CRM Information Assurance by Adding Specificity

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Abstract
We propose a CRM specificity enhancer (CSE) capable of information assurance through specifying CRM evidence. We use Dempster and Shafer's theory to process nonspecific customers attributes and their nonspecific purchase behaviors collected by the CRM data and technology components. Customer segmentation is performed while minimizing information conflicts in strategic marketing information generated by the CRM system and used by marketing management to send out marketing offers to targeted customer groups.
CRM information assurance, through the CSE model, achieves information confidentiality, data integrity, and system availability. Because information inconsistencies are a great source of information corruption, then CRM integrity will be enhanced by minimizing information conflicts. Also with the absence of such specificity capability then marketing management cannot target the right customers and may hence rely of junk mail and spam to reach more customers. However the more untargeted marketing offers are sent through spam or junk mail the more company information is leaked to the external world. Leaking valuable information about a company's marketing product and strategies violates the confidentiality security goal set by the CRM security policy.
Moreover, because the CSE model works in a real time manner by classifying new customers as they arrive, any denial of service by some components of the CRM system will not oblige customers to reject marketing offers but will instead default to the last marketing offers communicated to marketing management before the CRM system is affected by the denial of service incident.

Keywords:
CRM, Information assurance, Confidentiality, Integrity, Denial of service, Specificity, Security, basic belief assignment, Belief function.

1. Introduction

Before we start discussing CRM information assurance let us advance few CRM definitions that are more relevant to our information assurance subject. Wayland & Cole (1997) defined CRM as a system that includes sharing four elements: customer combination management, value positioning, additional-value role and reward, and sharing which determine customer value. Swift (2001) defined CRM as an enterprise approach to understanding and influencing customer behavior through meaningful communications in order to improve customer acquisition, customer retention, customer loyalty, and customer profitability. Wang & Kang, (2008) defined CRM as a system providing individualized products and services by means of information technologies and database, consequently establishing relationship with customers and therefore building Customer Loyalty and acquiring their Lifelong Value.
While those CRM definitions are all different they all insist of business value generation based on personalizing marketing efforts towards enhancing customer loyalty. The CRM concept remains however a relatively new concept. Many of the features currently adopted in different markets have not been studied. This article discusses the information assurance part that has been neglected in the available CRM literature.

2. Information assurance in a CRM system

CRM information assurance is modeled in this article in terms of CRM confidentiality, CRM integrity, and CRM availability. In their general information security use, those terms are defined in Raggad 2010 as follows:

CRM confidentiality

CRM confidentiality aims at preventing CRM information leakage to unauthorized recipients. For example, in order to protect CRM confidentiality in customers' online sessions, the transmission of their purchase orders has to be encrypted. In fact, any data store that is part of the CRM system has to be encrypted and/or adequately secured. Confidentiality may be violated, for example, if customer orders are placed over the phone or using a fax line. The inappropriate disposal of a CRM document that has sales information is another form of breaching of confidentiality.

CRM integrity

CRM integrity aims at preventing information corruption in a CRM system. Corruption is the unauthorized modification of information by an agent, whether it is human or automatic. This agent can be a person, a virus, a process, or a system. For example, an intruder obtains access to a customer's record and modify his/her shipping address. A virus infection can also lead to information

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corruption if a CRM file or one of its records is modified or deleted.

CRM availability

CRM availability aims at making CRM information available to users as stated in the security policy of the information resource where it resides. This requires however that all CRM components that are needed to produce CRM information function as stated in the CRM system's security policy.

3. Security goals vs business goals

Almost all the literature (Layton, 2007), and most companies, have accepted that security goals are what matters and the only security goals they adopted are those constituting the CIA triad: confidentiality, integrity, and availability defined earlier.

