A Consumer Support Architecture for Enhancing Customer Relationships

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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, such technologies have been proposed as recommendation systems and intelligent agents that provide customers with more sufficient information for their possible needs/helps. These technologies, nevertheless, have still some shortcomings that initiate the recent discussion of a new paradigm, namely Consumer Support Systems (CSS). CSS is specifically structured to support effective information provision from enterprises to consumers where sophisticated information management mechanisms are necessarily employed to help on consumer decision making. In this paper, we present an architecture for the construction of such a new CSS paradigm that provides an advanced management of customer relationships by emphasizing on the information provision from enterprises to consumers. 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 a 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 [14-16]; and (5) Intelligent Agent [17,18]. In general, these approaches focus on using knowledge about customers (e.g., characteristics or preferences derived from their past transactions) or knowledge from customers (i.e., knowledge residing in themselves) to catch more customer information; their usefulness on enhancing customer relationships has already been demonstrated [7]. Nonetheless, several limitations or shortcomings can still be found:

1. CDS does not address the compiling (e.g., extracting or filtering) of services/products info. from various enterprises such that customers often receive massive and unstructured distributions and therefore be difficult on their decision making.
2. CRM does not capture truly valuable customer information due to its focusing customer knowledge on previous transactions [11]. Also, it focuses on individual enterprises and hence is not effective on collecting services/products information from multiple enterprises.
3. CKM emphasizes on truly valuable customer info. by capturing knowledge from customers (i.e., residing in themselves). However, as in CRM, it addresses on individual enterprises and hence is not effective on delivering services/products info. from various enterprises to customers.
4. Recommendation System delivers services/products information from multiple enterprises to customers based on their preferences. However, as in CRM, it relies primarily on past transactions and thus is difficult to catch what customers really need by capturing truly valuable customer information.

5. Intelligent Agent serves individual customers based on their detailed information. However, as in CDS, it does not support the compiling of services/products info. from various enterprises for an effective aid on the decision making process of individual customers.

In addition, from the viewpoint of information flow, these approaches emphasize mainly on collecting customer info. for enterprises (i.e., capturing knowledge about/from customers for enterprises) where the reverse delivery of information (i.e., receiving services/products info. from enterprises to benefit customers) is somehow insufficient. This presents a notable problem of information asymmetry that hurdles 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 [19] 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 [20-26]. 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 [27,28] and illustrated by an exemplified CSS for book publishing.

This paper is organized as follows. Section 2 presents our architecture that results in the creation of two UML diagrams, including component and 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:
1. **Architectural identification** with a component diagram that determines architectural components to support the realization of identified CSS characteristics.
2. **Collaboration Specification** with a sequence diagram that specifies collaborations among architectural components to realize desired CSS characteristics.

2.1 The architecture identification

The first step is to identify those characteristics to be possessed in CSS. Initially, consider the functionality in CSS [19], the following issues about CSS should be concerned:

1. Effective services/products info. from various enterprises is needed to support consumer decision making. The information should be structured and easily comprehended. Also, it needs to 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 services/products) according to 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 [29-31] 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 and/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.

