Real-Time Advertising

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1 Data-Driven Online Advertising

Over the last two decades, online advertising has become one of the most important elements of corporate communications. Whereas static banner ads dominated initially, search advertising (Varian 2007) now encompasses the largest part of global online advertising spending. In recent years, a new form of online advertising, real-time advertising[1] (RTA), has been increasingly used. RTA is based on auctions in which individual advertising spaces are sold within a few milliseconds after calling a website. Advertisers or their media agencies participate in these auctions. RTA was first established in the U.S. and is now represented in the German market, with a market share of approximately 10 % (BVDW 2013). RTA will progressively replace the traditional forms of purchasing online advertising space, which nowadays is being sold in large quotas and at predetermined prices that are mediated by marketers and media agencies. Thus, from the perspective of publishers, RTA allows both a reduction of transaction costs and an increase in revenues due to higher utilization. Advertisers can target ads based on the product affinity of user groups, which allows for the optimization of advertising campaigns in a short period of time (Ghosh et al. 2009).

In the context of RTA, information systems research can contribute to a number of research topics due to its interdisciplinary orientation. For example, research topics include the automated decision support within the auction process, management of the large quantities of data, perceptions of RTA by various actors, and development of sustainable digital business models. The present article describes RTA from the perspective of stakeholders and outlines selected research questions.

2 Actors and the RTA Process

In addition to Internet users, publishers and advertisers, additional technology service providers are involved in the RTA process (**Fig. 1**). These service providers include supply-side platforms (SSPs) that are commissioned by the publishers to offer advertising space in the market places. These market places are known as ad exchanges. The advertising spaces are auctioned on behalf of the advertisers by demand-side platforms (DSPs). Other actors include data management platforms (DMPs), which offer individual user profiles and interest data to support decisions in the auctions that are handled by the DSPs.

The RTA process starts when a website that contains RTA ads is displayed in the browser (**Fig. 1**, Browser). The returned HTML code causes the browser to send an HTTP request to the SSP; the request is similar to the classic banner display advertising. The SSP (**Fig. 1**, SSP) recognizes the size and position of the advertising space and adds additional information to prepare for the auction (e.g., minimum price, allowed and excluded forms of advertising content, the environment's characterization). While the browser waits for an answer, the SSP sends the data to the ad exchange to trigger an auction (**Fig. 1**, Ad Exchange).

The ad exchange does not forward the request to all of the connected DSPs. Rather, the participating DSPs are selected based on the information that is contained in the request and on findings from previous auctions. This method of selection reduces the data volume that needs to be transferred and processed by the different actors. Afterwards, the ad exchange forwards the information about the advertising space to the selected DSPs in the form of a bid request. The bid request is usually formatted in JavaScript Object Notation and includes information about the user, context, and advertising space (**Fig. 2**).

Within approximately 20 milliseconds, the DSPs must decide on the advertiser and campaign for which to place a bid (**Fig. 1**, DSPs). To make this decision, all of the available data about the current user can be considered. When a user is visiting the website for the first time, the available information is limited to the bid request. Later, the user can be detected by cookie matching. This allows the cookies of the SSP/ad exchange to be linked to the user IDs of the advertiser. The user's activities (e.g., ad contacts, website visits, and purchasing activity) can be stored in a customer journey and used for automated decisions during the bidding process. Additionally, DSPs can use third-party data (e.g., socio-demographic characteristics, user interests) that are offered by DMPs to support the decisions within the auction process.

Regarding auction participation, the DSPs send a bid response within a predetermined time interval. The response contains the bid, advertisement URL, target web page, and content information of the advertising material. The ad exchange selects the highest bidder and forwards the advertising media to the SSP, which then forwards the media to the waiting browser.

