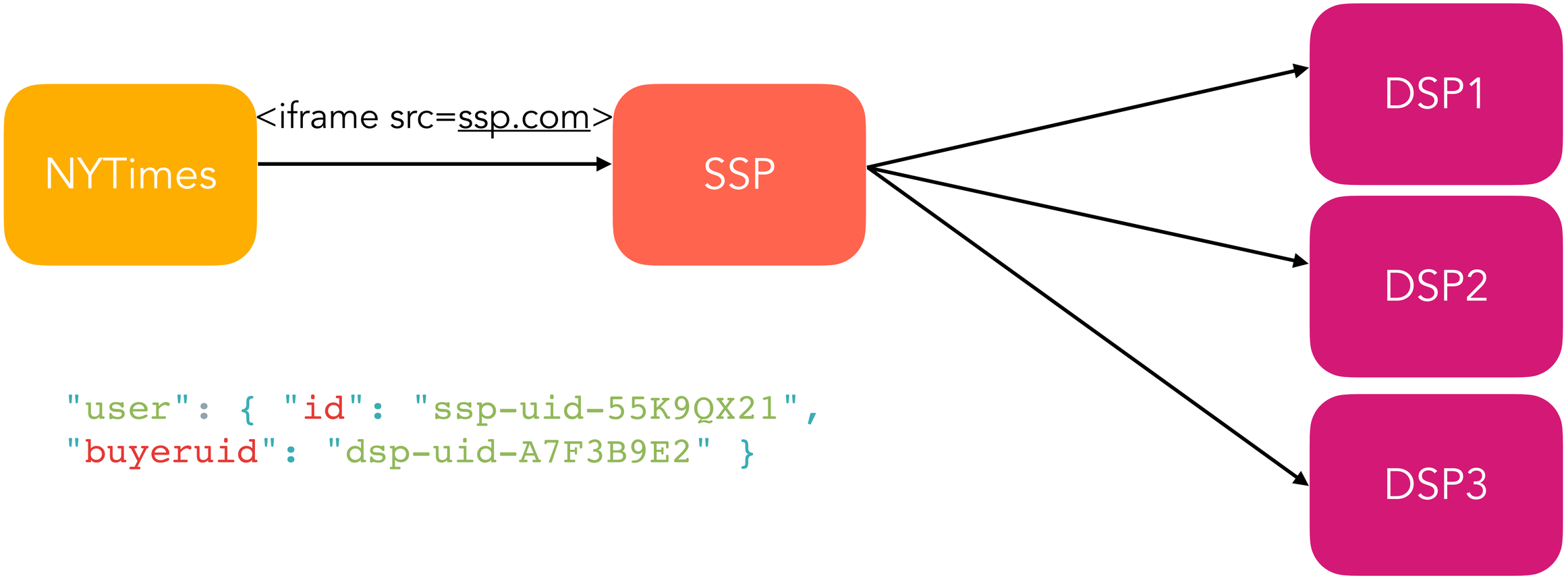
Redirects!

A common cookie syncing protocol



DSP symmetrically shares their cookies with ssp.com

A common cookie syncing protocol




```
"user": { "id": "ssp-uid-55K9QX21",
"buyeruid": "dsp-uid-A7F3B9E2" }
```

Now, when the <iframe> loads, SSP just sends identifier over with OpenRTB request. If known, both sell side *and* buy side are sent.

Can you do it in one request?

Can you do it in one request?

- Yes!
  - Simple — just have the initial <iframe> request redirect + perform syncing with DSPs, and *then* send along the OpenRTB request

What are some problems with this strategy?

What are some problems with this strategy?

- Cookie syncing requires *significant* overhead (redirects) which may not be possible with all DSP partners
- Killing third-party cookies means that syncing in this way is not obviously possible (could use CNAME cloaking, but it requires coordination) — affects non-Chrome browsers
- Partitioned cookies means the syncing is no longer as fruitful as it once was — also affecting non-Chrome browsers
- **So I guess advertisers just gave up, right?**

Advertisers never give up!

```
"user": {
  "id": "<SSP_UID>",
  "buyeruid": "<DSP_UID>",
  "eids": [
    { "source": "uidapi.com",   "uids": [{ "id": "<UID2 token>", "atype":
3 }] },
    { "source": "liveramp.com", "uids": [{ "id": "<ATS envelope>", "atype":
3 }] },
    { "source": "id5-sync.com", "uids": [{ "id": "ID5*...", "atype": 1 }],
      "inserter": "publisher.com", "matcher": "id5-sync.com", "mm": 2 }
  ]
}
```

Advertisers never give up!

```
"user": {
  "id": "<SSP_UID>",
  "buyeruid": "<DSP_UID>",
  "eids": [
    { "source": "uidapi.com",   "uids": [{ "id": "<UID2 token>", "atype":
3 }] },
    { "source": "liveramp.com", "uids": [{ "id": "<ATS envelope>", "atype":
3 }] },
    { "source": "id5-sync.com", "uids": [{ "id": "ID5*...", "atype": 1 }],
      "inserter": "publisher.com", "matcher": "id5-sync.com", "mm": 2 }
  ]
}
```

OpenRTB requests can be “enriched” by *partnerships* the SSP makes on behalf of the seller

Post-Cookie Identifier Tracking

- A user is browsing the web using a browser that **blocks** third-party cookies (e.g., Safari). But somehow, they keep seeing targeted advertisements, especially on their newsletter websites they subscribe to. The user is suspicious that somehow, there is still **stateful tracking** happening by third-parties. What might be going on?

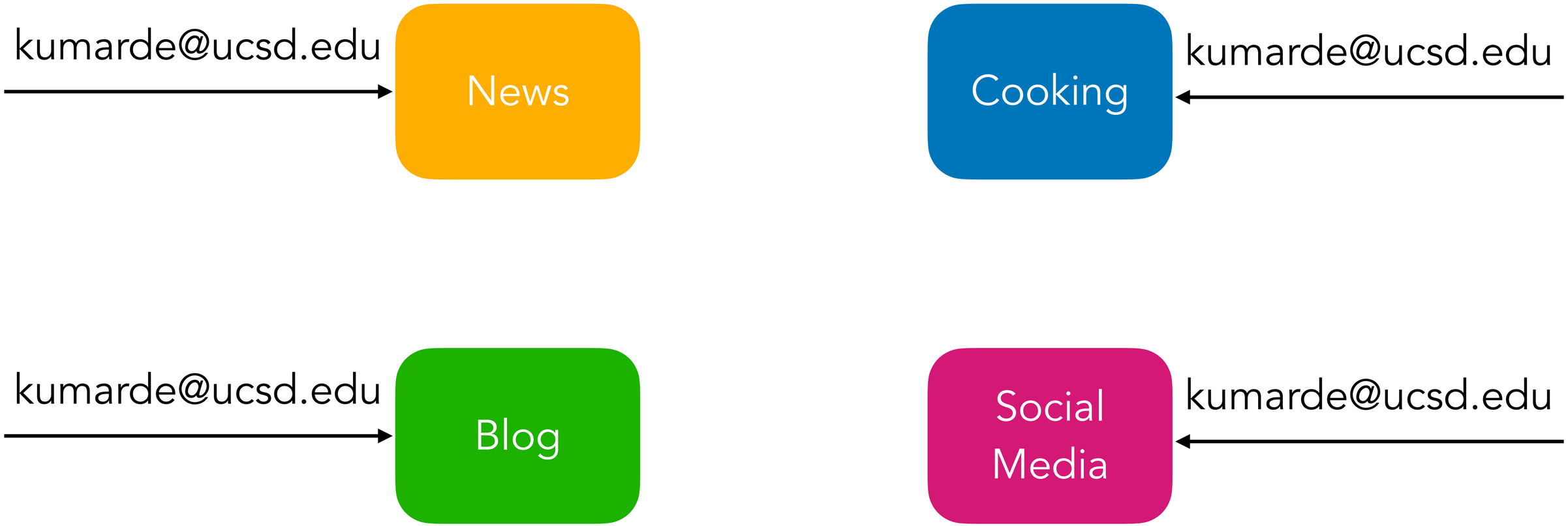
Post-Cookie Identifier Tracking

- A user is browsing the web using a browser that **blocks** third-party cookies (e.g., Safari). But somehow, they keep seeing targeted advertisements, especially on their newsletter websites they subscribe to. The user is suspicious that somehow, there is still **stateful tracking** happening by third-parties. What might be going on?
    - If a third-party tracker is able to get some **JavaScript** running on the page, they can *inspect potential PII sent to the website as an identifier*