5. 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 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.
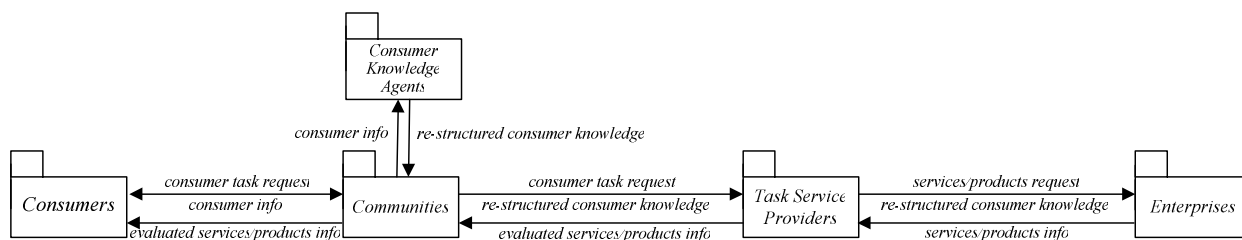
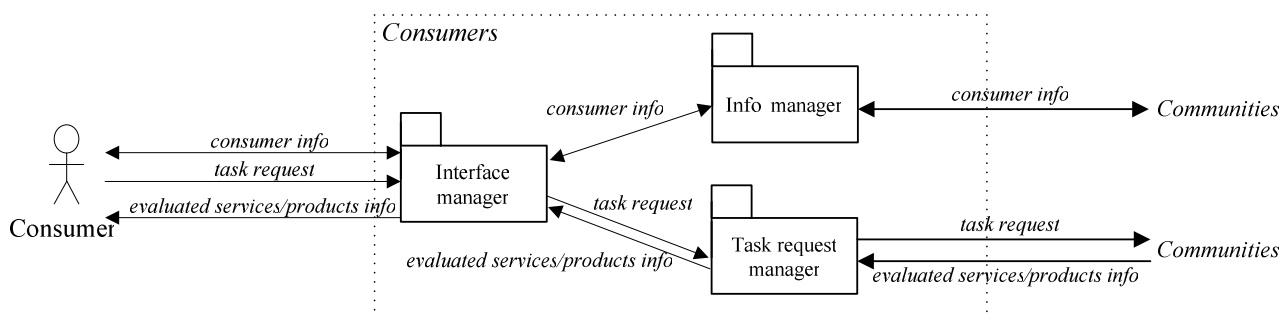Figure 1 the architecture for consumer support system

Figure 2: the *Consumers* component for consumer support system

(1) 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, Figure 2 shows its constituents that collaborate to achieve its responsibilities. As shown in the figure, three constituents 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 products/services information.

(2) Communities

Communities are organized for consumers to share or co-learn their information 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 information sharing or exchanging. Also, communities are also responsible for forwarding such shared or co-learned
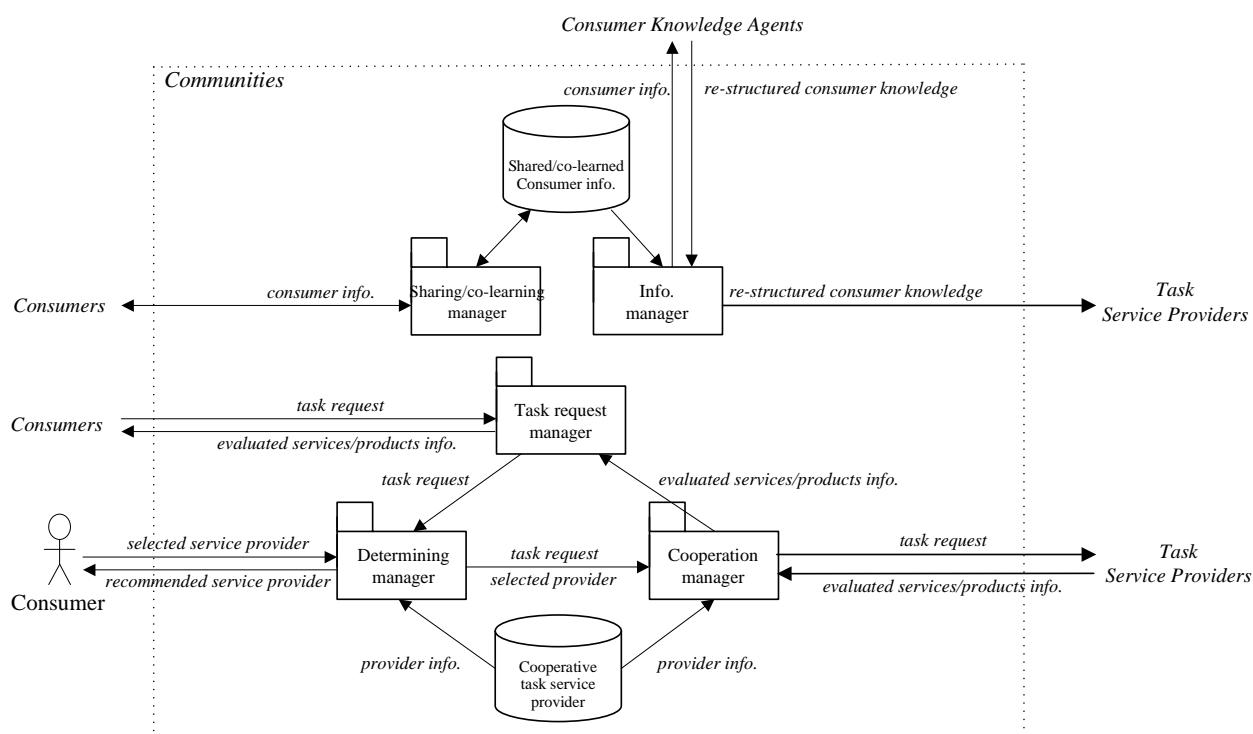
Figure 3: the *Communities* component for consumer support system