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[1] In practice, the terms "real-time bidding", "programmatic buying", and "data-driven display advertising" are used synonymously with RTA.
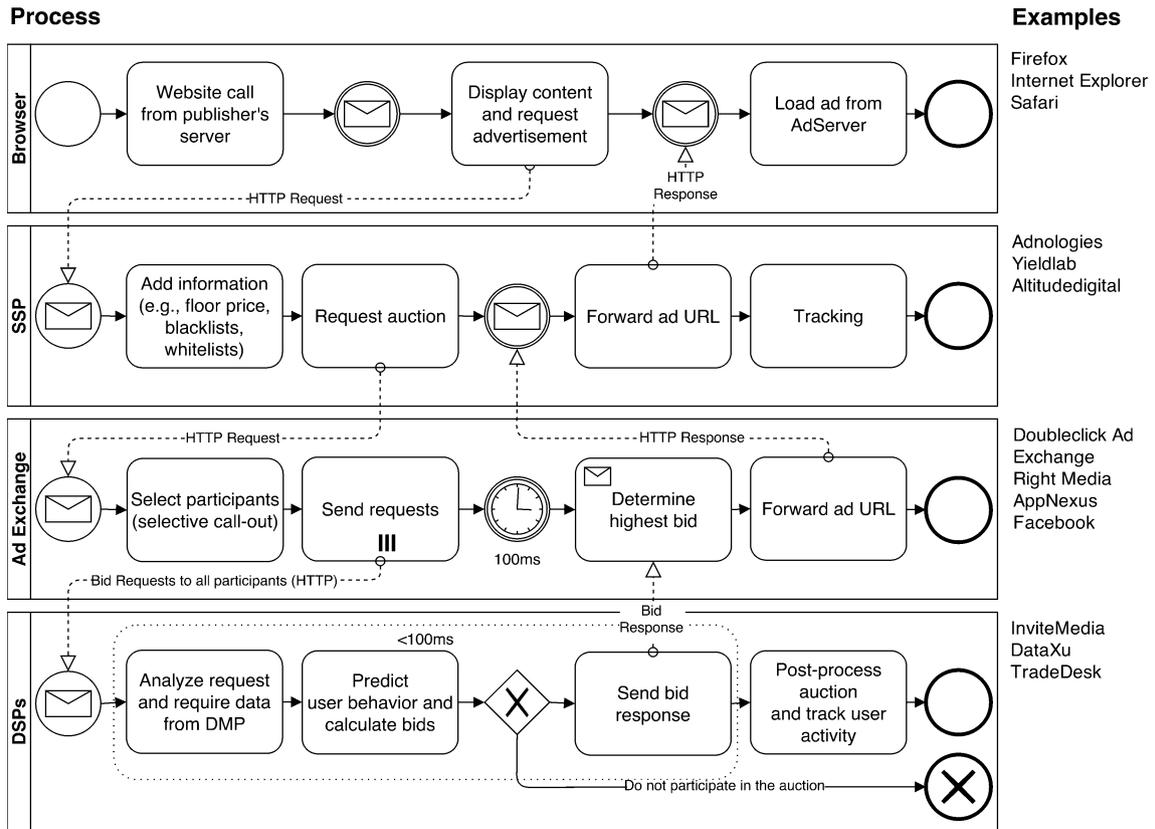
Process   **Examples**

Fig. 1 The business process model of RTA and examples for the involved actors

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User information
Request ID	`id: "Mv\2005\n\345\177"`
Encoded IP address of the user	`ip: "\314j\310"`
Operating system and device	`user_agent: "Mozilla/5.0 (Windows; U; Windows NT 5.1;`
	`en-US) AppleWebKit/534.13"`
User ID	`google_user_id: "CAESvb-4SLDjMqsY9"`
Time zone of the user	`timezone_offset: -300`
Cookie age	`cookie_age_seconds: 7685804`
Origin of the user	`region: "US-MA"; city: "Boston"`

Context information
URL of the website	`url: http://www.example.com/`
Language of the website	`detected_language: "en"`
Detected website content and weights	`detected_vertical {`
	`  id: 22`
	`  weight: 0.67789277 }`

Ad slot specification
Ad slot ID	`id: 1;`
Dimensions	`width: 300; height: 250`
Unallowed content	`  excluded_attribute: 7`
Floor price	`  matching_ad_data {`
	`    adgroup_id: 3254984134`
	`    minimum_cpm_micros:2000`
	`  }`
Visibility of the ad slot	`slot_visibility: BELOW_THE_FOLD`

Fig. 2 Example of a bid request (Google 2014)

Because second-price auctions are used in RTA, the URL of the ad contains the paid price in an encrypted form that can be decrypted by the DSP when the banner is loaded from the ad server. Ad servers are commonly used for user activity tracking and provide extensive tracking capabilities. On the side of the DSPs, these data can be added to the customer journey and later used to support decisions in the auction process.

In practice, different variants of the illustrated RTA process can be found. For example, Facebook operates its own ad exchange, where only advertising spaces from Facebook are traded. Hence, the differentiation among publisher, SSP, and ad exchange is absent.

3 Research Topics and Contributions of BISE Research

In the following paragraphs, specific Business and Information System Engineering (BISE) research topics are presented. Because of the wide array of topics, a systematic assessment of RTA-related research topics is not within the scope of this article.

3.1 Decision Support

In RTA, all of the involved actors make numerous decisions. For example, actors must decide which areas of a website – and under what conditions and with which intermediaries – should be offered to a specific selection of advertisers (Balseiro et al. 2011). BISE research can contribute to the dynamic selection of suppliers, i.e., the intermediaries and the technical infrastructure (Probst and Buhl 2012).

