

Optimizing Mobile Advertising Using Ad Refresh Interval

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Abstract: Optimizing the number of ad clicks is a large-scale learning problem that is central to the multi-billion dollar mobile advertising industry. There are currently several optimization methods used, including ad mediation and ad positioning. This paper proposes a new method to optimize mobile advertising by using the ad refresh interval. A new metric, which can measure and compare mobile advertising performance, takes into account time limitations. The results achieved from this optimization study could maximize revenue for mobile advertisers and publishers. This research has high applicability. It also lays out a solid background for future research in this promising area.

Keywords: Mobile ads, Optimization, Advertising, Measurement, Click, Refresh interval

1. Introduction

Mobile advertising has recently become one of the most effective marketing channels for business. In 2014, the global revenue for mobile advertising was more than US\$10 billion. Last year, businesses around the world spent about US\$30 billion on mobile advertising. And that number keeps increasing rapidly year after year.

Today, more companies than ever before are selling their products and services via mobile phones. As a result, there is a growing number of new mobile ad networks, including Facebook's Audience Network and Google AdMob.

There are basically two types of mobile ad: banner and interstitial. Two metrics are currently used to measure ad performance: click-through rate (CTR) and revenue per thousand (RPM) impressions. However, as ad impressions have their own duration and are refreshed with a chosen rate, these two metrics seem inadequate to measure ad performance and effectiveness in terms of display time.

The problem that advertisers face today is how to compare, on a large scale, the number of ad clicks when changing the refresh interval. The results from this study will help to maximize the number of mobile advertising clicks, and accordingly, increase mobile advertising revenue.

There already are several guideline documents about how to optimize mobile marketing [5-7]. However, they all mainly focus on ad mediation and ad positioning, not ad duration. That could possibly be due to the fact that advertisers were coming from newspaper, TV, and website

advertising, where time limitation is not a critical issue. And for a very long time, they lacked a mathematic tool to actually solve this issue.

This paper (1) proposes a new metric to accurately measure ad performance, taking into account ad duration; (2) presents the results when measuring the number of ad clicks at several refresh intervals; and (3) recommends the optimal value from among those intervals.

The methodology and experiment setup are presented in the next section, and then the measurement results are presented. After that is an examination of the findings and their applicability. Finally, research limitations are discussed, along with details of some new directions for future research.

2. Methodology

2.1 Data

It is necessary to carry out this research on big and complex data. The first thing is to have access to as many mobile users as possible. The next thing is to check that the data are unbiased and representative in all possible aspects, including age and gender.

The data for this study meet all of those requirements. The data were collected extensively over a very long period of time, with more than 600,000 mobile users involved and with an average of 30,000 ad impressions per day. Google Analytics was used to monitor and check all aspects of the data. Table 1 gives a quantitative view of the

Table 1. Data.

Quantity	Value
Number of Mobile Users	600,000
Number of Spoken Languages	30+
Number of Countries	200+
Average Number of Impressions Per Day	30,000
Daily Average Number of New Users	7,000
Daily Average Number of Active Users	25,000
Daily Average Number of Screens Per Session	3,4
Average Duration Per Session (min)	3:00



Fig. 1. Interest Category.

data.

Preparing to test ad refreshes over long intervals, quality apps and games were used, with user engagement of about three minutes per session. That allows deploying ads that are as long as 120 seconds. These apps and games also have users in almost every country around the world, with all the major spoken languages included for consideration. They also include users of both smart phones and tablets, with a diverse range of screen sizes.

The number of new users accounts for about one-quarter of all active users, which means having both first-time and returning users. Each user interacts with more than three screens per session, which guaranteed that there was more than just one user interface involved in any user session.

The data were also checked for users who have a diverse range of interests, including sports, computers, travel, and so on. Fig. 1 below shows more detail.

Now, look at the data’s age and gender demographics.

As seen in Fig. 2, about 60% of mobile users are younger than 35 years old. Most of them are between 25 and 34. As for gender, more than 50% are female.

Audience demographics data were then compared with data from the App Annie Audience Intelligence Report [4], and they are all similar as to percentages and their distribution.