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
also provide consumers with such services as
identification and recommendation of cooperative
task service providers that are capable of
accomplishing 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, Figure 3 shows its five constituents that
realize respectively the 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 information 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
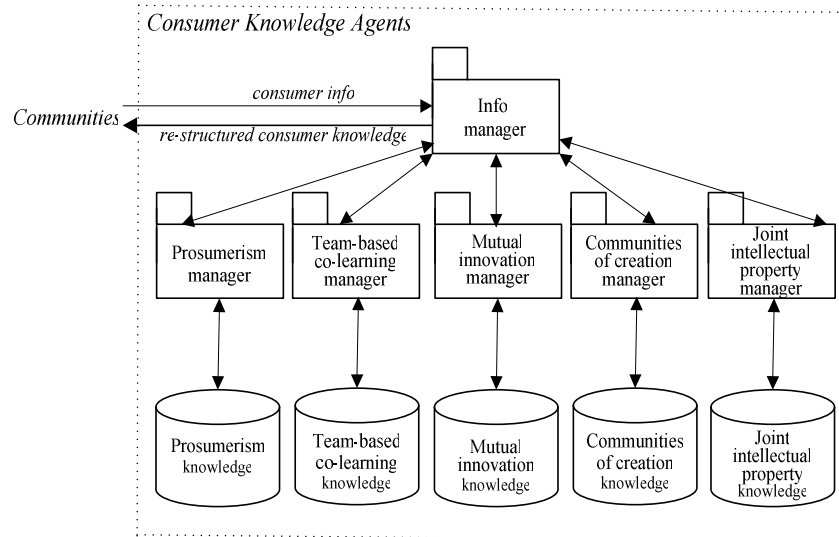returning evaluated services/products info.

