An Architecture for Consumer Support Systems

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Abstract

For enterprises, customer relationships have been commonly recognized as a critical factor to succeed their business. Effective customer relationships could help enterprises deliver services/products to customers based on their needs, preferences, or past transactions. This model however emphasizes on the use of customer information for benefiting enterprises; customers in contrast receive less information from enterprises. To address this issue, a new paradigm, namely Consumer Support Systems (CSS) is initiated to support effective information provision for customers to help on their decision making. In this paper, we present an architecture for the construction of such a new CSS paradigm. The architecture starts from the identification of CSS characteristics, through the recognition of architectural components that support the realization of these issues, and finally ends with the specification of collaborations among architectural components to realize these issues. The architecture is modeled by UML notations and illustrated by an exemplified CSS for book publishing.

Keywords: customer relationship management, consumer support system, architecture, UML

1 Introduction

For enterprises, customer relationships have been commonly recognized as a critical factor to succeed their business. Effective customer relationships could help enterprises deliver services/products to customers based on their needs, preferences, or past transactions. In this context, many strategic/technical discussions have already been presented: (1) Customer Decision Support (CDS) [1,2]; (2) Customer Relationship Management (CRM) [3-6]; (3) Customer Knowledge Management (CKM) [7-13]; (4) Recommendation System [14]; and (5) Intelligent Agent [15].

In general, these approaches focus on using knowledge about or from customers to catch more customer info.; their usefulness on enhancing customer relationships has already been demonstrated [7]. However, in terms of info. flow, these approaches emphasize on collecting customer info. for enterprises where the reverse delivery of info. (i.e., receiving services/products info. from enterprises to benefit customers) is insufficient. This presents a notable problem of information asymmetry that hinders customer relationships since customers have no sufficient services/products information to assist on their decision making about what they really need. To address this problem, a new Consumer Support Systems (CSS) paradigm has been introduced [16] that is structured by a 4-layer framework of collaborative mechanisms to support effective information provision from enterprises to customers. Under its framework, many technical/strategic solutions about the customer decision support can be employed as those in [17-23]. Therefore, there are already many approaches about the structural, strategic, or functional issues for CSS. For its development, nonetheless, any considerations on its architecture and characteristics to provide guidance on its construction are still missing. Such architectural considerations, however, should not be negligible since in our view sound architectures are critical for directing the construction of such new CSS applications.

Thus, we present in this paper an architecture for CSS development that emphasizes on delivering structured services/products information from enterprises to customers based on their needs (e.g., knowledge) to help on their decision making. The architecture starts from the identification of CSS characteristics, through the recognition of architectural components that support the realization of these characteristics, and finally ends with the specification of collaborations among architectural components to realize these characteristics. The architecture is modeled by UML notations [24,25] and illustrated by an exemplified CSS for book publishing.

This paper is organized as follows. Section 2 presents first our architecture that results in the creation of three UML diagrams, including component, class sequence ones. To illustrate, the architecture is applied in Section 3 to the development of CSS for book publishing. Finally, Section 4 has the conclusions and our future work.

2 The architecture

Our architecture elaborates on the following two steps with UML utilized as its modeling tool:

2.1 The architecture identification

The first step is to identify those characteristics to be possessed in CSS. Initially, consider the functionality in CSS [16] with the following issues that should be concerned:

1. Effective services/products info. from various enterprises is needed to support consumer decision making. The information should be structured and comprehensible. Also, it should be comparative for any
desired attributes of these services/products to aid on the analysis and decision making by consumers.

2. To make services/products info. useful for consumers, referencing truly valuable consumer knowledge [11] to capture what consumers really need must be supported for enterprises. In general, capturing truly valuable knowledge from consumers (i.e., residing in themselves) is trust-sensitive, and hence should be served by some independent and reliable agents or organizations (i.e., consumer knowledge agents).

3. Consumers usually make requests for their needs by issuing desired tasks (e.g., buying or selling or renting services/products) in accordance with their knowledge or characteristics. These tasks lead to their awareness of desired service/product attributes which in turn results in the search, recognition, and comparisons of available services/products that exhibit those attributes. To aid on such desired tasks, some task-centered services are required to act as an intermediary between enterprises and consumers. For enterprises, these services help to capture truly valuable knowledge from consumers (in the context of their desired tasks) to provide services/products information useful for these consumers. For consumers, these services help to collect, structure, and evaluate task-desired services/products information from various enterprises, and then present to them for their possible recognition and comparisons. As in above, for reliability, such services should be provided by some independent and reliable marketplaces or organizations (i.e., task service providers).