The ad content comes from all categories listed in Fig. 3. The categories include Entertainment, Education, Sports, Social Networking, and many others. That ensures all the users are equally served by their target ads.

With all those checks carefully in place, it is certain

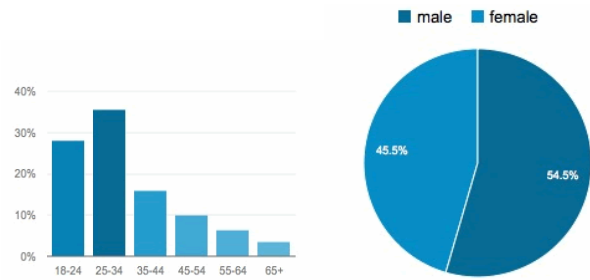


Fig. 2. Age and Gender Demographics.

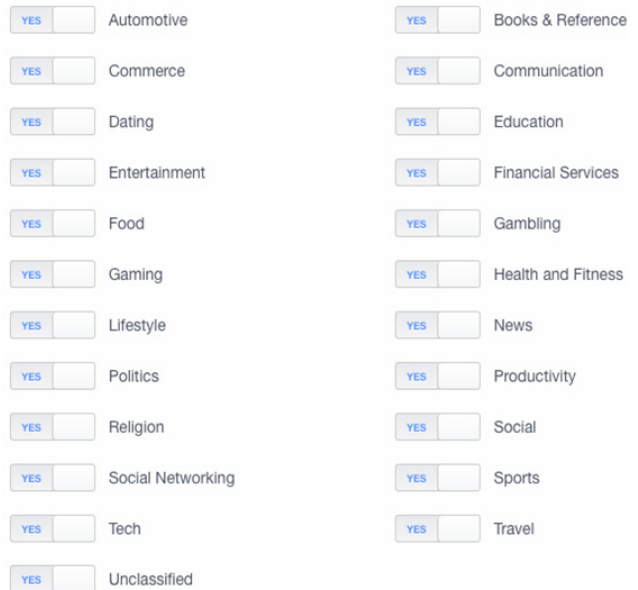


Fig. 3. Ad Categories.

that the data are unbiased, representative, and diverse in all possible aspects. They are ready for measurement.

2.2 Measurement

To measure ad click performance, advertisers and publishers currently use Click-Through Rate with a formula as follows:

$$Click - Through Rate(CTR) = \frac{Number\ of\ Clicks}{Number\ of\ Impressions}$$

Fig. 4 is what a typical CTR report looks like.

However, as everyone knows, each impression has its own duration. The CTR metric cannot tell how regular the clicks actually are.

Instead, a new metric called clicks per hour (CPH) is recommended, with a formula as follows:

$$Clicks\ Per\ Hour(CPH) = \frac{Number\ of\ Clicks \times 3600}{Number\ of\ Impressions \times Refresh\ Interval}$$

Requests	Impressions	Clicks	Estimated Revenue	Details		
Show Breakdown By <input type="button" value="Date"/> <input type="button" value="Country"/> Show Performance Details For <input type="button" value="All Ad Placements"/>						
Date	Requests	Filled	Impressions	Clicks	Fill Rate	CTR
Tue Aug 18, 2015	1,116	582	330	17	52.15%	5.15%
Mon Aug 17, 2015	78,609	37,404	27,053	1,102	47.58%	4.07%
Sun Aug 16, 2015	83,807	42,989	32,147	1,209	51.3%	3.76%
Sat Aug 15, 2015	84,868	40,286	31,006	1,287	47.47%	4.15%
Fri Aug 14, 2015	75,302	36,418	27,807	1,175	48.36%	4.23%
Thu Aug 13, 2015	30,447	18,176	12,642	1,342	59.7%	10.62%
Wed Aug 12, 2015	29,079	17,942	12,320	1,264	61.7%	10.26%

Fig. 4. Sample CTR Report.

Clicks per hour is the average number of clicks in one hour over the whole range of all users and over the whole range of displayed ads.

With information about the number of impressions and their refresh intervals, it is possible to figure out the total duration of all ad impressions. Then, with the number of clicks, it is possible to find the average number of clicks per second. As the refresh interval is in seconds, multiply that result by 3600 to get the average number of clicks per hour. A higher CPH indicates a better result.