Figure 4: the *Consumer Knowledge Agents* component for consumer support system

(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 truly 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:
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 these two requirements, Figure 4 shows the constituents that collaborate to achieve its responsibilities. As shown in the figure, six constituents are imposed to realize the two 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, based on the task-relevant extent, forward the task-relevant part of that knowledge to the participant enterprises that utilize it to provide services/products information useful for consumers. 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 these 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*:
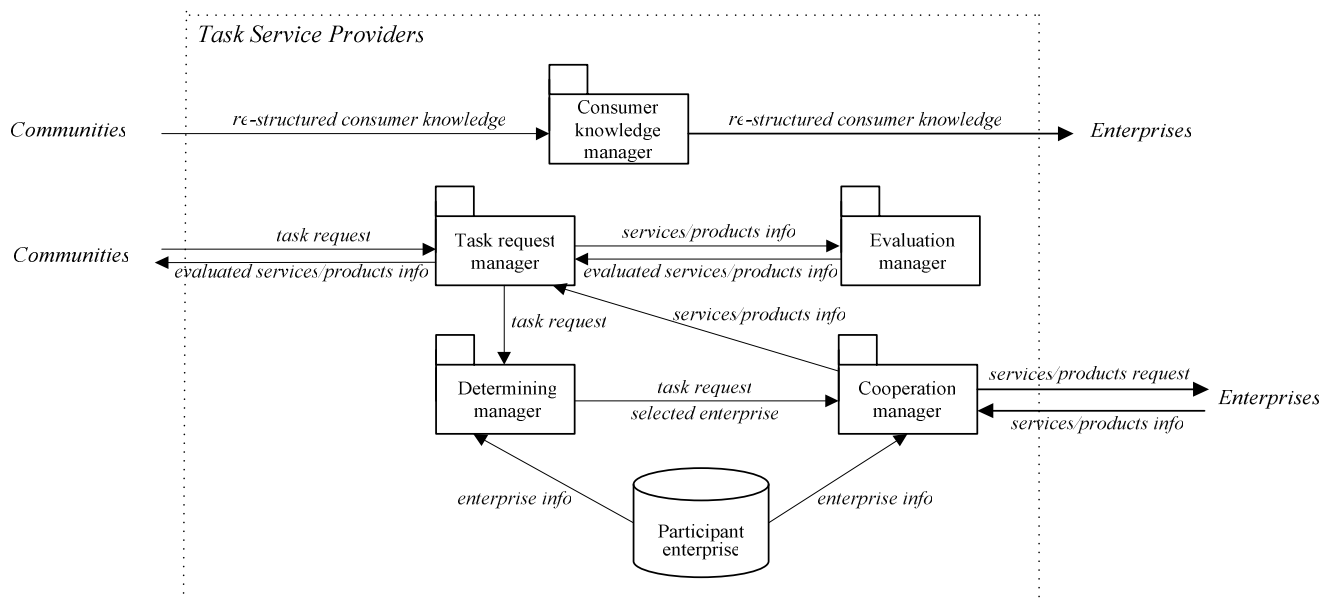
Figure 5: the *Task Service Providers* component for consumer support system

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 provide services/ products information desired 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 info. provided by selected participant enterprises

Based on these five requirements, Figure 5 shows the constituents that collaborate to achieve its responsibilities. As shown in the figure, five constituents are imposed to realize respectively these requirements. Particularly, 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.
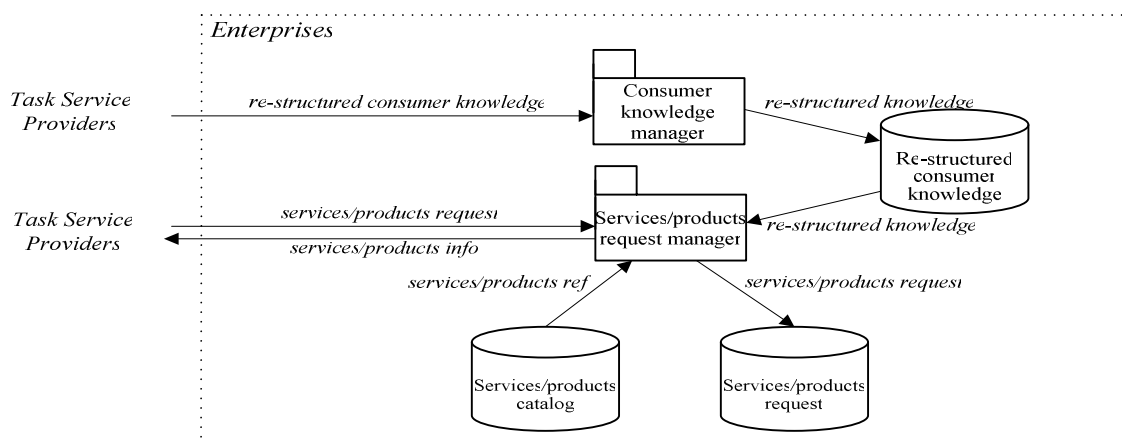
(5) Enterprises

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 requirements for the *Enterprises* component, Figure 6 shows its respective constituents that realize the two requirements. Particularly, 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.