As in Raggad 2010, along with the CIA triad, the community of security consumers found out they cannot do much without additional security requirements like authentication, needed for access control, and non-repudiation, needed to assert the origins of transmissions. For example, If you are managing a CRM system, what good does confidentiality do to you if the online orders that are encrypted to assure their confidentiality are intercepted on their way to you. A missing patch in the CRM software may be to blame, but you just lost sales despite confidentiality! What good does integrity do to you if the online orders that are encrypted to assure their integrity get lost on their way to you? A computer virus may be to blame, but you just lost sales despite data integrity. What good does availability do to you if all CRM servers connected to your decision support system are 100% available if the online orders disappear before they get to you? Faulty software may be to blame, but you just lost sales despite availability! Well, what good have all those security goals of the CIA triad done to you when you continue to lose business despite the presence of all those security goals?

This example should be sufficient to assert that achieving CRM security goals may not necessarily lead to the achieving CRM business objectives. There is certainly a faulty connection somewhere between security goals and business goals. May be the security goals in the CIA triad have to be rewritten in terms of business goals? Adopting a goal-driven security model alone may be bothersome because achieving your security goals may not always agree with the achieving of your business goals. What would happen when the CIA triad security goals are achieved as prescribed but other undesired incidents with catastrophic consequences due to threats related to the design of the CRM system itself?

In this article, we propose a CRM specificity enhancer (CSE) capable of information assurance through specifying customers' evidence, partitioning customers based on their nonspecific attributes and nonspecific purchase behaviors, and by minimizing information conflicts in strategic marketing information generated by the CRM system when making marketing offers to targeted customer groups.

CRM information assurance, through the CSE model, achieves information confidentiality, data integrity, and system availability. Because information inconsistencies are a great source of information corruption, then CRM integrity will be enhanced by minimizing information conflicts found in customers segmentation and by preventing customers with conflicts in their attributes or purchase behaviors reside in the same customer groups and thus obtaining the same marketing offers.

CRM systems without enhanced specificity cannot generate accurate decision support information that the marketing management team can use to match the available marketing offers to the customers with the most appropriate attributes. Unfortunately, in the absence of such a capability then marketing management cannot target the right customers and may hence rely of junk mail and spam to reach more customers. However the more untargeted marketing offers are sent through spam or junk mail the more company information is leaked to the external world. Leaking valuable information about a company's marketing product and strategies violates the confidentiality security goal set by the CRM security policy. General security controls that apply to all components of the CRM system, including CRM people, CRM activities, CRM data, CRM technology, and CRM network are well specified in NIST SP 800-53 and NIST SP 800-18.

Moreover, because the CSE model works in a real time manner by classifying new customers as they arrive, any denial of service by some components of the CRM system will not oblige customers to reject marketing offers but will instead default to the last marketing offers communicated to marketing management before the CRM system is affected by the denial of service incident.

4. The CRM specificity enhancer

As in Schubert (1993), when simultaneously reasoning with evidences about several different marketing offers it is necessary to separate the evidence according to marketing offers. These marketing offers should then be handled independently. However, when propositions of evidences associated with customers' marketing behaviors are weakly specified in the sense that it may not be certain to which marketing offer they are referring to, this may not be directly possible. In this paper a criterion, called metaconflict, for partitioning CRM evidences into subsets

representing different marketing offers is established. This criterion, derived from the conflict within each group, involves minimizing a criterion function for the overall conflict of the customer segmentation/partition. We use Schubert algorithm for partitioning evidence.

5. Metaconflict is evidence on evidence

The customer evidence is partitioned as shown in Figure 1 based on a minimization criterion. Most often, for every customer segment/group there is a fixed cost per group in addition to internal costs of managing the customers in one group. This latter cost is internal for a grup and depends on the size of the group. In this article we assume the F is a fixed cost for managing a customer group, and fi is the cost per customer in group gi. That is, if we have 2 customer segments g1 and g2 with sizes respectively equal to n1 and n2, then the total cost to manage the segmentation of customers will be equal to 2F + n1f1 + n2 f2.

Of course, if F is gets very high then too many customer segments won't be so profitable because it will be costly but at the sime time a smaller number of groups will produce more conflicts.