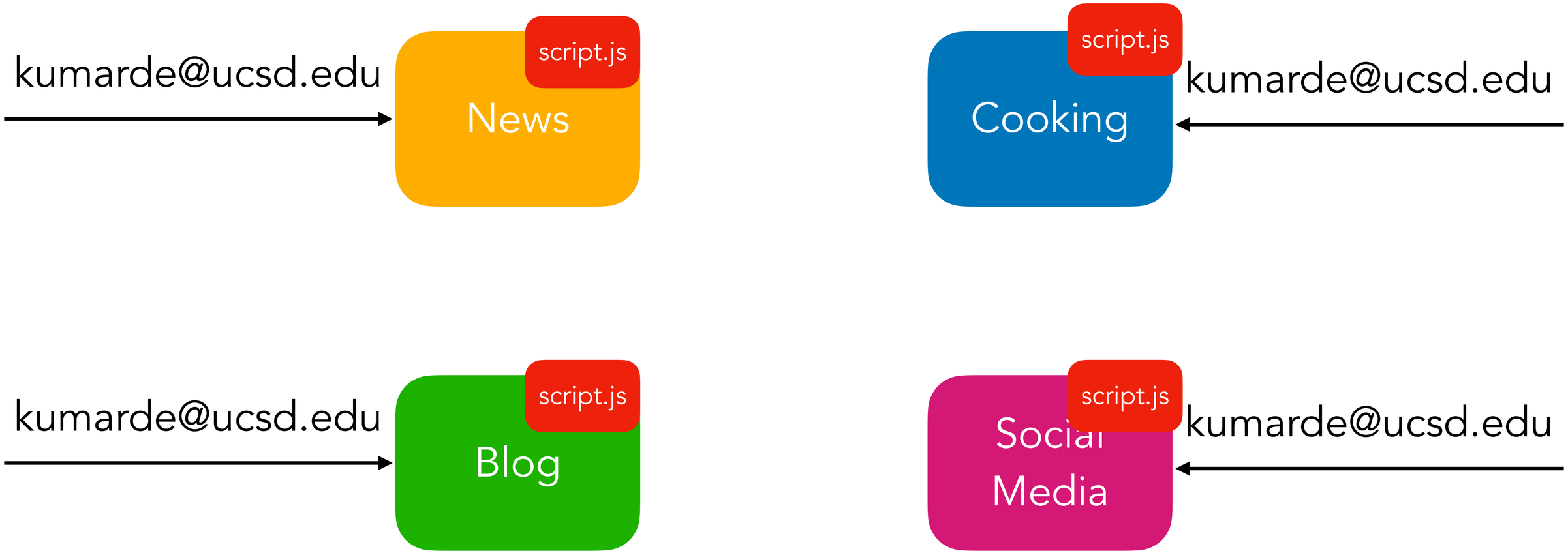
Post-Cookie Identifier Tracking



Post-Cookie Identifier Tracking

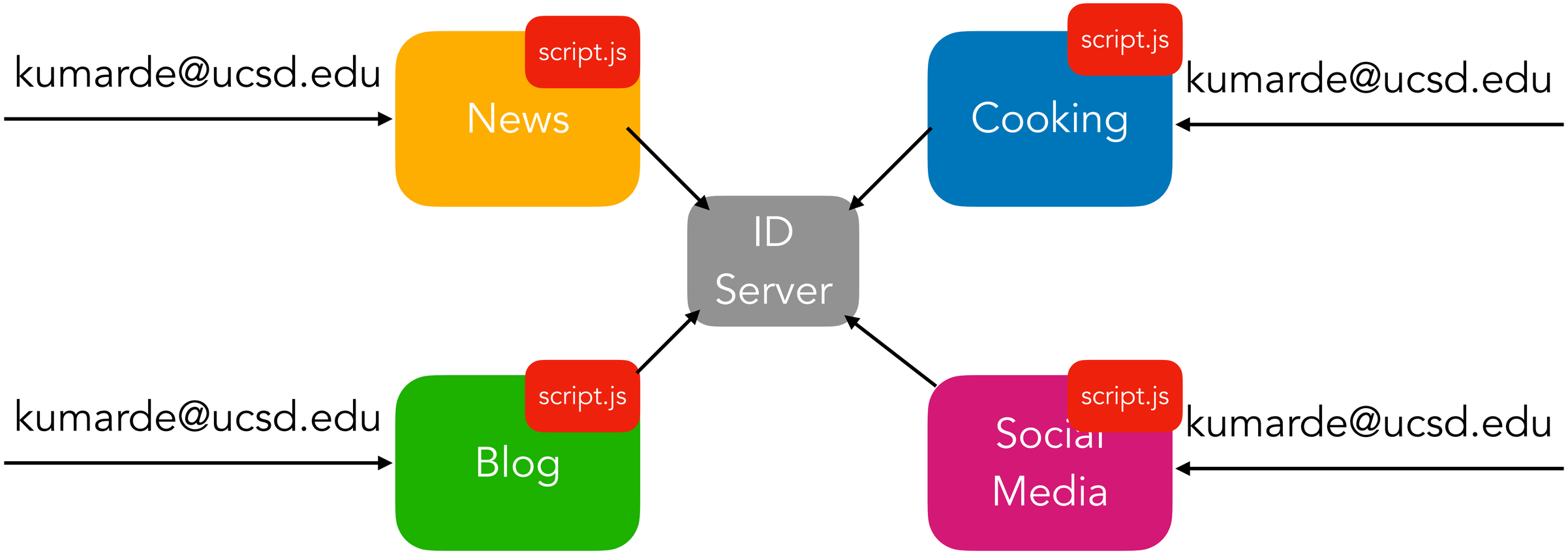


Post-Cookie Identifier Tracking



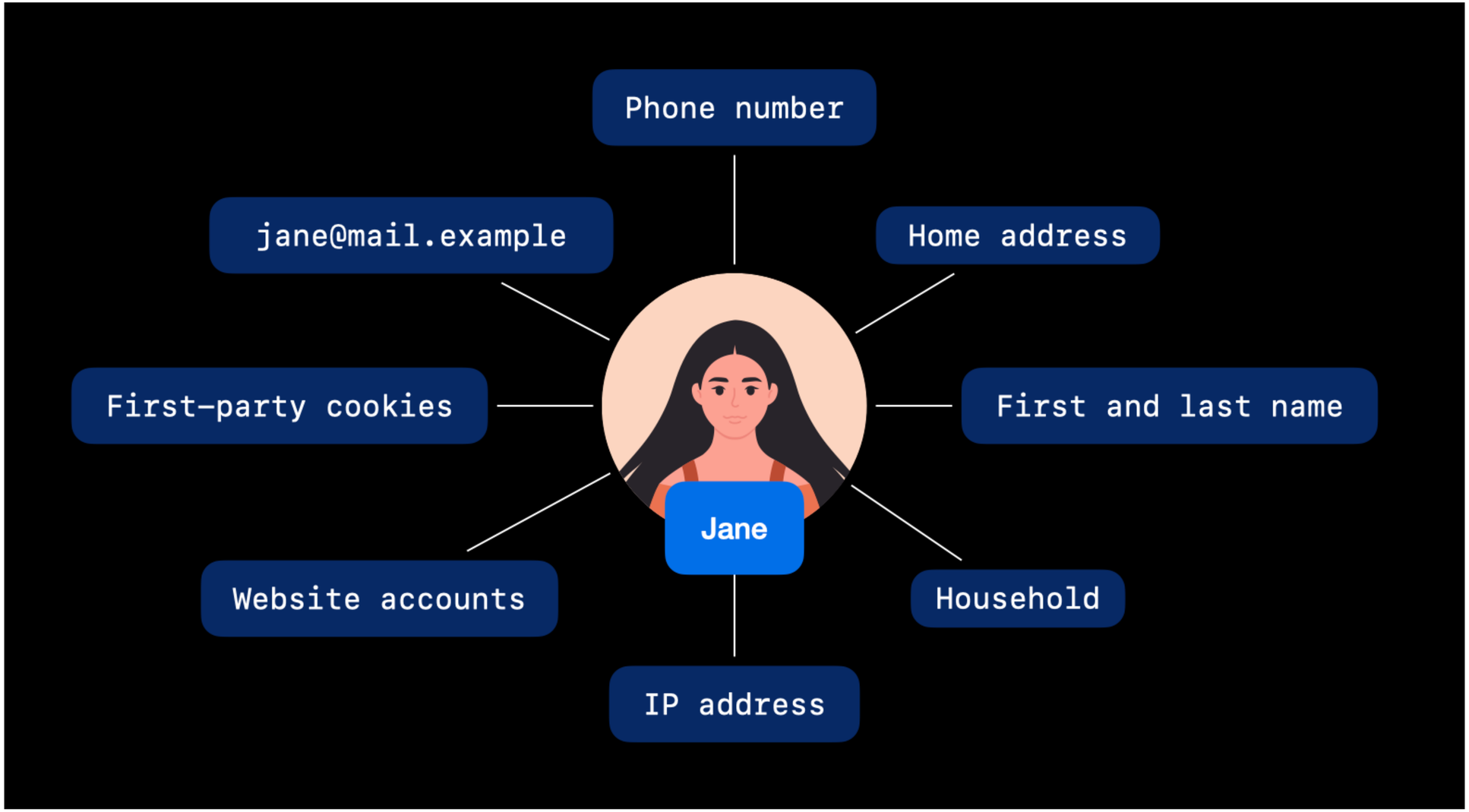

```
<script src="tracker.com/script.js"></script>
```