Figure 6: the *Enterprises* component for consumer support system

2.2 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 Figure 7.a, after a consumer tries to share his/her info. 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. In addition, as illustrated in Figure 7.b, after a consumer requests a task through the system, both of the *Consumers* and *Communities* components collaborate to determine which task service providers are cooperative for him/her to process the request. With a selection by the consumer, the *Communities* component forwards the request to the *Task Service Providers* component (i.e., the selected task service providers). After determining participant enterprises, the *Task Service Providers* component forwards then the request to these enterprises (i.e., the *Enterprises* component) that return desirable task-relevant services/products information based on the re-structured knowledge stored in the 'Re-structured consumer knowledge' file.

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.
3. ***write a new book***: a teacher writes a new book by authoring chapters and preparing art work of the book.
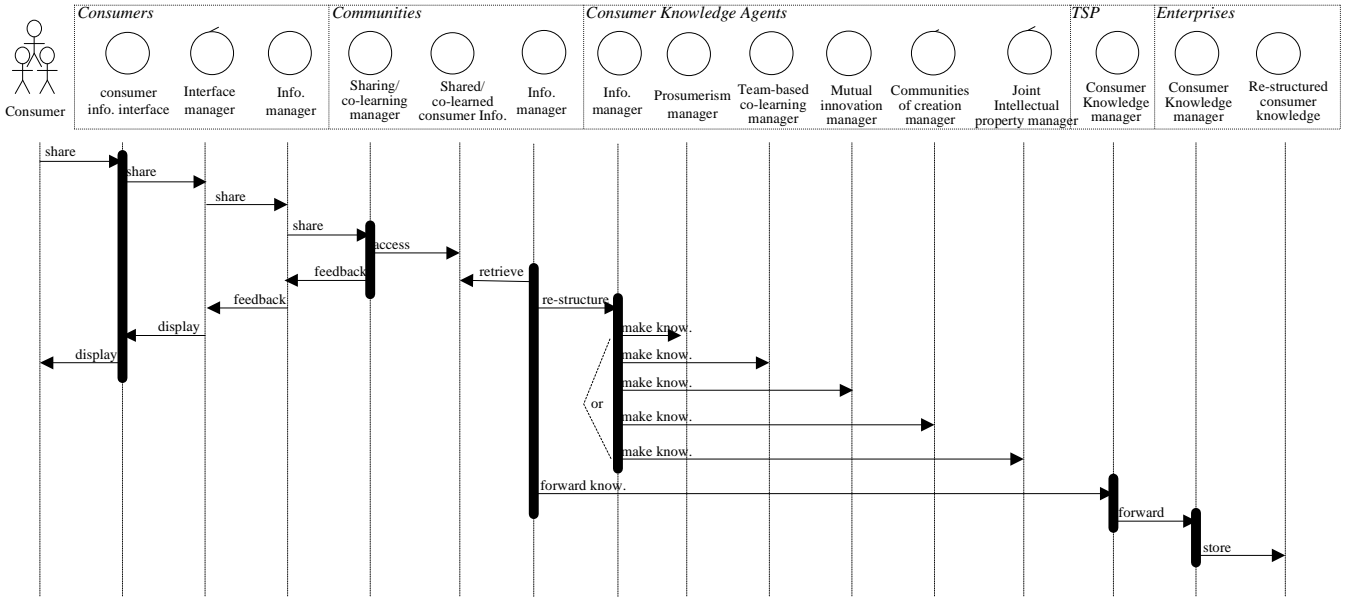4. ***organize a new book***: a teacher organizes a new book by structuring contents of the book.