For now, we assume that F=0 so we can only be concerned about the production of a good partition process, one that minimizes evidential conflicts throughout customer segments. In this case, we use the metaconflict criterion, as in Schubert (1993) to represent all types of conflicts in the partition process. In Figure 1, several pieces of evidence are assigned to a small number of customer groups. The 11 pieces of evidence are partitioned into 3 customer groups. Of course the number of marketing offers is uncertain and hence the number of customer groups. The partition is simply the distribution of customer evidence into several subsets delineating well defined marketing offers characterizing customer groups. As in Schubert 1993, the number of marketing offers is uncertain and there will also be a "domain conflict" c0 which is a conflict between the current number of groups and marketing management prior knowledge. The partition will be then simply an allocation of all customer evidence to the different groups characterized by well defined marketing offers. Even if we know the number of marketing offers and their groups it is still uncertain where to place individual customers due to their nonspecific purchasing behaviors.

That is, given the uncertainty associated with both customer attributes and their purchasing behaviors, we can use the conflict in Dempster's rule (Shafer 1976; Smets & Kennes, 1994) when all evidence pieces within a group are combined, to see to what extent those pieces of evidence actually belong together. The higher this conflict is, the less credible that they belong together. Schubert introduced an additional piece of evidence for each group where the proposition of this additional evidence states that this is not an "adequate partition". This proposition takes a value equal to the conflict of the combination within the group. These pieces of evidence express the reason about the partitioning of the original evidence. Shubert (1993) call these pieces of evidence "metalevel evidence," and this support is called the "metaconflict". The smaller this support is, the more credible the partitioning. Thus, the most credible partitioning is the one that minimizes the metaconflict.

Of course we should not consider any

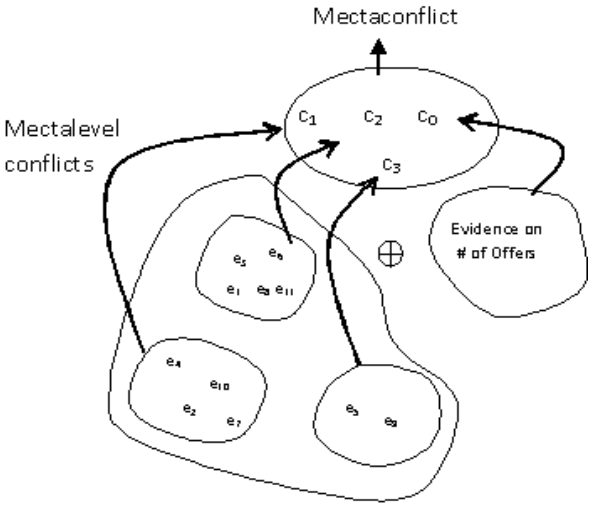

Figure 1: Metaconflict and evidence combination in Schubert partition

solutions with fewer than r segments when the basic probability number for r marketing offers is greater than the basic probability number for fewer offers as declared in the marketing management subjective prior knowledge. As shown in Schubert 1993, these solutions need never be considered because the nondomain part of the metaconflict function always increases with fewer subsets and when the basic probability number for fewer subsets is smaller than the basic probability number for r subsets, then the domain part of the metaconflict function for fewer subsets has also increased, yielding an overall increase in the metaconflict. We can then depict the variation of the metaconflict in terms of the number of marketing offers as in Figure 2.

Let us assume that we have N customers ei, i=1,N. For our CRM, each customer ei, i=1,N is represented by two components of evidence Ei and Ai. The components Ei contains evidence on the customer segment; and the component Ai evidence on customer's actions. The segment component describes the class defining the common needs of customers in this segment. For example, in a given campus, the student segment represents students' needs while the faculty segment defines faculty needs.