Post-Cookie Identifier Tracking



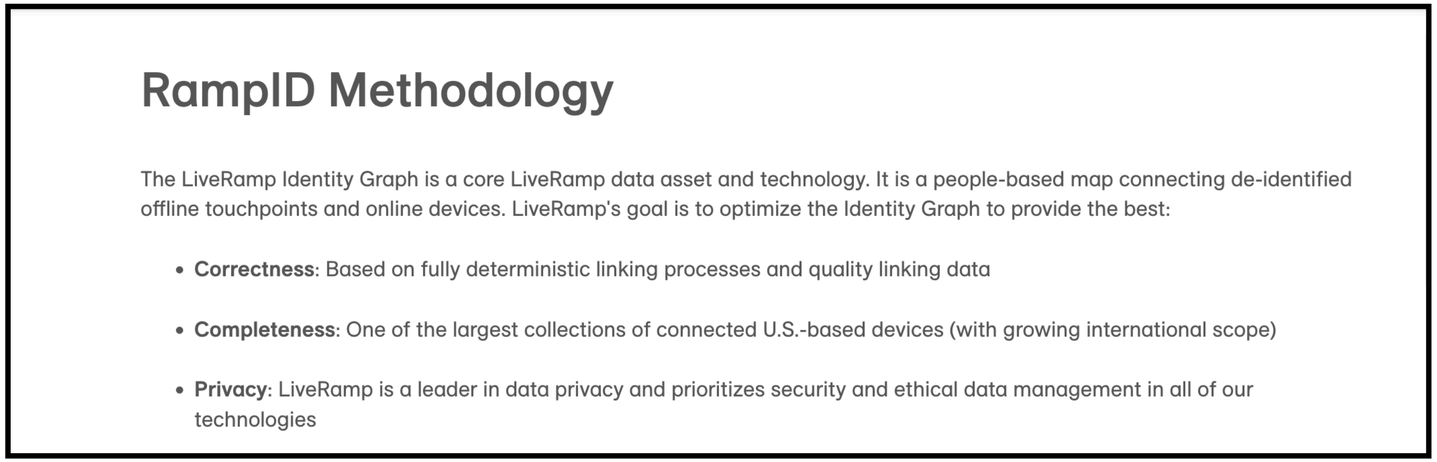
script.js will capture JS variables (e.g., email) and send to an ID server!

Post-Cookie Identifier Tracking



https://webkit.org/blog/18438/blocking-identity-resolution-infrastructure/

Secondary ID “Enrichment” Companies



LiveRamp

Secondary ID “Enrichment” Companies

RampID Methodology

The LiveRamp Identity Graph is a core LiveRamp data asset and technology. It is a people-based map connecting de-identified offline touchpoints and online devices. LiveRamp's goal is to optimize the Identity Graph to provide the best:

- **Correctness**: Based on fully deterministic linking processes and quality linking data
- **Completeness**: One of the largest collections of connected U.S.-based devices (with growing international scope)
- **Privacy**: LiveRamp is a le
  technologies

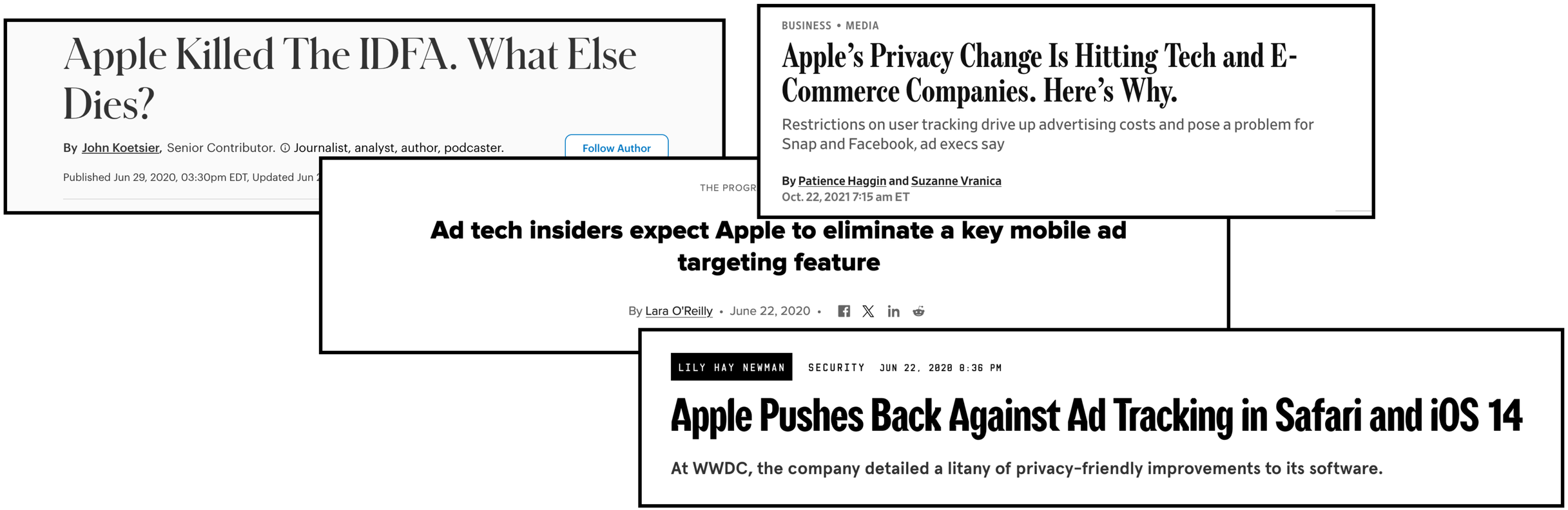


Experian… a credit score company, also plays the game

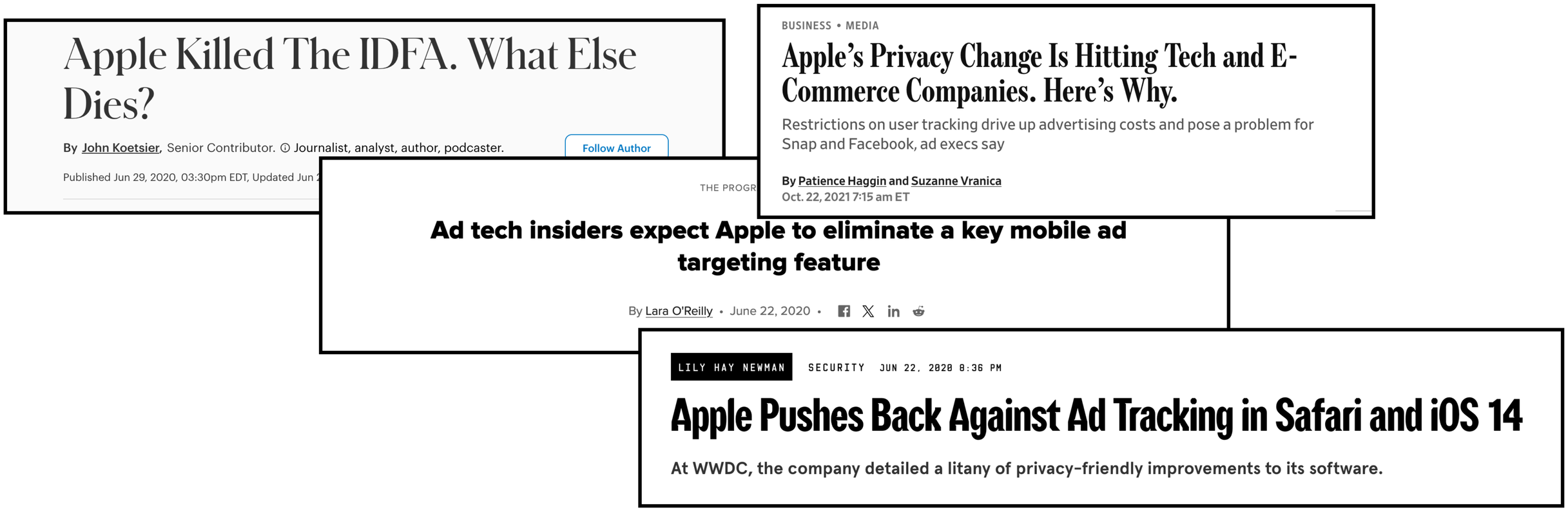
Identifiers are everywhere

- **Takeaway:** Companies are constantly trying to build identifiers out of whatever stable signals they can receive
  - Email, phone number, etc. —> these are **durable** signals that are shared across platform
- On the web, this is cookies, but on other platforms (e.g., mobile), there are other ones built for other places
  - IDFA — Identifiers for Advertisers (Apple)
  - AAID — Android Advertising ID (Android)