4. Consumer communities [26-28] are helpful for consumers to share or co-learn information about their desired tasks. It is therefore usually organizing consumers into various communities by their common interests or personal characteristics. Each community relates consumers to their desired tasks for sharing or exchanging information among each other. In addition, each community could provide them with such services as identification and recommendation around cooperative task service providers, and negotiation and cooperation with those service providers selected by them to process their task requests (i.e., return evaluated services/products information relevant to these requests). In general, communities are the last intermediary between consumers and the outside world, and thus are usually supported by some independent or reliable marketplaces or organizations.

To address these issues, the following specifics about CSS can then be identified:

1. Consumers may enroll into communities where they are able to share or co-learn information about their desired tasks for services/products.

2. Such shared or co-learned information can then be re-structured by some consumer knowledge agents into appropriate styles of consumer knowledge which will be captured by enterprises (via task service providers) to provide services/products info useful for these consumers.

3. Through identification and recommendation by communities, consumers select task service providers to which their task requests are issued; communities then negotiate and cooperate with these providers to accomplish these issued task requests.

4. Based upon requests received, task service providers help to collect, structure, and evaluate information about task-desired services/products from various enterprises, and then present (via communities) to consumers for their possible recognition and comparisons. Since task requests lead consumers to be aware of desired service/product attributes, the structured and evaluated services/products information makes them be able to recognize and compare available services/products that exhibit those attributes.

As a result, CSS has the characteristics to be possessed as follows.

1. It is structured into a 4-layer architecture of collaborative mechanisms (i.e., five architectural components as shown in Figure 1) where consumers are no longer interacting directly with enterprises, but via three intermediaries: communities, consumer knowledge agents, and task service providers.

2. It emphasizes on truly valuable customer info. by collecting knowledge from customers (i.e., residing in themselves) to help enterprises catch their needs.

3. It addresses on delivering structured services/products info. from multiple enterprises to help customers make recognition and comparisons.

4. Each of its five architectural components plays a designated role independently from others such that the addition or modification of new components can be easily accomplished for maintenance purposes.

Based on these characteristics and relevant specifics about CSS mentioned above, CSS is designed as shown in the UML package diagram in Figure 1 to address them by the interactions between consumers and enterprises through three intermediaries. The following presents how these five components play their designated roles for participating in CSS.

(I) Consumers

In CSS, consumers may make requests for their needs by issuing desired tasks (e.g., buying, selling, or renting services/products) in accordance with their knowledge or characteristics. To enhance their knowledge about these tasks, they may enroll into various communities through which to share or co-learn information among each other. With such shared or co-learned information, consumers may get more awareness of desired service/product attributes relevant to their tasks. After issuing task requests (via communities), consumers expect to receive information about available services/products that exhibits those attributes. In particular, before presenting to consumers, the services/products information should be collected (by task service providers) from various enterprises, and then structured and evaluated (in terms of desired service/product attributes) to aid consumers on their analysis and decision making.
In summary, these characteristics need to be possessed as the requirements for the Consumers component:

1. **share/co-learn consumer info.** – help to interact with consumers to access information that is shared or co-learned (through communities) among each other.

2. **issue task request** - help to interact with consumers to issue task requests (through communities), and then present desired task-relevant services/products information (from communities).

Based on the above requirements for the Consumers component, as shown in the UML class diagram in Figure 2, three constituents (specified as classes) are imposed where (1) the two ‘Info. manager’ and ‘Task request manager’ constituents are responsible respectively for realizing the two requirements; and (2) the ‘Interface manager’ constituent is employed particularly to assist the interaction with consumers to access their shared or co-learned information and task requests, and then present their desired task-relevant services/products information.

(2) **Communities**

Communities are organized for consumers to share or co-learn their info. about their desired tasks or interested services/products. Consumers may enroll into various communities within which those with common interests or personal characteristics are grouped together for info. sharing or exchanging. Also, communities are also responsible for forwarding such shared or co-learned information to some consumer knowledge agents that re-structure it into appropriate styles of consumer knowledge. Communities then forward the knowledge to cooperative task service providers that will in turn pass it to enterprises for capturing what consumers really need.