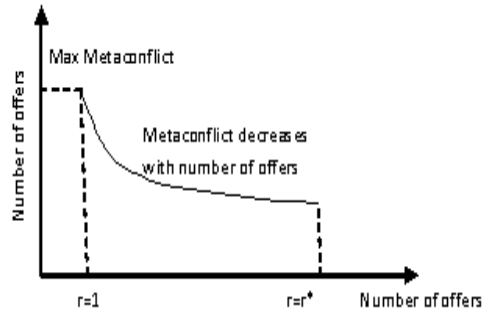

Figure 2: Metaconflic decreases when the number of offers increase

Of course, this example has specific evidence and customer groups are easily known, but our article is dealing with nonspecific evidence in customer attributes and we cannot directly and that easily know the customer groups. The action component describes customer's purchase behavior. Note that while segments do not overlap, conflict is possible, for example, teaching students may belong to both student or faculty segments. Also actions may be similar among different segments, for example, a faculty member and a student, even though residing in different segments, may show similar purchasing habits.

Consider then N customers ei, i=1,N that we intend to partition into m different segments based on evidence available in their segment components. The number of segments m is estimated based on some prior knowledge provided by the marketing management team in terms of a probability distribution {(r, p(r); r=1,M}. We can then write ei=(Ei, Ai), i=1,N where Ei is a vector representing selected customer attributes and where Ai provides a bba on some frame of discernment relevant to the customer purchasing behavior being studied.

The evidence in Ei is on customer attributes and is interpreted by the marketing management team or any computer program made for this purpose to produce a list possible segments Sj, j=1,i1 where customer ei may reside. On the other hand, a frame of discernment Ωi is defined for the action component Ai which includes a bba defined on Ωi. Table 1 provides an example:

Table 1: Example of customer evidence

Customer e1	***Customer e2***
Segment component: S1	Segment component: S1, S2
Action component: Ω1={Low Frequency, Moderate Frequency, High Frequency} m1({Moderate Frequency})=,6 m1(Ω1)=.4	Action component: Ω2={Low Value, High Value} m1({High Frequency})=,3 m1(Ω1)=.7

6. Segmentation Partition

The segmentation partition is performed based on the prior knowledge expressing the size of the partition and the evidence provided by the segment component of a candidate customer. In the absence of our specificity enhancer, marketing management has to rely on their subjective judgment. That is, management will decide the size of the partition by taking the size r* that has the highest probability value $p(r^*) \geq p(r)$ for all r=1,M. Customers are then taken one by one and placed in one of the segments S1, i=1,r*. The evidence in ei is studied and one segment is selected to include customer ei. Figure 3 depicts the working of the segmentation process.

After assigning, in a first round, all customers ei, i=1,N into segments Sj, j=1,m, we now have a partition of m segments populated with customers. If we consider two customers ei1 and ei2 in the same segment Si, there are two possible conflicts generated by the presence of the two customers in the same segment: the first conflict is associated with the evidence presented by the segment components Ei1 and Ei2 due to the fact that the two customers may better belong to two different segments; and the second conflict is associated with the evidence presented by the action components Ai1 and Ai2 due to the fact that the two customers may present different purchasing behaviors even though they both belong to the same segment Si. As you can see, without a specificity enhancer embedded in our partition process the results may be very arbitrary because customers are assigned to marketing offers that do not match their attributes.

The goodness of the partition obviously depends on the goodness of two decisions we have made: the selection of r* representing the size of the partition based on marketing management prior knowledge, and the decisions of assigning each customer based on the evidence presented by customers' action components. The overall goodness of the partition is represented by the plausibility that the partition is correct and this is called, as in Shubert (193), the metaconflict of the partition. The internal conflict in each segment is called the metalevel conflict or the metalevel evidence against the partitioning of the evidence e={ei, i=1,N} into the segments Si, i=1,m.

We introduce a simple frame of discernment, as in Shubert (1993), Ω={GP, BP}, where GP means good partition and BP bad partition. For every segment Si we define a basic belief assignment (bba) expressing support to the conflict yielding a bad partition as follows:

mSi (BP) = total conflict in Si
mSi (Ωi) = 1- mSi (BP)
Ωi= Ω

The total internal conflict is computed as Dempster's k when all the action components are combined.