Still, things are getting harder for the stateful world…

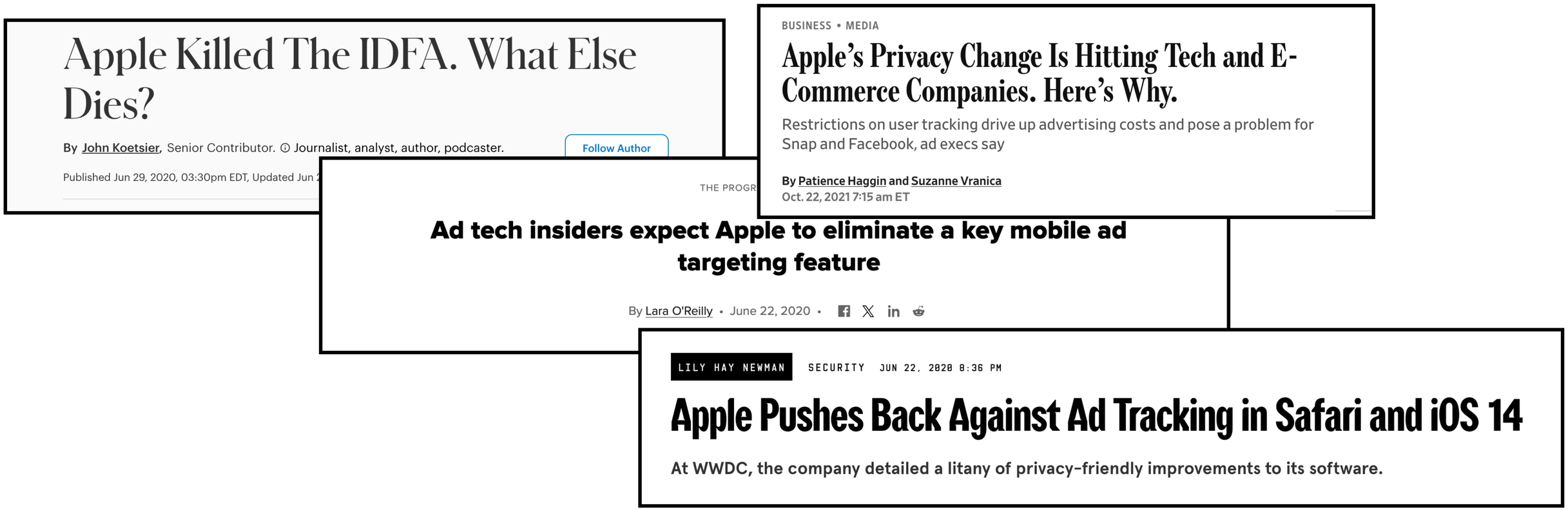


Still, things are getting harder for the stateful world…



After asking people to "opt-in" to tracking, how much do you think cross-device mobile tracking dropped?

Still, things are getting harder for the stateful world…



Only **16%** of people opted into tracking… otherwise known as a *revealed preference* — **when given the choice, users choose privacy.**





Apple is not stopping!

Blocking Identity Resolution Infrastructure

Oct 19, 2026
by John Wilander, Charlie Wolfe, and Matthew Finkel.

Apple and WebKit have shipped protections against web tracking for a long time. We put privacy protections in place for cookies in the very first version of Safari, we invented storage and cache partitioning and shipped it ten years before other major browsers, and we're actively fighting device fingerprinting.

We do this because users deserve to not be tracked, not across websites and not covertly through fingerprinting, unless they explicitly opt in to it. See WebKit's Tracking Prevention Policy for a comprehensive overview.

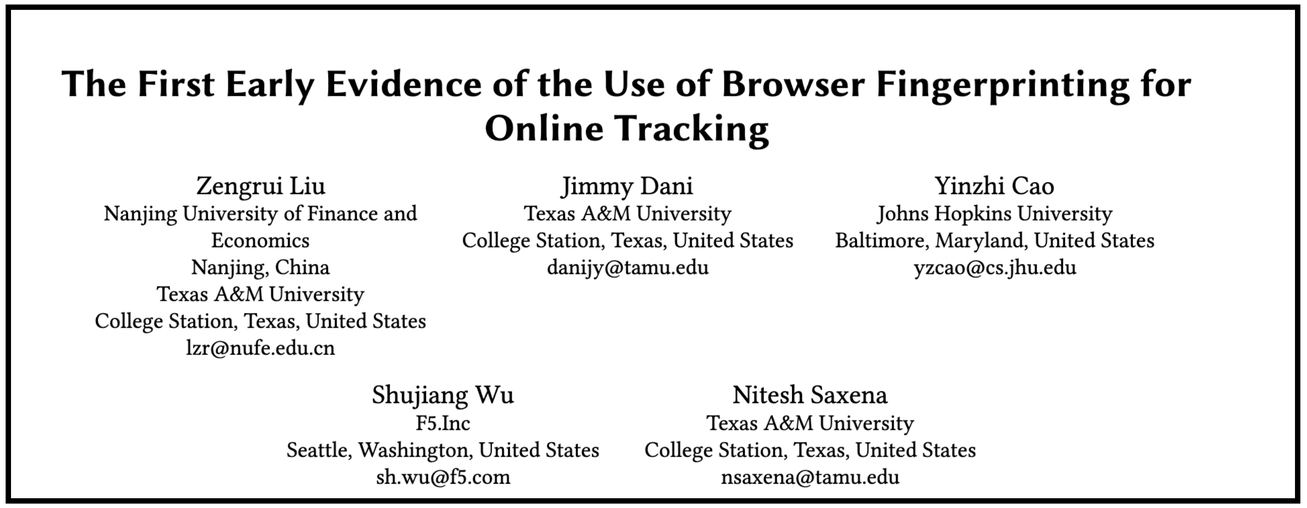
Safari will block identity resolution infrastructure in all new versions! Very exciting.

A small peek ahead: device fingerprinting

- Let’s say third-party cookies and third-party identifiers all go away one day. How else might we track people?

A small peek ahead: device fingerprinting

- Let's say third-party cookies and third-party identifiers all go away one day. How else might we track people? **Fingerprinting!**
  - This was the same thing as what we did on "day 1," and the focus of the class right after the midterm. Called "stateless tracking" (in contrast to stateful tracking)



The First Early Evidence of the Use of Browser Fingerprinting for Online Tracking

Zengrui Liu
Nanjing University of Finance and Economics
Nanjing, China
Texas A&M University
College Station, Texas, United States
lzr@nufe.edu.cn

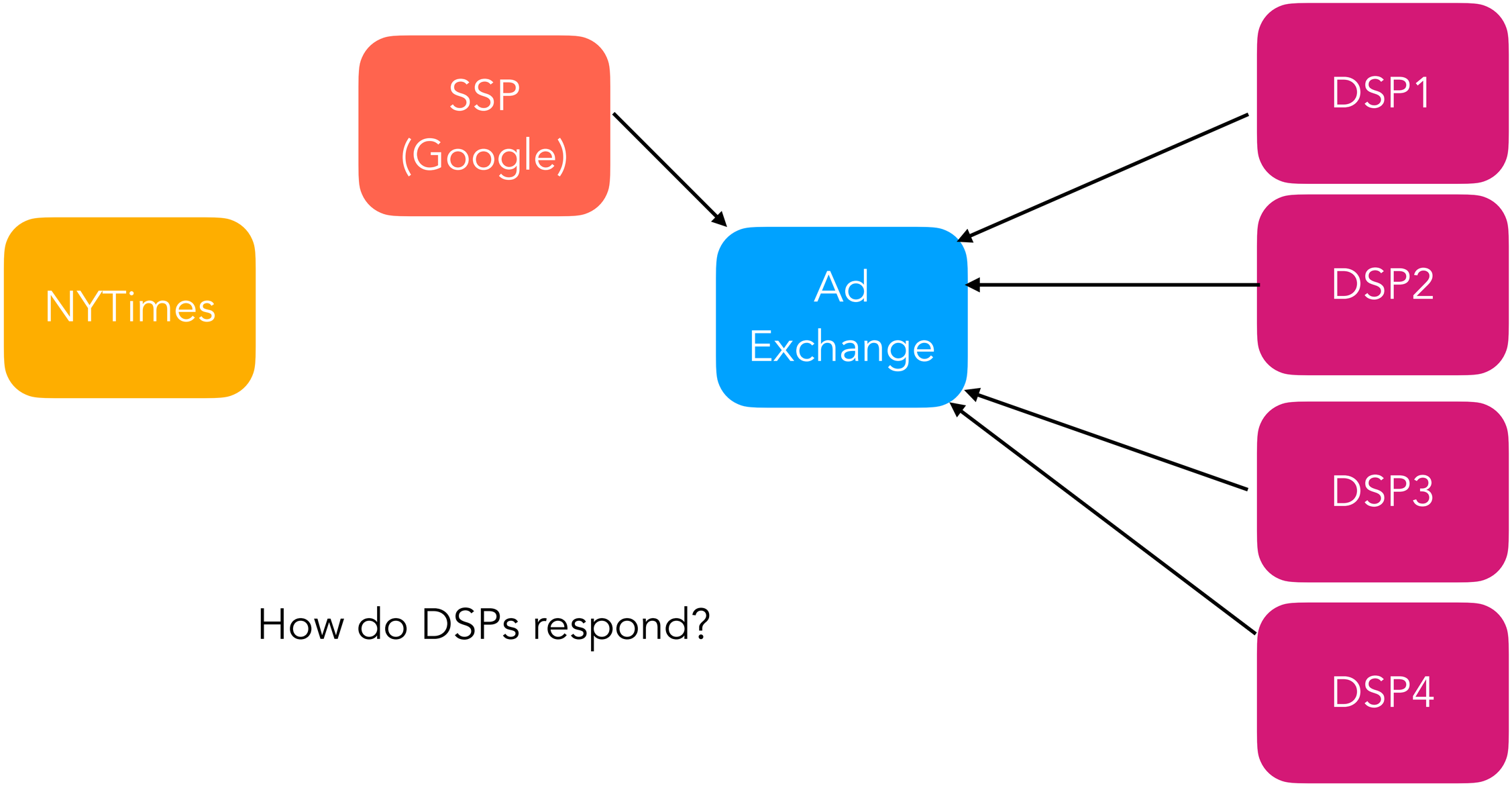
Jimmy Dani
Texas A&M University
College Station, Texas, United States
danijy@tamu.edu

Yinzhi Cao
Johns Hopkins University
Baltimore, Maryland, United States
yzcao@cs.jhu.edu

Shujiang Wu
F5.Inc
Seattle, Washington, United States
sh.wu@f5.com

Nitesh Saxena
Texas A&M University
College Station, Texas, United States
nsaxena@tamu.edu

OpenRTB also powers responses



How do DSPs respond?