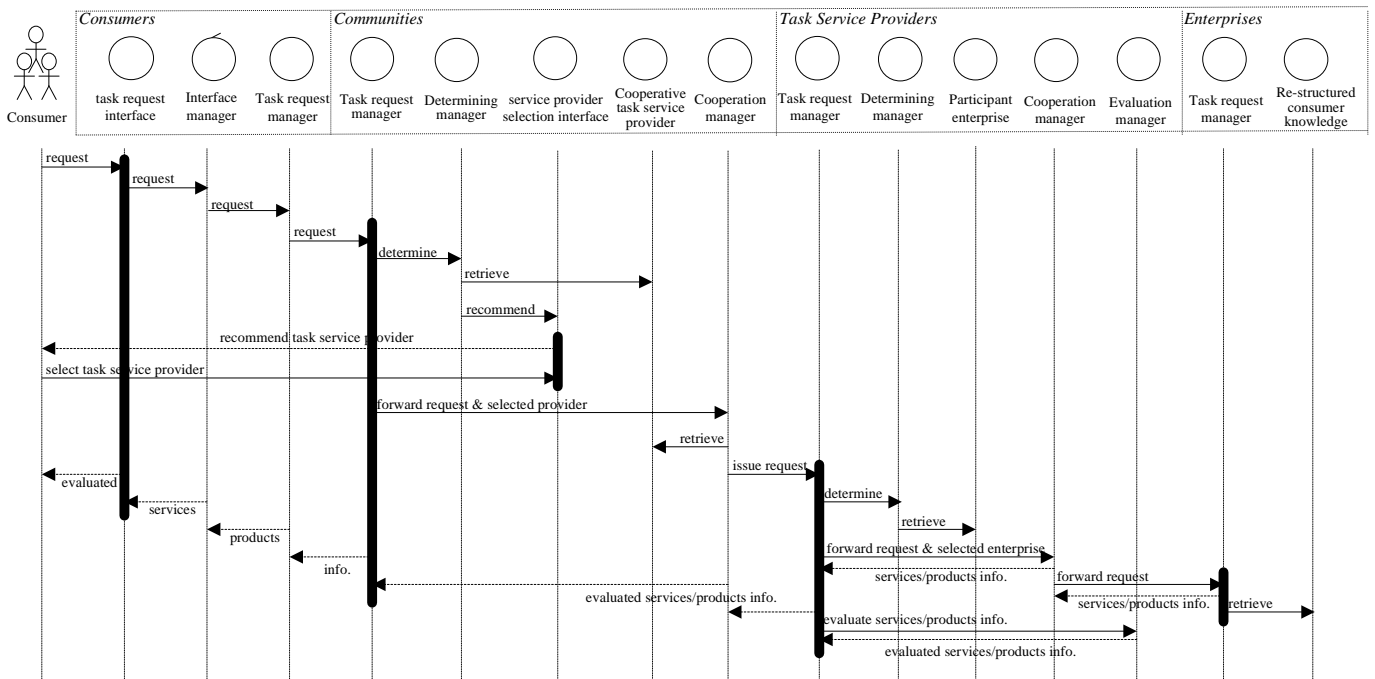Figure 7.a: the sequence diagram for consumer info./knowledge management

Figure 7.b: the object sequence diagram for service provision of consumer task request
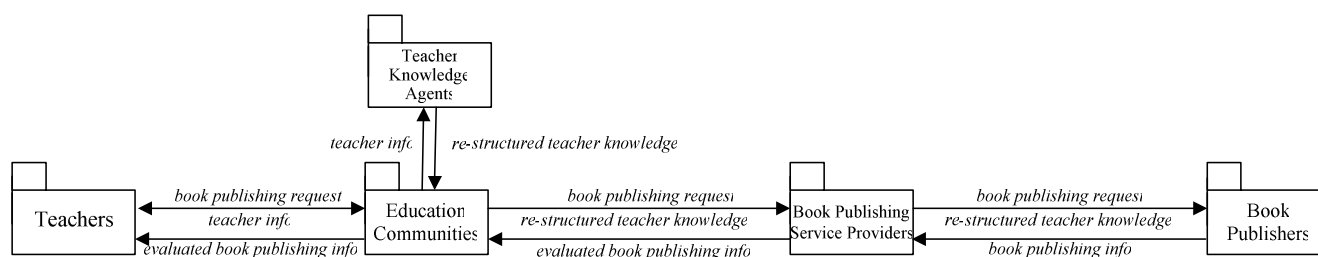
Figure 8 the CSS architecture for book publishing

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.