We also have a bba on the probability distribution's domain D={r, r=1,M} conflicting with the actual size of

the partition r* used in the partitioning process. This bba assigns support to a proposition against the partitioning process:
mD(BP) = total conflict between D and r*
mD(Ω) = 1 – mD(BP).
The combination of the bba's above determine the plausibility of the goodness of the partition as follows:
Pl(GP) = (1- mD(BP))∏i=1,r* (1- mSi (BP)).
The metaconflict mc of the partitioning process becomes then 1 minus the plausibility of the goodness of the partition, computed as follows:
mc = 1- (1- mD(BP))∏i=1,r* (1- mSi (BP)).
The metaconflict mc can then be computed as mc = 1-(1-c0))∏i=1,r* (1-ci) where

c0 = ∑r≠r* p(r) and
ci = ∑^xi=ø ∏i=1,r* mSi (xi)
xi ε {GP, BP, Ω}
^: Intersection.

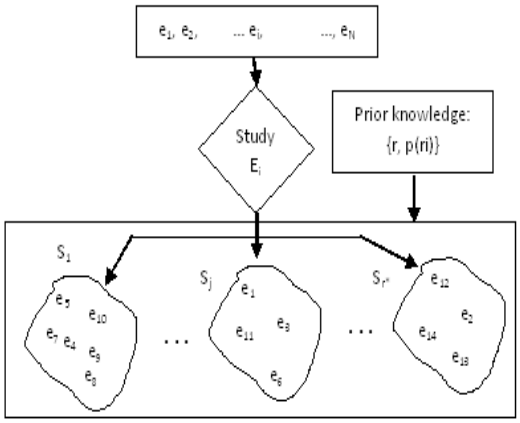

Figure 3: Customer Partition in groups/segments

7. Business value generation

Every coming customer comes with a demand di, i-1,N. Marketing management will use the decision support information generated by the CRM to propose the most appropriate marketing offer to the customer. The marketing offer should be designed in a way to fully satisfy customer demand d_i. Unfortunately, because of nonspecifity characterizing the customer's attributes and its purchasing behavior conflict will be always present in the customer segment where this customer is assigned. If s_i is the customer segment for e_i, then only a fraction of customer demand equal to $c(s_i)*d_i$ can be satisfied where $c(s_i)$ is the conflict resulting from assigning customer e_i to group s_i.

That is, after using Schubert's partition algorithm to compute the optimal number r* of marketing offers, i.e., the number of customer groups, we obtain r* customer groups $\{g_j, j=1,r^*\}$. The total revenues generated by customer segmentation is computed as follows:

$$R = \sum_{i=1,N} c(s_i)d_i$$

A customer segmentation often involves a fixed cost F for every segment and an internal cost in every segment g_j denoted as f_j, $j=1,r^*$ that depends on the size of segment. That is the total cost is computed as follows;

$$C = r^*F + \sum_{j=1,r^*} f_j|g_j|.$$

That is, CRM profitability after enhancing CRM specificity is obtained as follows:

P = R – C =
∑i=1,N c(si)di - r*F - ∑j=1,r* fj|gj|.

Unfortunately, the Schubert algorithm does not take into account of the segment's fixed cost F. That is, if F is very high then despite the minimization of the metaconflict which leads to satisfying customers to the most possible extent, the high value F makes it unprofitable proposing the optimal marketing offers generated by the CRM. However, this problem can be easily solved when we replace the metaconflict criterion in Schubert algorithm by the metaconflict divided by CRM profitability. The new criterion then becomes as follows:
Minimization Criterion =
Metaconflict / CRM profitability
= 1- (1- mD(BP))∏i=1,r* (1- mSi (BP)) / ∑i=1,N c(si)di - r*F - ∑j=1,r* fj|gj|.