A Simple OpenRTB Response

```
{
  "id": "req-123",
  "seatbid": [{ "bid": [{
    "impid": "1", "price": 1.10,
    "adm": "<a href='...'><img src='...'></a>",
    "nurl": "https://dsp.example/win?p=${AUCTION_PRICE}"
  }]}]
}
```

What does this response seem to contain?

A Simple OpenRTB Response

```
{
  "id": "req-123",
  "seatbid": [{ "bid": [{
    "impid": "1", "price": 1.10,
    "adm": "<a href='...'><img src='...'></a>",
    "nurl": "https://dsp.example/win?p=${AUCTION_PRICE}"
  }]}]
}
```

The price that the bidder is willing to pay (CPM)

A Simple OpenRTB Response

```
{
  "id": "req-123",
  "seatbid": [{ "bid": [{
    "impid": "1", "price": 1.10,
    "adm": "<a href='...'><img src='...'></a>",
    "nurl": "https://dsp.example/win?p=${AUCTION_PRICE}"
  }]}]
}
```

The advertisement itself! Rendered in HTML.

A Simple OpenRTB Response

```
{
  "id": "req-123",
  "seatbid": [{ "bid": [{
    "impid": "1", "price": 1.10,
    "adm": "<a href='...'><img src='...'></a>",
    "nurl": "https://dsp.example/win?p=${AUCTION_PRICE}"
  }]}]
}
```

A “notice URL,” telling the DSP that they won the auction, and at what price.

OpenRTB Responses Dissected

- A DSP will respond with information about the **bid** – basically including only **what they will pay** and **what to display if they win**, as well as associated metadata
- If a DSP is representing *multiple advertisers*, they can respond with multiple bids for the same impression at once
- Bidders also have three open request paths after a bid:
  - `nurl` — fired when the auction is won
  - `burl` – fired when the bid is billed
  - `lurl` – fired when auction is lost

OpenRTB Responses Dissected

- A DSP will respond with information about the **bid** – basically including only **what they will pay** and **what to display if they win**, as well as associated metadata

- If a DSP is representing *multiple advertisers*, they can respond with multiple bids for the same impression at once

- Bidders also have three open request paths after a bid:

  - **`nurl` — fired when the auction is won**
  - **`burl` – fired when the bid is billed**
  - `lurl` – fired when auction is lost

Why are these different?

Winning an auction is not the same as paying for the auction

- Winning != Billing
- You can win an auction for an ad that is never billed for. Example?

Winning an auction is not the same as paying for the auction

- Winning != Billing
- You can win an auction for an ad that is never billed for. Example?
  - An ad that renders at the bottom of the page and the user never goes there!
- **Takeaway: Always decouple winning an auction from the billing. These are often separated in logic, and weird race conditions can emerge if you think of them as the same event!**

OpenRTB categories

- There are *lots* of fields, lots of ways to customize, for example… categories!

```
{
  "id": "req-002",
  "imp": [{ "id": "1", "banner": { "w": 300, "h": 250 } }],
  "site": {
    "domain": "sports.example",
    "page": "https://sports.example/running/marathon-training",
    "cattax": 7,
    "cat": ["483"],
    "pagecat": ["<ContentTax3.0 ID for Running>"]
  }
}
```

OpenRTB categories

- There are *lots* of fields, lots of ways to customize, for example… categories!

```
{
  "id": "req-002",
  "imp": [{ "id": "1", "banner": { "w": 300, "h": 250 } }],
  "site": {
    "domain": "sports.example",
    "page": "https://sports.example/running/marathon-training",
    "cattax": 7,
    "cat": ["483"],
    "pagecat": ["<ContentTax3.0 ID for Running>"]
  }
}
```

There are taxonomies and categories of content, users, etc… everything you can possibly imagine

Deciding on bidding

- Question: **Do DSPs bid on every request?**

Deciding on bidding

- Question: **Do DSPs bid on every request?**
  - No! “No Bid” in OpenRTB is a **204** with no body
  - So… how to decide?
- DSPs have an *enormous* latency burden: they need to respond in ~200ms with the best bid they have. How many bids does a DSP need to process in day?

Deciding on bidding

- Question: **Do DSPs bid on every request?**
  - No! “No Bid” in OpenRTB is a **204** with no body
  - So… how to decide?
- DSPs have an *enormous* latency burden: they need to respond in ~200ms with the best bid they have. How many bids does a DSP need to process in day?
  - ~30M bid requests/s, or about a **trillion per day**

DSP Logic

- With a group, take a few minutes and discuss strategies you may employ as a DSP to process trillions of bid requests in 200ms.

DSP Logic

- With a group, take a few minutes and discuss strategies you may employ as a DSP to process trillions of bid requests in 200ms.
  - Drop most requests (no-bid) — average DSPs estimated to only respond to < 5% of bid requests
  - Sample bids (i.e., only operate on 1%) — Doesn't this leave money on the table?

DSP Logic

- With a group, take a few minutes and discuss strategies you may employ as a DSP to process trillions of bid requests in 200ms.
  - Drop most requests (no-bid) — average DSPs estimated to only respond to < 5% of bid requests
  - Sample bids (i.e., only operate on 1%) — Doesn't this leave money on the table? Yes, but you **price it into the bids you do make.**
  - Get as close as possible to the SSP (multiple, anycast vantage points around the world)
  - Make any ML very fast and cheap (usually **not** a transformer or LLM… some deep learning is used, but needs to be effective)

DSPs have to also consider many other things…

- Historical success rates
- Brand safety
- Language
- Previous engagement signals
- Publisher deals
- Timing (e.g., what time is it?)
- Shady SSPs asking for money when they didn’t do anything…

DSPs have to also consider many other things…

- Historical success rates
- Brand safety
- Language
- Previous engagement signals
- Publisher deals
- Timing (e.g., what time is it?)
- **Shady SSPs asking for money when they didn’t do anything…**

Thought experiment

- Let's say a DSP receives an OpenRTB request for a spot on the Financial Times (ft.com).
    - How does the DSP know this is a *real* bid?

Thought experiment

- Let's say a DSP receives an OpenRTB request for a spot on the Financial Times (ft.com).
  - How does the DSP know this is a *real* bid? **By default, they don't!**



FT warns advertisers after identifying jaw-dropping levels of domain spoofing

Ad Fraud, Financial Times, IAB News

Thursday, September 28th, 2017 Author: **Tyrone Stewart** Share this article:

About $1.35M in fraudulent advertising billing was clocked per month.