Finally, communities provide consumers with services such as identification and recommendation of cooperative task service providers that are capable to accomplish their task requests, and negotiation and cooperation with those service providers selected by them to actually accomplish these requests.

In summary, these characteristics need to be possessed as the requirements for the Communities component:

1. **share/co-learn consumer info.** – help on info. sharing or co-learning among consumers.

2. **process shared/co-learned info.** – forward shared/co-learned info. to consumer knowledge agents that return re-structured knowledge, and then forward the knowledge to cooperative task service providers.

3. **process task request** - receive task requests from and return desired task-relevant services/products information to consumers.

4. **determine task service provider** - identify and recommend cooperative task service providers to be selected by consumers.

5. **cooperate with task service provider** - negotiate and cooperate with those service providers selected by consumers that actually accomplish task requests by returning evaluated services/products information relevant to these requests.

Based on the above requirements for the Communities component, as shown in Figure 2, five constituents are imposed to realize respectively these five requirements. In particular, the ‘Sharing/co-learning manager’ constituent accesses the ‘Shared/co-learned consumer info.’ file for information sharing or co-learning among interested consumers, while the ‘Info. manager’ constituent accesses it to retrieve shared/co-learned info. for re-structuring into comprehensible knowledge by consumer knowledge agents. Further, the ‘Determining manager’ constituent accesses the ‘Cooperative task service provider’ file to identify and recommend cooperative task service providers to be selected by consumers, while the ‘Cooperation manager’ constituent accesses it to negotiate and cooperate with those service providers selected by consumers that actually accomplish task requests by returning evaluated services/products info.

(3) **Consumer Knowledge Agents**

In CSS, information from consumers is critical for enterprises to capture what they really need in order to provide services/products information useful for them. However, such information may initially be unstructured and even, after sharing or co-learning among consumers, complex for usefulness. It is therefore necessary to have a specific mechanism that is responsible for re-structuring it into various comprehensible styles of knowledge (i.e., the five styles of knowledge defined in [11] where information from consumers can be attributed into one or more of these five styles of knowledge) for enterprises to capture what these consumers really need. For this requirement, consumer knowledge agents are imposed to re-structure consumer info. into these comprehensible styles of knowledge.

In summary, these characteristics need to be possessed as the following two requirements for the Consumer Knowledge Agents component:

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**Figure 1** The architecture for consumer support system
1. **process consumer info.** – identify the style(s) of knowledge (i.e., the five styles of knowledge defined in [11] - ‘prosumerism’, ‘team-based co-learning’, ‘mutual innovation’, ‘communities of creation’, and ‘joint intellectual property’) into which consumer info. is categorized to capture truly valuable knowledge from consumers (i.e., residing in themselves)

2. **make five styles of consumer knowledge** - re-structure consumer information into appropriate style(s) of knowledge

Based on the two requirements, as shown in Figure 2, six constituents are imposed to realize these requirements. In particular, each of the lower five constituents is imposed to access a style-specific knowledge file to make the corresponding style of consumer knowledge based on the received shared/co-learned consumer information.

(4) **Task Service Providers**

Task service providers are an important intermediary between enterprises and consumers. For enterprises, they receive re-structured consumer knowledge from communities and forward the task-relevant part of the knowledge to participant enterprises. For consumers, based on the task requests received from communities, they identify and cooperate with those participant enterprises that may provide services/products information desired by those task requests. Furthermore, with the information about task-desired services/products, they also help to structure and evaluate it in a comprehensive and comparative model that is presented to consumers (via communities) to aid on their analysis and decision making.

Thus, these characteristics need to be possessed as the following requirements for the **Task Service Providers**:

1. **process consumer knowledge** - receive re-structured consumer knowledge from communities and forward the task-relevant part of the knowledge to participant enterprises

2. **process task request** - receive task requests from and return evaluated task-desired services/products info. to communities

3. **determine participant enterprise** – identify and select participant enterprises that may provide services/products information demanded by task requests

4. **cooperate with participant enterprise** - negotiate and cooperate with those selected enterprises to actually provide desired task-relevant services/products info.