8. Numerical example

Let us provide a simple example of a cell phone provider and where we have evidence about 4 customers with nonspecific evidence on their attributes and on their purchase behaviors. Let us also assume that marketing management thinks that two marketing offers {Offer 1, Offer 2} may be induced through subjective judgment based on their knowledge experience. Also assume that we currently have available four product features characterizing customer purchasing behaviors Ω={B1:Interested in Family Plan, B2: Interested in Text Messaging, B3:Interested in Internet, B4: Interested in International Package}. Customer nonspecific evidence is provided as follows:
e1: E1={Offer 1}; {A1: m({B1,B4}=.8; m(Ω)=.2}
e2: {E2 ={Offer 1, Offer 2}; {A2: m({B1, B4)=.7; m(Ω)=.3}}

e3: {E3={Offer 2}; {A3: m({B3})=.6; m(Ω)=.4}}
e4: {E4={Offer 1, Offer 2}; {A4: m({B1})=.5; m(Ω)=.5}}
Let us also assume that marketing management holds the following prior knowledge:{ p(r=1) =.6; p(r=2)=.4; p(r>2)=0}.
Applying Schubert algorithm (Schubert 1993) without taking into account of CRM profitability produces two customers segments g1={e2, e3} and g2={e1, e4}. For a small fixed segment cost F, Schubert algorithm gives the same partition, but when F is sufficiently high less segments are produced; in this example, only one offer is proposed to all four customers.

9. Conclusion

We proposed a CRM specificity enhancer (CSE) capable of information assurance through specifying CRM evidence. We used Dempster and Shafer's theory to process nonspecific customers' attributes and their nonspecific purchase behaviors collected by the CRM data and technology components.
The article reduced information inconsistencies which are a great source of information corruption by enforcing CRM integrity through minimizing information conflicts in the CRM system decision support components. With the CSE there will be no need to engage in spamming or junk mail which will both unnecessarily divulge company confidential information on marketing strategies. Leaking valuable information about a company's marketing product and strategies violates the confidentiality security goal set by the CRM security policy.
Moreover, because the CSE model works in a real time manner by classifying new customers as they arrive, any denial of service by some components of the CRM system will not oblige customers to reject marketing offers but will instead default to the last marketing offers communicated to marketing management before the CRM system is affected by the denial of service incident.

References

[1] Layton, T.P. (2007). Information Security: Design, Implementation, Measurement, and Compliance. Boca Raton, FL: Auerbach publications.

[2] NIST SP 800-18, (2006). Guide for Developing Security Plans for Federal nformation Systems. National Institute of Standards and Technology, USA.

[3] NIST SP 800-37, (2004). Guide for the Security Certification and ccreditation of Federal Information Systems, National Institute of Standards and Technology, USA.

[4] NIST SP 800-53, (2005). Recommended Security Controls for Federal nformation Systems. National Institute of Standards and Technology, USA.

[5] Raggad, B., (2010). Information Security Management: Concepts and Practice, RC Press, New York.

[6] Schubert, J. (1993). On Nonspecific Evidence, International Journal Of Intelligent Systems, Vol. 8, 711-725.

[7] Shafer, G., (1976), A Mathematical Theory of Evidence, Princeton University Press, Princeton, NJ.

[8] Smets, P. and R. Kennes, (1994), The Transferable Belief Model, Artificial Intelligence, vol. 66, pp 191-243.

[9] Swift, R. S. (2001). Accelerating Customer Relationships – Using CRM and Relationship Technologies. Prentice-Hall PTR. P. 480.

[10] Wang, M.L. and K.W. Kang, (2008). Applying Customer Relationship Management on the New Recruiting Force Project -An \ Example of Ministry of National Defense The Journal of Human Resource and Adult Learning, Vol. 4, No. 2.

[11] Wayland, R. E. and Cole., P. M., (1979). Customer Connections: New Strategies For Growth, Harvard Business School Press, Boston, MA