Right now, on all the ad networks, including Google AdMob and Facebook’s Audience Network, there is no metric helping to measure the effectiveness of ad refresh interval. This is the first time a metric like this has been suggested. In the next section, the results obtained with this new metric are presented.

3. Results

There are two types of mobile ad: banner and interstitial. The measurement results reflect them separately.

3.1 Banner Ads

Table 2 shows the CPH for banner ads, calculated from the daily average number of impressions, the daily average number of clicks, and the refresh interval.

A graph based on Table 2 illustrates the CPH versus refresh interval.

Table 2 and Fig. 5 show that the number of ad clicks at the refresh interval of six seconds is highest. In fact, it is 26% higher than at 30 seconds, and 51% higher than at two seconds.

Having said that, also note that for refresh intervals ranging from 5 to 7.5 seconds, the CPH values are very much the same. According to one eye-tracking study [3], mobile users normally take from five to six seconds to click on what they want. So, this result once again confirms that a display time of six seconds should be long enough for users to be impressed, to decide, and to take action.

Fig. 5 also shows that the CTR metric gives the wrong indication about ad click performance. At no refresh,

Table 2. Banner Ads.

Interval	Impressions	Clicks	CTR
2	437,061	760	0.2%
3	297,345	840	0.3%
4.3	194,885	980	0.5%
5	164,211	1,040	0.6%
6	150,444	1,186	0.8%
7.5	110,211	1,047	1.0%
10	85,819	975	1.1%
15	50,946	830	1.6%
30	25,851	810	3.1%
60	15,000	740	4.9%
90	11,429	700	6.1%
120	8,630	630	7.3%
No Refresh	4,904	510	10.4%

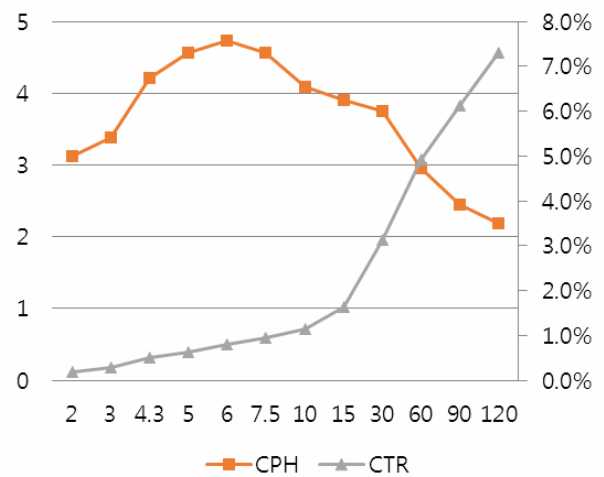


Fig. 5. Banner Ads CPH Graph.

according to the experiments, CPH is lowest. However, CTR is at its highest at that time. A higher CTR, in this case, is due to the fact that the ads are shown longer, much longer than is actually needed. If the average session duration is three minutes, as seen in Table 1, those ads could have been shown for as long as 180 seconds. As a result, the number of impressions is low, in that case, leading to a higher CTR. In this case, the CTR metric does not take into account the ad duration, and clearly gives an inaccurate indication about ad performance.

In the meantime, the CPH metric has been proven a better choice. The CPH metric helps to exactly calculate the number of ad clicks in one hour, and it is possible to know exactly at which optimal refresh interval that value can be reached.

About CTR, another way of understanding that metric is to associate it with a fixed interval, for example, 30 seconds. It is then possible to use the metric to implicitly compare click performances between one ad network and another.

Table 3. Interstitial Ads.