5. **evaluate services/products info.** - structure and evaluate into a comprehensive and comparative model task-relevant services/products information provided by selected participant enterprises
Based on these five requirements, as shown in Figure 2, five constituents are imposed to realize respectively these requirements. In particular, the ‘Determining manager’ constituent accesses the ‘Participant enterprise’ file to determine those participant enterprises that may provide services/products information desired by task requests, while the ‘Cooperation manager’ constituent accesses it to negotiate cooperate with those selected participant enterprises to provide desired task-relevant services/products info.

(5) Enterprises

Enterprises that participate in CSS may respond to consumer task requests from task service providers with information about services/products that exhibits those attributes desired in these requests. As mentioned above, to make the info. truly useful for consumers, enterprises need to reference the re-structured consumer knowledge received from task service providers within the extent of those tasks requested by these consumers.

In summary, these characteristics need to be possessed as the requirements for the Enterprises component:

1. **process consumer knowledge** – store re-structured consumer knowledge for references to provide info. truly useful for consumers
2. **accomplish task request** - based on the consumer knowledge, accomplish task requests by returning task-desired services/products information

Based on the above two requirements for the Enterprises component, as shown in Figure 2, two constituents are imposed to realize respectively these requirements. In particular, the ‘Consumer knowledge manager’ constituent accesses the ‘Re-structured consumer knowledge’ file to store re-structured knowledge of consumers on which info. about those services/products requested by these consumers is decisively based.

1.2 The collaboration specification

With architectural components identified, it is now good time to create a sequence diagram that specifies how such components collaborate to realize desired requirements. As illustrated in the UML sequence diagram in Figure 3, after a consumer tries to share his/her information through the system, both of the Consumers and Communities components collaborate to help his/her sharing or co-learning purpose with other consumers by accessing all shared/co-learned info. from the ‘Shared/co-learned consumer info.’ file. The shared/co-learned info. is then re-structured into comprehensible knowledge by the Consumer Knowledge Agents component that is in turn forwarded to the Enterprises component (i.e., the participant enterprises) via the Task Service Providers component (i.e., the cooperative task service providers). Finally, the Enterprises component stores the re-structured knowledge in the ‘Re-structured consumer knowledge’ file on which information about those services/products requested by consumers is decisively based.

3. Applying to a CSS for book publishing

Providing customers with services about book publishing is very important for book publishing companies. Many existing companies offer relevant services such as searching, viewing, and ordering books via their own web sites or some intermediary agents (e.g., Amazon). However, these ordinary functions are not sufficient for many customers who desire more sophisticated services (e.g., knowledge-based decision support) for their advanced purposes such as publishing new books after sharing and learning related experiences with other customers. For these limits, we present in this section how such knowledge-based decision support functions can be realized in our architecture.

3.1 The CSS Requirements for Book Publishing

In our example, possible prospective customers like teachers may desire sophisticated knowledge-based decision support services about book publishing after sharing and learning related experiences with other colleagues. Therefore, four functions below are often necessary to satisfy their needs:

1. **share book writing experiences**: a teacher shares book writing experiences with other teachers.
2. **share book organizing thoughts**: a teacher shares book organizing thoughts with other interested teachers.

With knowledge-based functions, the following specifics about CSS for book publishing can be identified:

1. **The teacher and other interested ones** may enroll into an education community where they are able to share or co-learn experiences about their book writing and organizing purposes.
2. These shared or co-learned experiences can be re-structured by a teacher knowledge agent into certain style(s) of knowledge to be captured by a book publisher (via a book publishing service provider in the book publishing extent) that provides book publishing information useful for these teachers.
3. Through identification and recommendation by the education community, the teacher issues a book writing and organizing request to a book publishing service provider selected by him/her, and the education community is then responsible for negotiation and cooperation with the book publishing service provider to accomplish this issued book writing and organizing task.

Based upon the book writing and organizing request, the book publishing service provider helps to collect, structure and evaluate information about book writing and organizing from the book publisher that is then presented (via the education community) to the teacher for his/her recognition and comparisons. Since the book writing and organizing request can lead the teacher to be aware of desired book publishing
attributes (e.g., authoring chapters, structuring contents, and status tracking of the publishing process), the structured and evaluated information about book publishing makes him/her be able to recognize and compare available book publishing services by the book publisher that exhibit those attributes.

