Towards Autonomic Marketing

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***Abstract*— This paper explores one of the current innovation waves within computing technology, that of the application of Autonomic Computing (AC) to the marketing domain – termed "Autonomic Marketing", the result being an adaptive, highly effective marketing strategy set to significantly change target marketing and a company's relationship with customers. Marketing has often been at the forefront of business adoption and utilization of the latest computing technologies and functionality. Indeed, the marketing function is interlinked with technology and has been proactively using the capabilities of new technologies from the earliest databases and mail merge functionality to sophisticated Customer Relationship Management systems and intelligent behavioural marketing systems. The Autonomic Computing paradigm provides a framework in which marketing systems could become self-configuring and context-aware, using a variety of learning and decision-making techniques, providing the potential of even more refined targeting of marketing information to customers. In this paper, we introduce the concept of Autonomic Marketing and outline some of the research issues involved in the implementation of such a system that will, indeed revolutionize the marketing world.**

Keywords-Autonomic Computing; Autonomic Marketing; Marketing Intelligence Systems.

I. INTRODUCTION

There has always been a close relationship between information and communication technology (ICT) and marketing where marketers are often at the forefront of exploiting new technological capabilities. From the early days of using customer databases to the later multiple channel Customer Relationship Management (CRM) systems, marketers have used technology to better target marketing information to customers. Each technological wave has resulted in a step change in marketing activity and capabilities [1][2]. Technology brings marketers closer to their customers, and new technologies bring new channels and approaches to marketing [3]. Database systems enabled the recording and collation of many data items relating to customers. Every interaction between a company and a customer could be recorded and analyzed to generate customer profiles which could then be used to target specific marketing information. Similarly, Internet technologies have enabled close monitoring and interaction of a user on the Internet where preferences, behaviour, use patterns and much more can be tagged and logged [1][4]. The move towards Web 2.0 technologies bring more advanced monitoring capabilities, drawing upon a wealth of personal information [5].

Mitch [6] argued that, historically, there have been three stages of marketing initiated by technological changes, these being:

- *Research based* that used qualitative and statistical data to guess what people wanted.
- *Transaction based* that used the stored transaction data collected by organizations to help analyze and profile customers. This saw the growth of database marketing and CRM type systems.
- *Volunteered Personal Information*, a technology based on customers being active participants in providing key data, enabled by the later Web 2.0 technologies. Often the data is personal and interlinked with a host of customer context information, both personal and business information. Companies have a far richer set of data to collect, collate and analyze.

Each of the different stages has fundamentally changed marketing activity.

We propose a new marketing approach, "Autonomic Marketing" (AM), which employs the fundamentals of Autonomic Computing (AC) to monitor the current environmental state (including social trends, world events as well as characteristics of the target consumer base) and use these inputs to formulate an appropriate marketing strategy to yield the best results given the current conditions. The approach is adaptable, using feedback loops to monitor,

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analyze, plan and subsequently execute the new marketing plans on the fly.

The remainder of the paper is organized as follows. Section II presents the overview of Autonomic Computing. In Section III, we introduce the Autonomic Marketing concept architecture. Section IV discusses the research issues arising from the AM concept. We conclude the paper in Section V.

II. AUTONOMIC COMPUTING PRINCIPLES

Two seminal papers, Ganek and Corbi [7] and Kephart and Chess [8], consolidated a theme within computer science - that of the practical emergence and development of sophisticated autonomic systems which have the ability to operate autonomously in remote dynamic environments with limited intervention from human operators. Ganek and Corbi discussed the 'dawning of the Autonomic Computing era' describing the main attributes of Autonomic Computing systems as being self managing systems with self-configuring, self-healing, self-optimizing and self-protecting capabilities. Kephart and Chess explored the grand challenges to create self-managing computing systems that can manage themselves according to an administrator's goals.

The concepts of autonomic computer systems derive from the human autonomic (vegetative) nervous systems [9], the regulatory mechanisms of visceral functions such as digestion, respiration, and the circulation of the blood, etc. These biological systems operate autonomically, that is, without conscious control by the individual.

In the past decade, many autonomic systems have been developed for self-management of complex systems. For instance, AC has been applied to database management systems [10], web services environments [11], elastic services in the cloud [12], workload management [13], and complex networks [14]. Autonomic systems have the ability to cope with dynamic environments [15]. Autonomic systems have begun to reach a level of maturity with a variety of models, applications and techniques [16][17]. A further aspect of Autonomic Computing is the ability of units and agents to interact with each other [18]. There are many potential models for interaction, such as sharing resources, sharing environment information, collaborating on a joint activity or a multitude of transaction based information sharing models.