What do we do about it? `ads.txt`

- Publishers can designate **verified sellers** by putting a TXT file up on their page called **`ads.txt`**
- Basically designates **which SSPs** (and exchanges) can offer their inventory for real
  - Example on the right is nytimes.com/ads.txt
- When does a DSP fetch `ads.txt`?

```
OWNERDOMAIN=nytimes.com
amazon-adsystem.com, 3030, DIRECT
google.com, pub-4177862836555934, DIRECT
google.com, pub-9542126426993714, DIRECT
indexexchange.com, 184733, DIRECT
liveintent.com, 130, DIRECT
openx.com, 537145107, DIRECT
openx.com, 539936340, DIRECT
openx.com, 539052954, DIRECT
openx.com, 544071378, DIRECT, 6a698e2ec38604c6
rubiconproject.com, 12330, DIRECT
rubiconproject.com, 17470, DIRECT
triplelift.com, 746, DIRECT
pubmatic.com, 158573, DIRECT, 5d62403b186f2ace
pubmatic.com, 158945, DIRECT, 5d62403b186f2ace
pubmatic.com, 163427, DIRECT, 5d62403b186f2ace
media.net, 8CU2553YN, DIRECT
media.net, 8CU83M88N, DIRECT
Media.net, 8CU4XCJ1B, DIRECT #OB
yahoo.com, 55861, DIRECT, e1a5b5b6e3255540
google.com, pub-1793726897772453, DIRECT, f08c47fec0942fa0
aps.amazon.com, 3030, DIRECT
indexexchange.com, 196165, DIRECT, 50b1c356f2c5c8fc
indexexchange.com, 205938, DIRECT, 50b1c356f2c5c8fc
adswizz.com, nytimes, DIRECT
triplelift.com, 746-EB, DIRECT, 6c33edb13117fd86
liveintent.com, 74445, DIRECT
themediagrid.com, B7HPLK, DIRECT, 9fac4a4a87c2a44f
adswizz.com, 463, DIRECT
connatix.com, 2013252542147178, DIRECT, 2af98acdee0e81ed
kargo.com, 9123, DIRECT
```

What do we do about it? `ads.txt`

- Publishers can designate **verified sellers** by putting a TXT file up on their page called **`ads.txt`**
- Basically designates **which SSPs** (and exchanges) can offer their inventory for real
  - Example on the right is nytimes.com/ads.txt
- When does a DSP fetch `ads.txt`?
  - **Not** during the bid (too slow!)

```
OWNERDOMAIN=nytimes.com
amazon-adsystem.com, 3030, DIRECT
google.com, pub-4177862836555934, DIRECT
google.com, pub-9542126426993714, DIRECT
indexexchange.com, 184733, DIRECT
liveintent.com, 130, DIRECT
openx.com, 537145107, DIRECT
openx.com, 539936340, DIRECT
openx.com, 539052954, DIRECT
openx.com, 544071378, DIRECT, 6a698e2ec38604c6
rubiconproject.com, 12330, DIRECT
rubiconproject.com, 17470, DIRECT
triplelift.com, 746, DIRECT
pubmatic.com, 158573, DIRECT, 5d62403b186f2ace
pubmatic.com, 158945, DIRECT, 5d62403b186f2ace
pubmatic.com, 163427, DIRECT, 5d62403b186f2ace
media.net, 8CU2553YN, DIRECT
media.net, 8CU83M88N, DIRECT
Media.net, 8CU4XCJ1B, DIRECT #OB
yahoo.com, 55861, DIRECT, e1a5b5b6e3255540
google.com, pub-1793726897772453, DIRECT, f08c47fec0942fa0
aps.amazon.com, 3030, DIRECT
indexexchange.com, 196165, DIRECT, 50b1c356f2c5c8fc
indexexchange.com, 205938, DIRECT, 50b1c356f2c5c8fc
adswizz.com, nytimes, DIRECT
triplelift.com, 746-EB, DIRECT, 6c33edb13117fd86
liveintent.com, 74445, DIRECT
themediagrid.com, B7HPLK, DIRECT, 9fac4a4a87c2a44f
adswizz.com, 463, DIRECT
connatix.com, 2013252542147178, DIRECT, 2af98acdee0e81ed
kargo.com, 9123, DIRECT
```

It’s actually even more complicated…

- Sellers can *chain*
  - Exchanges can pass things to other exchanges which can pass to DSPs… oh my
- OpenRTB allows including this information in what’s called a `sellers.json` object — helps the DSP know if:
  - The request is valid inventory
  - What path the inventory came from
- **DSPs use all these signals, and more, to try and generate a bid response in < 50ms. Why?**


ALL I DO IS
WIN

Real-time auctions

Break Time + Attendance



Codeword:
Identify

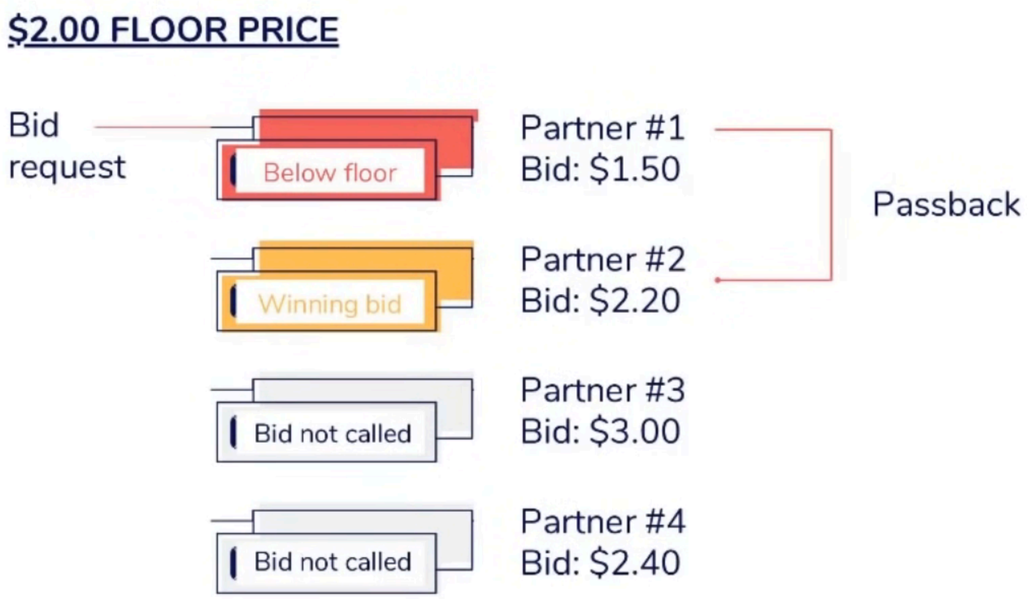
https://tinyurl.com/webtracking-attendance

Bidding for ad spots

- **Real-time bidding** is an auction process that is kicked off when a publisher tells an advertising network that they have an open ad-spot with certain properties
- Two most widely used methods of auctioning
  - Waterfall bidding (old)
  - Header bidding (the newness)

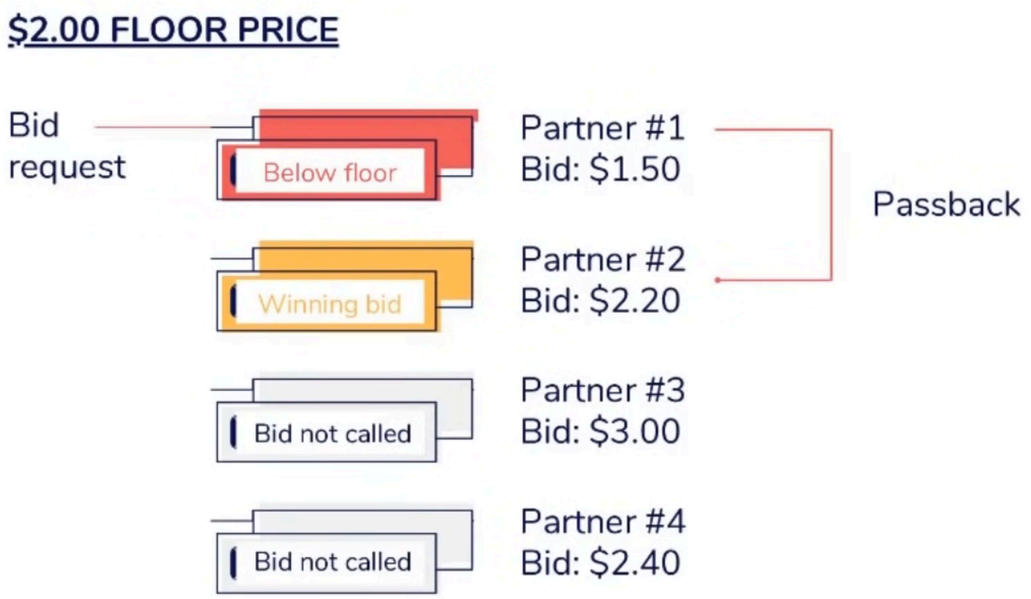
Waterfall Bidding

- Publishers pre-define a hierarchy of advertising networks (e.g., in a waterfall) about any spot
- Publishers set a floor that they needed for the ad spot
  - The first network to fulfill the floor would win the spot



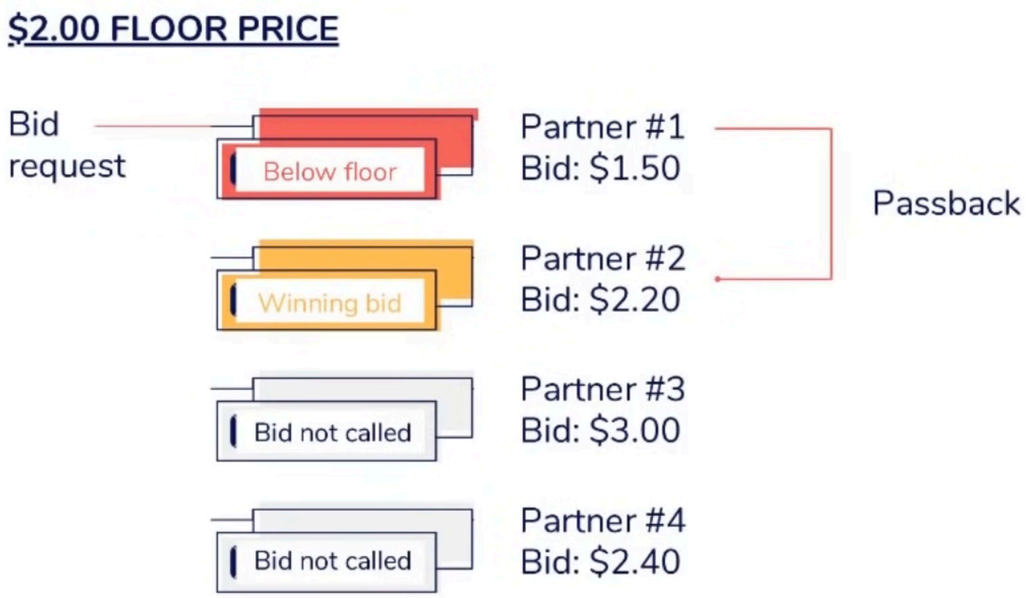
Waterfall Bidding

- Publishers pre-define a hierarchy of advertising networks (e.g., in a waterfall) about any spot
- Publishers set a floor that they needed for the ad spot
  - The first network to fulfill the floor would win the spot
- What problems might you see with waterfall bidding?