Interval	Impressions	Clicks	CTR
2	44,029	170	0.4%
3	24,637	209	0.8%
4.3	16,586	230	1.4%
5	14,447	246	1.7%
6	12,376	270	2.2%
7.5	9,639	250	2.6%
10	6,983	225	3.2%
15	5,549	212	3.8%
30	4,519	180	4.0%
60	3,902	160	4.1%
90	2,143	90	4.2%
120	1,163	50	4.3%
No Refresh	706	30	4.3%

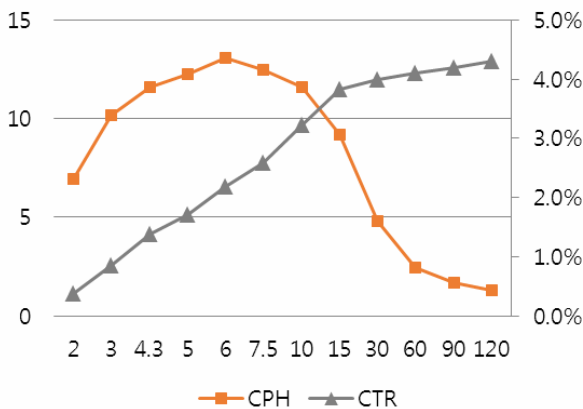


Fig. 6. Interstitial Ad CPH Graph.

3.2 Interstitial Ads

The results presented in Table 3 are for interstitial ads.

Table 3 includes information about the number of ad impressions and the number of ad clicks, together with the CTR values and the CPH values for further comparison.

Similarly, a graph can be drawn for CPH versus refresh interval, as seen in Fig. 6.

Here, for interstitial ads, the CPH graph is quite the same as Fig. 5, indicating the same result where, at the refresh interval of six seconds, CPH is highest. In fact, it is 18% higher than at three seconds, 88% higher than at two seconds, and 163% higher than at the normal 30 seconds.

Noticeably, CPH for a refresh interval shorter than 10 seconds is much higher than longer refresh intervals. Clearly seen is exponential growth over this range.

That could be due to the fact that full screen ads normally get more attention from the users. And with a big close button on the screen, the users can quickly click on the ad, or close it right away. That explains the difference seen here between these two graphs.

Again, for this type of ad, the CTR metric gives an inaccurate indication. By following the CTR metric, ads should not be refreshed at all. In fact, at no refresh, the CPH value is at its lowest, meaning the lowest number of

Table 4. CPH Summary.

Ad Type	Refresh Interval	CPH
Interstitial	6	13.09
Interstitial	7.5	12.45
Interstitial	5	12.26
Interstitial	4.3	11.61
Interstitial	10	11.60
Interstitial	3	10.18
Interstitial	15	9.67
Interstitial	2	6.95
Interstitial	30	4.96
Banner	6	4.73
Banner	7.5	4.56
Banner	5	4.56
Banner	4.3	4.21
Banner	10	4.09
Banner	15	3.91
Banner	30	3.76
Banner	3	3.39
Banner	2	3.13
Banner	60	2.96
Banner	90	2.45
Banner	120	2.19
Banner	No Refresh	2.08
Interstitial	60	1.99
Interstitial	90	1.52
Interstitial	120	1.17
Interstitial	No Refresh	0.8

clicks per hour. That is absolutely wrong. The ads are longer, but there are fewer of them. The utilization rate is low.

The revenue per thousand impressions metric does not help in this situation either. The RPM metric does not take into account the ad duration. Actually, the RPM values are proportional to CTR values, because the ad revenue is proportional to the number of clicks.

In both cases, the CPH metric is shown to be a better metric, giving a better indication. With CPH, one can see at which refresh interval the number of clicks is highest over a fixed period of time. It is also possible to estimate how high that number could be. This is the first time a metric like CPH has been suggested, and it is proven better than all the others.

3.3 Summary

Now, all the results are summed in one table showing a combined view of both banner and interstitial CPH versus refresh interval.

This summary can help both app publishers and mobile advertisers select the ad type and ad refresh intervals accordingly, to get the highest number of ad clicks.