Autonomic Computing brings together the advances in artificial intelligence, intelligent agents and autonomic, or self*, capabilities that enable real-time, contextual adaptability and learning that can be applied to marketing activities.

We use the term Autonomic Marketing (AM) to describe a step-change in the sophistication of automated marketing systems, in which the marketing activity itself is dynamically configured and contextualized to suit the current market conditions. AM can be succinctly defined as 'it knows you want it' technology, effectively the Holy Grail of marketing that provides previously unprecedented levels of personalization and targeting of product and service information to customers - just when they need it, or when they are likely to be most receptive to it. The technology capabilities are already here and they are beginning to be applied in this area, however, activity is piecemeal. In addition, there is little consideration of the full capabilities, and the likely consequences, of Autonomic Marketing.

III. AUTONOMIC MARKETING

The Autonomic Marketing Interest Group [19] defined some initial concepts and promise of Autonomic Marketing, that of "it knows you want it" technology or, applying it to a real-time setting, "it knows you want it, when and where you want it". Effectively, Autonomic Marketing is heading towards the marketing Holy Grail where marketers can utilize artificial intelligence capabilities to trawl through the mass of data and data channels to closely match customers' needs, likes and preferences.

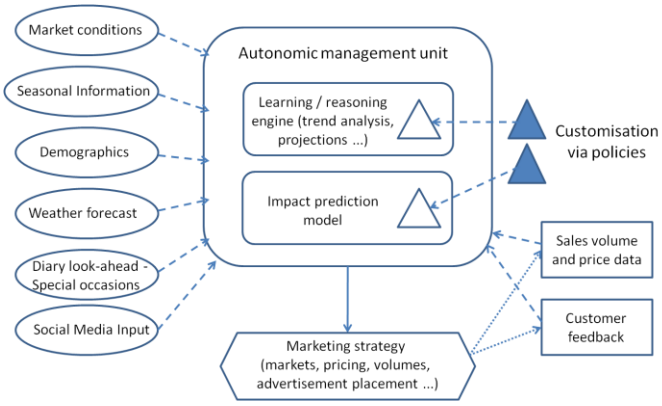

Figure 1. The Autonomic Marketing Architecture

Figure 1 outlines the AM architecture. The autonomic management control unit monitors current state, taking input from various sources such as the market conditions, customer demographics, significant world events, trends emerging from social media analysis, weather, and seasonal information. The information is time correlated, analyzed and fed into prediction models to formulate the best possible marketing strategy. Success metrics include sales volume and customer reports, which are used as feedback to the autonomic manager. The behaviour of the autonomic manager is controlled by customizable policies.

Autonomic Marketing may take two distinct approaches: company-centric or customer-centric. Company-centric is a more targeted "information push" approach, whereas consumer-centric is more of an information pull technology. In a company-centric approach, marketing strategies are defined using data that is readily accessible and targets the population as a whole. A consumer-centric approach is one in which an individual provides context data and the system sifts through potential offerings to select items most relevant to the consumer based on the context provided.

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As an example of company-centric AM, consider an organization that sells sportswear. The company wishes to run an adaptable marketing campaign on television with the ads to be aired on different networks during different (unpredictable) events. The ads feature different products, and the content is adaptable to be appealing to different audiences with different demographics. Before each ad is run, the current viewer demographics are analyzed (based on past and/or present statistics gathered by the television network), information about the current television show being aired is considered (is it a sporting event, a comedy or a reality television show?), if applicable, the current state of the show is taken into account (who is winning the game?) and social networking trends (such as fan favourites) are determined. Different ads are run depending upon the current conditions. For instance, if a football match is currently airing, and Manchester United is the fan favourite and are currently winning, Man U merchandise may be advertised and the ad may feature Man U fans celebrating a win, wearing their gear. Conversely, if FC Barcelona is currently winning, more generic, non-team related merchandise may be a better choice, or perhaps the ad should not be run at that time. The audience demographics may further refine the merchandise that is shown and the type of ads that are aired at any particular time.

