No more Chasing Waterfalls: A Measurement Study of the Header Bidding Ad-Ecosystem

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Outline

• Background
• Motivation
• Methodology
• Header Bidding Facets
• Analysis
• Summary
• Limitations and Future work
Background

• Largest portion of online advertising follows a programmatic model
  • Usually via Real-Time Bidding (RTB) protocol

• Waterfalling: Traditional ad-buying standard
  • Different ad networks are prioritized hierarchical
  • Not all partners compete simultaneously
  • Publishers do not get optimal prices
  • Lack of transparency
  • Reduced fairness
Background: HB Concept

1M imps
$1.1 CPM/imp

/Header Auction (1st best price)

Direct Order

Winner
$1.5 CPM

Bid reqs

Bids

10K imps
$0.5 CPM/imp

Fallback

$1.5 CPM

DSP

$0.9 CPM

ADX

$1.0 CPM

SSP1

$0.9 CPM

SSP2

Intersection

$0.9 CPM

$1.0 CPM

$0.7 CPM

$1.9 CPM

$1.0 CPM

$0.7 CPM

$0.9 CPM

$1.1 CPM

$0.2 CPM

RTB Auction (2nd best price)

RTB Auction (2nd best price)

RTB Auction (2nd best price)
Background – HB Process

1. Website Request
2. Website’s header
3. Bid Requests
4. Pushing Bid Responses to Ad Server
5. Winning Bid Response
6. Winner Notification
7. Check other channels (direct deals, placements, etc.)
Background – HB Process

Diagram:

1. Website Request
   - Website’s header

2. Bid Requests
   - Bid Responses

3. Pushing Bid Responses to Ad Server
   - Winning Bid Response

4. Winner Notification
   - Check offer channels (direct email, SMS, call, etc.)
Background – HB Process
Background – HB Process
Background – HB Libraries

• Publishers need to include HB third-party libraries to their webpages

• Libraries consist of two components:
  • **Core**: responsible to issue bid requests and collect responses
  • **Adapters**: plugged to core, provides functionality for specific Demand Partners

• HB libraries trigger DOM events
  • Contain metadata about auctions
  • Sent directly to user’s browser
Motivation

• Header Bidding (HB) is a recently proposed advertising standard
• It gained wide acceptance among publishers but little is known about it

Research questions:
• How does it work?
• What is its performance overhead?
• Who are the big players?
• ...

Methodology – HB Detection

• Designed HBDetector plugin to monitor and measure HB
• HBDetector:
  • Adds a content script in webpage header
  • Distinguishes HB activity by monitoring events triggered by HB libraries
    • auctionEnd, bidWon, slotRenderEnded
  • Monitors web requests in webpage
  • Detects all requests sent/received from known HB demand partners
Methodology – HBDetector Overview

WebRequest Inspector
- Web request inspection for identification and metadata collection of demand partners
- Applies HB list

HTML DOM Event Inspector
- DOM event inspection for auction metadata collection
- Monitors HB events

Store for further analysis

Plugin Database

Web Browser + HBDetector

HB latencies

HB metadata
Methodology – Data Collection

<table>
<thead>
<tr>
<th>Data</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td># of websites crawled</td>
<td>35,000</td>
</tr>
<tr>
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Methodology – HB Adoption

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Header Bidding Facets

In-depth investigation on HB ecosystem revealed three different facets.

1. Client Side HB: 17.3% market share
2. Server Side HB: 48% market share
3. Hybrid HB: 34.7% market share
Header Bidding Facets – Client side

Pros:
• Completely transparent to publisher
• Publishers know participating HB partners
• Publishers know exact bids placed

Cons:
• Harder to set up, requires technical knowledge
• Need to operate their own ad servers
• Higher latencies can be observed due to increased requests
Pros:
- Just a single request needs to be sent
- Minimum effort required to set up (no need for tuning)
- Reduces latency

Cons:
- Publishers need to trust Demand partner
- Transparency reduced to minimum
Header Bidding Facets – Hybrid

- Semi-transparent to publisher
- Requires a moderate effort to tune
- Publishers know in some extend bids of each partner
Analysis – Demand partners involved in HB

![Bar chart showing the percentage of websites for different header bidding demand partners](chart1.png)

- DFP: 80%
- AppNexus: 20%
- Rubicon: 10%
- Criteo: 8%
- Index: 6%
- Amazon: 4%
- Openx: 3%
- Pubmatic: 2%
- AOL: 1%
- Sovrn: 1%
- Smart: 1%
- Other: 1%

![Empirical cumulative distribution function (ECDF) of the number of demand partners](chart2.png)

- Number of demand partners range from 0 to 20
- ECDF from 0.0 to 1.0
Analysis – HB Latency
Analysis – HB Latency
Analysis – HB Latency
Analysis – HB Latency
Analysis – HB late bids
Analysis – HB late bids
Analysis – HB Auctioned ad-slots

![ECDF graph showing the cumulative distribution of auctioned ad-slots per website for Client-Side HB, Server-Side HB, and Hybrid HB.](image)

![Box plot showing latency (seconds) for different auctioned ad-slots per website.](image)
Analysis – HB Auctioned ad-slots
Analysis – HB Auctioned ad-slots

% of ad-slots

Server-Side HB
Client-Side HB
Hybrid HB

ad-slot dimensions

0 10 20 30 40 50

300x250 300x250 300x250 300x250 300x250 300x250 300x250
Analysis – HB Bid Prices
Summary

- Designed & implemented HBDetector plugin
  - Can detect HB in real time

- Findings:
  1. Identified 3 types of HB: client side, server side, hybrid
  2. Previous top RTB partners dominate the HB ecosystem
  3. Median HB latency=0.6sec; In 10% of websites: HB latency > 3sec
  4. More ad-slots in a webpage means higher overall HB latency
  5. In more than 50% of auctions, half of bid responses arrive too late
Future work

• **HB Coverage:** Analysis of all available HB libraries to increase coverage
  • Here only covered limited (top) HB libraries

• **Page Load Time & UX:** Impact of HB on UX and page load time

• **User Privacy:** Investigate implications of HB to online users accessing HB-enabled websites

• **Publisher Revenue:** Study with real users, to confirm HB claims about revenue increase
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