Waterfall Bidding

- Publishers pre-define a hierarchy of advertising networks (e.g., in a waterfall) about any spot
- Publishers set a floor that they needed for the ad spot
  - The first network to fulfill the floor would win the spot
- What problems might you see with waterfall bidding?
  - Slow (computation is serial)
  - Anti-competitive!
    - Google had both an SSP and a DSP, which often meant they got first pick at ad spots



Header Bidding

- Every DSP is offered an opportunity to bid at the *same time*
  - Why is this a good thing for competitiveness?

Header Bidding

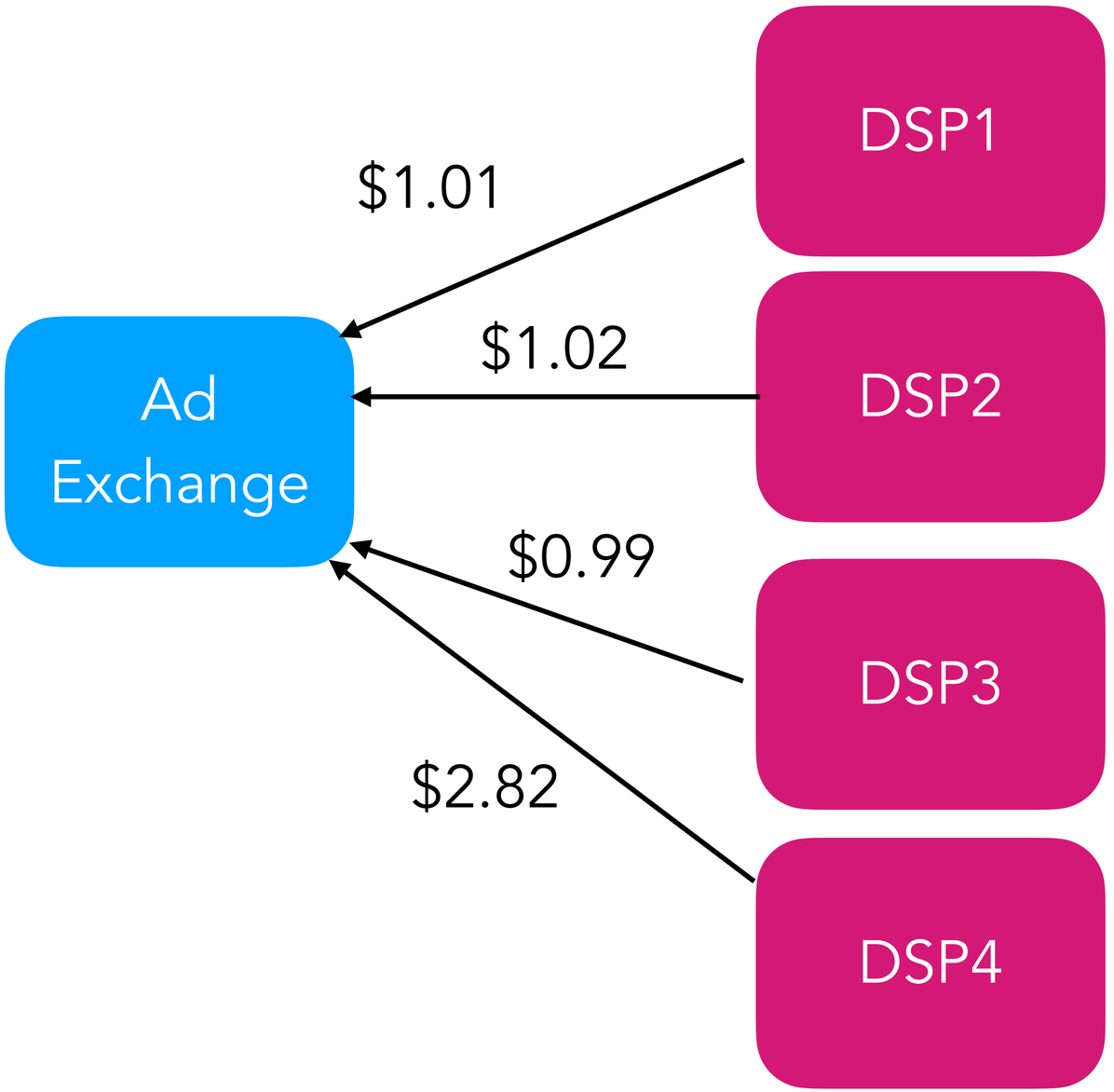
- Every DSP is offered an opportunity to bid at the *same time*
  - Why is this a good thing for competitiveness?
  - DSPs are incentivized to provide their true value for the advertising spot (theoretically)
- Two types of auctions you'll see in online advertising markets
  - Second-price auctions (Vickrey)
  - First-price auction

Second-Price Auction

- In a second-price auction, the **highest bidder** wins the auction, but only pays **the second-highest bid price** (+0.01)

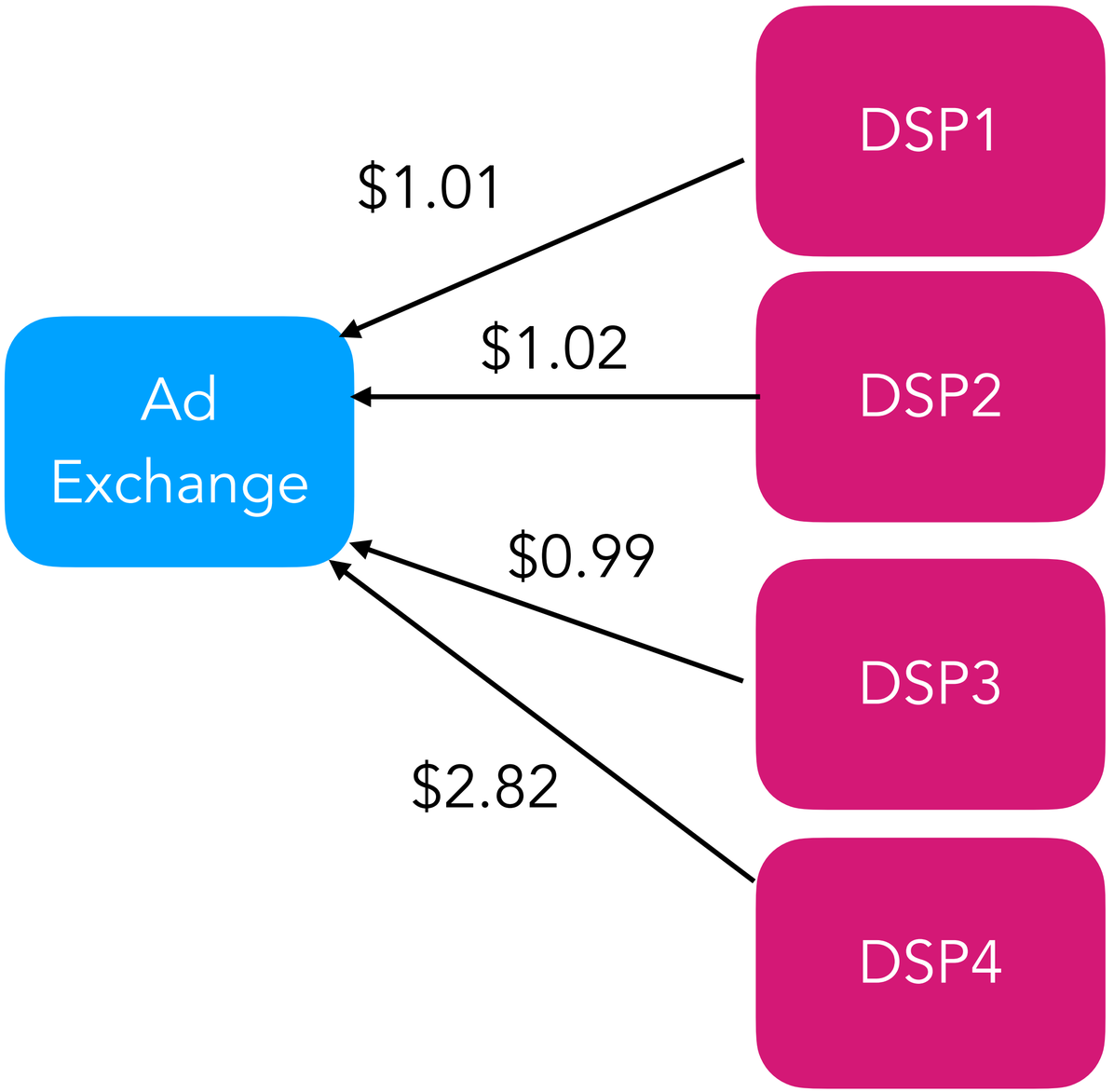
Second-Price Auction

- In a second-price auction, the **highest bidder** wins the auction, but only pays **the second-highest bid price** (+0.01)
- Which DSP should win the auction?