It also helps publishers estimate their ad sales, based on the amount of time their apps are used on a daily, monthly,

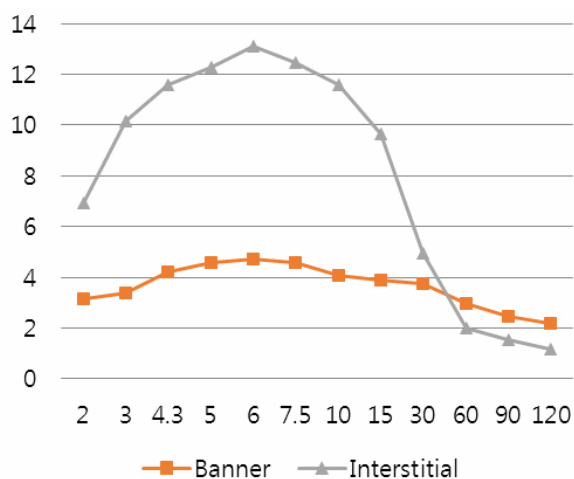


Fig. 7. CPH Combined Graph.

and yearly basis. For example, an app that has a base of 10,000 daily users and an average session duration of three minutes can expect to have 1,500 clicks per day. And with that information, it is possible to estimate revenue. That is really handy and useful for business planning.

Table 4 shows that most interstitial ads perform better than banner ads. The highest CPH for interstitial ads is 13.09, nearly three times that of the highest CPH for banner ads. So, for refresh intervals shorter than 30 seconds, interstitial ads are recommended.

Comparing the performance between these two types of ad, notice that for ads longer than 30 seconds, the CPH of banner ads is not too low, compared with interstitial ads. That proves that each ad type has its own advantage.

There currently is a misunderstanding that banner ads should not be used due to their low CTR. However, the results here have shown that even when an ad type has a lower CTR, the number of clicks by the end of the day is still high. That could be because banner ads are always on the screen. And with the total display time that they have continuously, they can generate as many clicks as the full screen ads can.

Now, draw a combined graph for CPH.

Fig. 7 shows clearly that for an ad refresh interval longer than 30 seconds, banner and interstitial ads have the same chance of being clicked on, given that they are displayed for the same amount of time.

All the significant results presented here can only be obtained thanks to the new CPH metric. CPH helps give a clearer view of a problem that seems to be a mystery with many misunderstandings. It also provides a mathematical tool to address other issues discussed in the next section.

In summary, this study achieved the following significant findings.

- For both banner and interstitial ads, the optimal refresh interval is six seconds. At this value, the average number of clicks in one hour is highest.
- As for ad duration, it is recommended to create banner ads with a display duration of between 5 and 7.5 seconds, and interstitial ads with a duration between 3 and 10 seconds. Those were proven to be long enough for mobile users to be impressed and

take action.

- For ads shorter than 30 seconds, interstitial ads provide better click performance. Recommended is using as many interstitial ads as possible, whenever appropriate.

4. Discussions

A higher CPH does not directly imply higher revenue, because a shorter refresh interval could lead to a lower fill rate on some networks. So, a combination of several mobile ad networks is recommended to guarantee ad request filling.

This research is not for newspaper, TV, and other non-clicked ads. There are ads that are displayed solely for branding and offline purchases. Those are not considered in this study.

From the findings achieved with this research, it is possible to continue the work to explore other ways to optimize mobile advertising, for example, based on content. The idea is to use the CPH metric to compare ad click performance among text, image, and video ads.

Another direction for future research is to make the ads refresh on a dynamic, rather than a fixed, interval. So, depending on ad type, advertisers can change the refresh intervals accordingly. That could improve the results further.

Native ads are becoming more and more popular these days [8]. The method could be applied to that new type of mobile ad, with results that will be very promising.

It is also possible to find a new way to apply the method in other types of advertising, for example, web advertising. It is kind of a traditional business, but it currently faces a lot of challenges [1, 2]. CPH is the right tool to address current issues.

5. Conclusion

Mobile advertising is a fast-growing business. Optimizing mobile advertising by itself is a new subject. This research is one of the first attempts digging into this promising area.

A new metric was found that can measure and compare the mobile advertising performance, taking into account ad duration.

From a large-scale measurement, the recommendation is to use a refresh interval of six seconds for both banner and interstitial ads.

As for ad duration, advertisers should create banner ads between 5 and 7.5 seconds long and interstitial ads between 3 and 10 seconds long. For app publishers, the recommendation is to use interstitial ads wherever appropriate.

With their high applicability, the results achieved from this optimization research could immediately maximize revenue for mobile publishers and advertisers by bringing the right ads with the right amount of time to the right mobile end users.

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