Previous research primarily focused on the bidding process with its millions of individual auctions. In addition to budget constraints, campaign periods, and the maximum frequency of impressions per user and bid request, the customer journey is used to determine the price a DSP should bid. Statistical models (Nottorf 2014) enable companies to predict user behavior (e.g., the probability of a purchase). Essentially, conditional probabilities in the following form are derived: "The impression of an RTA display ad at the present time for user X with profile attributes Y and customer journey Z increases the probability of a purchase within a given time interval

by A %". With the help of these conditional probabilities, the economic assessment of the potential RTA ad and the calculation of the maximum bid are possible (Perlich et al. 2012). Today, it is common practice, however, that bids are based on the available budget rather than being determined by the user or context. This is especially true for branding campaigns, where the measurement of success is more difficult to calculate than in performance-oriented campaigns.

Research in this context offers several methodologically sophisticated questions that are highly relevant in practice. For example, how can decision-making consider user-specific and context-specific factors? How can heterogeneity in user behavior be modeled? What interactions between RTA and other marketing channels in the customer journey can be measured? What are the dynamics of user behavior, and how do these dynamics impact the predictive power of the models?

3.2 Data Management

RTA produces large amounts of data. For example, Google's DoubleClick Ad Exchange processes tens of thousands of bid requests per second and forwards them to the connected DSPs. For the DSPs, this process results in data volumes that exceed one TByte in a few days, which quickly leads to data volumes in the order of PBytes. If DSPs and advertisers keep these data for later analysis, they face high costs of data storage and processing. Various research questions can address the ratio of the cost of data collection, storage, and processing to the benefit of data analyses, and research can consider how this ratio is used in RTA in terms of the value of the data (Nottorf and Funk 2013). This involves questions regarding the optimal amount of data needed per user and whether an aggregation of user leads to a reduction in the amount of data. In practical terms, there is the question of whether the handling of data is economically sensible in terms of decisions that need to be made within the auctions. For these decisions, there is the question of how to sample from the data prior to the analysis (i.e., model estimation). This is important because statistical methods can be computationally intensive (e.g., simulation-based approaches to model estimation); thus, in addition to the cost of data storage, the cost of the computing capacity must be considered when es-

timating the total costs of data management. The answer to these questions depends on many factors, such as the dynamics of user behavior, seasonal effects and competition.

In today's practices, systematic decisions about which data will be collected, stored, and processed are rare. Instead, all of the available data are collected but primarily remain unanalyzed; thus, RTA is a prime example of Big Data. Research in IS can estimate the economic value of the data and develop processes that can be used to manage the data. These contributions are especially important in the context of the increasing use of cloud services.

3.3 User Perceptions

Online advertising is an essential financing strategy of many websites, whereas user fees are not always enforceable because of users' internet experience and competition. RTA allows to analyze user behavior and target users individually. With regard to banner advertising in general and, thus, RTA in particular, Goldfarb and Tucker (2011) have shown that the personalization of advertising messages has a positive effect on sales. In the U.S., this study has also shown that privacy concerns of users are connected with obtrusive, personalized ads. This aspect of advertising has not been well studied, and there may be long-term or negative effects. Therefore, sensitive and transparent handling of user-specific profiles is advisable, particularly in Europe. The study of user behavior (e.g., cookie acceptance, use of ad blockers, acceptance of fingerprinting) and users' willingness to disclose personal data represents an exciting BISE research field (Carrascal and Riederer 2013). With regard to emerging legal restrictions, there is uncertainty about whether current business models of RTA actors will remain over time and about what changes are necessary and sustainable.

4 Implications

The auction principle of RTA will become more prominent in marketing in coming years. Existing business models will continue to evolve, and at the same time, new business models will be developed. Changes in data protection legislation in Europe and changes in user behavior, as well as the growing conver-

gence of media channels, are expected to play an important role in this context. Furthermore, the quality of available advertising space is expected to continue to improve, which means that RTA can also be used for branding campaigns. DMPs will become increasingly important because automated decisions rely on high-quality data. In the era of online video stores and streaming services, the use of RTA as personalized advertising will likely increase in the classic online arena and even in radio and television. Several companies (e.g., http://wywy.com) already rely on this trend. The RTA process also shows certain parallels to the products in financial markets. However, whether other forms of selling media will evolve in RTA, such as in analogy of financial futures, depends on the development of appropriate business models (Veit et al. 2014).

In summary, RTA offers an exciting, interdisciplinary field for BISE research due to its high degree of practical relevance and is characterized by a range of economic, methodological, technical, and social issues.

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