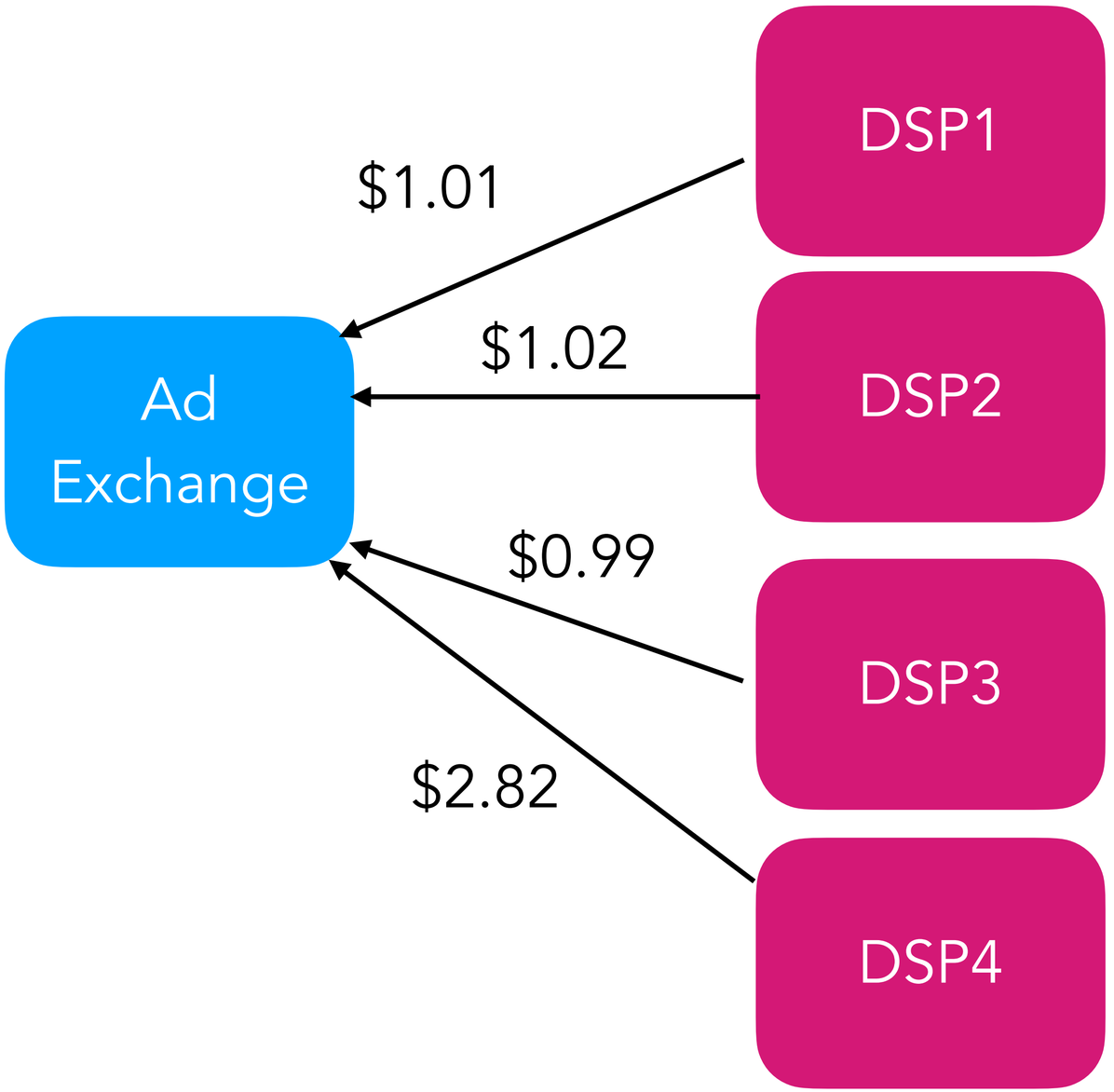
Second-Price Auction

- In a second-price auction, the **highest bidder** wins the auction, but only pays **the second-highest bid price** (+0.01)
- Which DSP should win the auction?
  - DSP4! How much should they pay?



Second-Price Auction

- In a second-price auction, the **highest bidder** wins the auction, but only pays **the second-highest bid price** (+0.01)
- Which DSP should win the auction?
  - DSP4! How much should they pay? **$1.03**



Second-Price Auction Economics

- A **dominant strategy** is one where your choice gives you the best likelihood of winning, regardless of what other entities (e.g., DSPs do)
- If you are a DSP, what is your dominant strategy?

Second-Price Auction Economics

- A **dominant strategy** is one where your choice gives you the best likelihood of winning, regardless of what other entities (e.g., DSPs do)
- If you are a DSP, what is your dominant strategy?
  - **Offer your true value!**
    - If you bid above your true value, you risk winning (and therefore paying out higher than your value)
    - If you bid below your true value, you risk losing at your profitable price

A shift in priorities

- Second-price auctions were the industry standard from 2009 — 2019ish — almost every single entity implemented them
- Nowadays, most everyone has shifted to a first-price auction.
  - What is a first-price auction?

A shift in priorities

- Second-price auctions were the industry standard from 2009 — 2019ish — almost every single entity implemented them
- Nowadays, most everyone has shifted to a first-price auction.
  - What is a first-price auction?
    - An auction where the highest bidder wins and pays they price that they bid!
- Why might the industry have moved to first-price auctions?

A humble ad exchange goes rogue

Google Misled Publishers and Advertisers, Unredacted Lawsuit Alleges

Details show Google employees fretting its ad tech auctions were 'untruthful' and based in 'insider information'

By Tripp Mickle and Keach Hagey
Updated Jan. 14, 2022 4:50 pm ET

Aa 88 Listen (2 min)

Google's Alleged Scheme to Corner the Online Ad Market

A newly unredacted legal filing sheds light on internal programs that antitrust enforcers argue advantaged Google at the expense of advertisers and publishers.

Questioning Second-Price Auctions in Ad Tech



Written by Matthew B. Wilson, December 21, 2018

Problems with first-price auctions

- What is the big problem with first-price auctions?
  - Bidders may end up overpaying when bidding their true value. Requires bidders to *guess* the right value… which means… **algorithms**

Enter: Bid shading!

- **Bid shading** is the process how advertisers *decide* how much to bid on an ad

- What's a simple bid shading algorithm?

Enter: Bid shading!

- **Bid shading** is the process how advertisers *decide* how much to bid on an ad
- What's a simple bid shading algorithm?
  - Take your true value and bid 0.9 * value
- There are **many** more complicated algorithms at play, complex ML, etc… lots of research here if you're interested!

Adaptive Bid Shading Optimization of First-Price Ad Inventory

NIKLAS KARLSSON and QIAN SANG

Bid Shading in The Brave New World of First-Price Auctions

Djordje Gligorijevic*, Tian Zhou*, Bharatbhushan Shetty, Brendan Kitts, Shengjun Pan, Junwei Pan and Aaron Flores
Yahoo Research, Verizon Media
Sunnyvale, CA, USA
{djordje.gligorijevic,tian.zhou,bharatbs,brendan.kitts,alanpan,jwpan,aaron.flores}@verizonmedia.com

An Efficient Deep Distribution Network for Bid Shading in First-Price Auctions

Tian Zhou, Hao He, Shengjun Pan, Niklas Karlsson, Bharatbhushan Shetty, Brendan Kitts, Djordje Gligorijevic, San Gultekin, Tingyu Mao, Junwei Pan, Jianlong Zhang and Aaron Flores
Yahoo Research, Verizon Media
Sunnyvale, CA, USA
{tian.zhou,hao.he,alanpan,niklas.karlsson,bharatbs,brendan.kitts,djordje,sgultekin,tingyu.mao}@verizonmedia.com,
jonaspan@tencent.com,jianlong.zhang@gmail.com,aaron.flores@verizonmedia.com

Next time…

- Influence, persuasion… and you!
- We'll talk about regulation against tracking (GDPR, CCPA, etc.) and how *trackers* have evolved to try and bypass regulation
- **Next time will be the last lecture to review before the exam.**