Alternatively, in a consumer-centric approach, the system would gather customer profile data (demographics and preferences, if available), prompt the customer for some additional information and then sift through offerings to identify products that may be of interest. Predictive models would provide guidance as to what products would be displayed. For example, the system may know that the customer is 20 years of age, is located in Valencia, Spain and knows, from previous searches, that the customer is a FC Barcelona fan. The system may prompt for more information, such as the fact that the customer is looking for a jacket. It would then search for items from a variety of companies and show the customer the items he/she is most likely to purchase. Predictive models would base decisions based on historical data (companies that the consumer has purchased from previously, or companies frequented by customers with similar demographics etc).

The way in which the various stages of the autonomic control loop {*monitor*, *analyze*, *plan*, *execute*} map onto such use cases can be explained in terms of Figure 1. '*Monitor*' current market conditions, and factors directly influencing this including diverse information such as weather, seasonal, economic, as well as customer feedback (direct via reviews etc, and also indirect in terms of sales figures) and current pricing model; provide the current sensed 'state'. '*Analyze'* takes this information, combines it with historical data, and searches for patterns / trends and thus identifies opportunities to improve the system's performance (ultimately to increase sales value or volume). '*Plan*' decides what changes could be made to the current marketing strategy and attempts to predict their impact. This could use a utility function or fuzzy reasoning, for example, to determine which of several possible adaptations yields the most beneficial results under the various conditions. '*Execute*' subsequently applies the changes by adjusting tuning parameters on the marketing strategy.

IV. RESEARCH ISSUES IN AUTONOMIC MARKETING

Although the principles of Autonomic Computing are well developed, the application of these principles to new domains remains challenging and a number of issues will need to be researched and resolved in order to make AM a reality. Infrastructure must be put in place to collect, store, analyze and mine the data sources, adaptable models must be built to predict the impacts of taking particular actions, and feedback mechanisms must be put in place.

AM requires data from many data sources – contextual information from the potential consumer base (demographics, geographical information, preferences etc), trends emerging from social networking sites or significant world events from news sources, weather/seasonal information, market conditions, historical information, etc. How and, from where, will this information be collected? What exactly is contextual data? What tools are in place for collecting this data? Who owns this data, and how do we deal with the privacy issues? Will the data be stored? If so, how, where, and for how long? Can the data be collected and analyzed efficiently to allow for real-time AM? Is all the data time-stamped to allow for time-correlation? Most organizations already collect part of this information, but it is held in disparate systems (e.g. for supply-chain management, logistics, stock control, and traditional marketing), and not used effectively in the way we propose. AM is to work smarter, not harder.

The system must be able to predict the outcome of applying AM strategies. How do we build and test the predictive models? These models must be adaptable and updated regularly, based on obtained feedback. How will we detect that the models are outdated and how often should they be updated? As with most current AC systems, a human supervisor is still required for such high-level decisions. The key goal of AM is to manage the complexity of making targeted management actions with low latency, freeing up the marketing executives to focus on only the highest-level concerns. Ultimately, when dealing with situations that have not been met before, or when new entities are encountered in the application environment, plasticity and flexibility must be greatly enhanced beyond the present state of the art. In this way restrictions arising due to having only the pre-programmed functionality familiar in current, predominantly 'playback', systems, can be overcome when dealing with novel situations [20].

The customer- & company-centric approaches are quite different, with one being an information push based on current knowledge and the other relying on gathering information from the customer in order to find relevant information. In terms of technology, what are the requirements of each, and how do they differ?

Along with the technological aspects of AM, we need to consider the implications of failure. AC systems take action based on current conditions. They are unpredictable as it is impossible to test all possible cases, especially with the large number of parameters involved in the AM system. If a

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marketing strategy employed by the AM fails, what are the implications? How can trust be established?

Some of the questions posed above have been studied extensively in the literature and solutions have been proposed or are already in widespread use. For example, the storage, correlation and analysis of massive amounts of data using data warehouses and/or open source tools such as HBase [21], Hadoop [22] and Mahout [23]. Other areas, however, require additional research. Our further work is to prototype a system and to pursue some of the open areas.

V. CONCLUSIONS AND FUTURE WORK

Autonomic Marketing, making use of the powerful capabilities that Autonomic Computing provides, offers many significant changes in marketing activity. As with any new wave of technology, the impact could be far reaching for customers and companies. Marketing budgets may be significantly reduced as large numbers of marketers are replaced by intelligent Autonomic Marketing agents that operate 24/7 providing increasingly accurate targeting and ad customization.

There are clearly challenges ahead, but Autonomic Computing is a key area in computer science with over 10 years of development of principles and techniques. We foresee that a natural extension of this science to marketing, a complex "system" that requires self-configuration and self-optimization, is the next technological wave that will sweep the industry.

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