As a result, CSS for book publishing has the following characteristics to be possessed.

1. It is structured into a 4-layer of collaborative mechanisms (i.e., five architectural components) where a teacher is no longer interacting directly with a book publisher, but through such intermediaries as an education community, a teacher knowledge agent, and a book publishing service provider.

2. It emphasizes on collecting experiences/thoughts about book writing and organizing by helping teachers to share or co-learn them among each other and then re-structuring them into certain style(s) of knowledge for the book publisher to catch the teacher’s needs.

3. It addresses on delivering structured information about book publishing from the book publisher to help the teacher to make possible recognition and comparisons.

Based on these characteristics and relevant specifics mentioned above, CSS for book publishing is thus designed as shown in Figure 4 to support interactions between the teacher and the book publisher via three intermediaries.

3.2 The CSS Architecture for Book Publishing

In CSS for book publishing, a teacher issues a book publishing request via an education community to acquire from a book publisher information about book publishing that is collected and evaluated by his/her selected book publishing service provider. In particular, bi-directional information flows between the teacher and the book publisher where (1) experiences/thoughts shared or co-learned among the teacher and other colleagues in the community is re-structured into various styles of teacher knowledge to be collected by the book publisher (via the book publishing service provider), and (2) along the reversed way, information about book publishing from the book publisher is structured and evaluated by the book publishing service provider for possible recognition and comparisons (via the community) by the teacher. Therefore, based on the generic CSS architecture in Figure 1, the CSS architecture for book publishing has the same five constituents as those in Figure 2.

3.3 modeling CSS behavior for book publishing by the sequence diagram

With components identified, it is now good time to create a sequence diagram that specifies how such components collaborate to realize the teacher’s needs. As shown in Figure 5

Figure 3: the object sequence diagram for consumer info/knowledge management

Figure 4: the CSS architecture for book publishing
4 conclusions and future work

In this paper, we present an architecture for the construction of a CSS. Our architecture addresses first on the identification of CSS characteristics. After identifying desired characteristics, the architectural components for CSS are specified in the second step to support the realization of these characteristics. For CSS, the architecture focuses on the achievement of these characteristics by imposing components that support both of the information from consumers to enterprises (i.e., for enterprises, capturing knowledge from consumers) and the reverse delivery of information from enterprises to consumers (i.e., for consumers, receiving services/products information from enterprises). As a common expectation, such a symmetric information flow could make enterprises enhance customer relationships by providing customers with sufficient information to aid on their decision making about their needs. After identifying architectural components, collaborations among these components to actually realize all desired characteristics are then specified.

For illustration, our architecture is applied to the development of a CSS for book publishing. Information about book publishing is shared or co-learned among teachers before they issue book publishing requests to book publishers. The shared or co-learned information is specifically re-structured into various styles of teacher knowledge on which information provided by these book publishers is decisively based. After then, whenever the teacher submits a book publishing request, the CSS could help him/her recognize and compare information from book publishers by structuring and evaluating the information before presenting it to him/her.

In general, many existing approaches to enhance customer relationships have been discussed for their disadvantages; mainly, they emphasize on the information from customers to enterprises where the reverse delivery of information is somehow insufficient, and hence results in a notable problem of information asymmetry that hinders their effectiveness. For this situation, CSS is specifically structured in recent years to support an effective bi-directional information flow between consumers and enterprises. For such a newly proposed CSS paradigm, nonetheless, any considerations on its architecture and characteristics to provide guidance on its construction are still missing. Such architectural considerations, however, should not be negligible since in our view sound architectures are critical for directing the construction of such new CSS applications. Our work presents a possible discussion on this subject.

As our future work, we will continue to explore the real application of our architecture on the book publishing domain. We will also study its application on other kinds of CSS including for instance services-oriented systems that provide customers with value-added services after their decision
making. As one may conceive, while developing these systems, experiences about the application can be correspondingly collected for validating the usefulness and effectiveness of our architecture. In fact, with our top-down fashion steps for precisely identifying and realizing desired features, the quality of these systems for customers can be expected. Thereafter, in addition to CSS, we will look also forward to the practical use of our work in other application domains like executive information systems; the usability of our incremental steps in modeling such decision support systems will be carefully experienced.

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