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, Figure 8 shows the CSS architecture for book publishing with five components (note that as one may conceive, these components would have the same constituents as those among Figures 2 – 6).
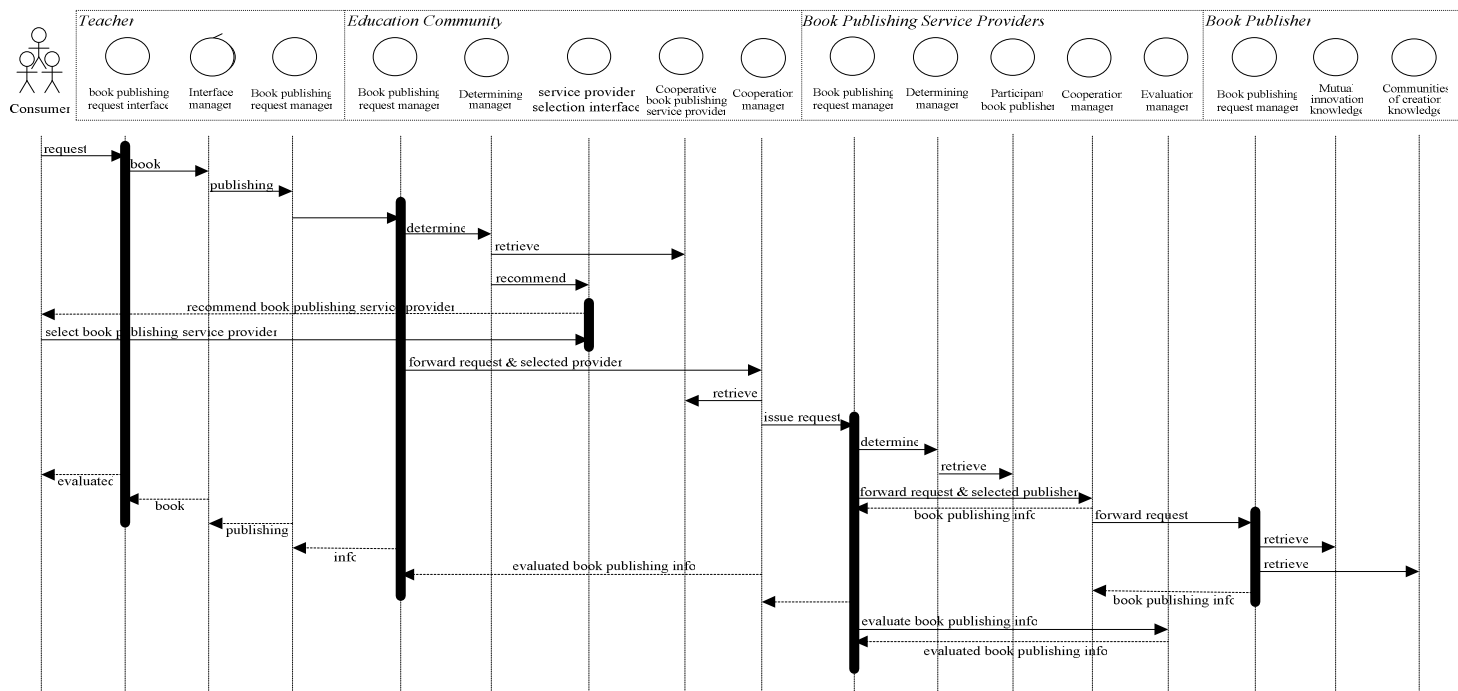
Figure 9: the sequence diagram for service provision of book publishing request

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 illustrated in Figure 9, with the teacher trying to submit a book publishing request through the system, both of the *Teacher* and *Education Community* components collaborate to determine which book publishing service providers are cooperative for him/her to process the request. With a selection by the teacher, the *Education Community* component forwards the request to the *Book Publishing Service Provider* component (i.e., the selected book publishing service provider). With the participant book publisher determined, the *Book Publishing Service Provider* component forwards the request to the publisher (i.e., the *Book Publisher* component) that returns desirable information book publishing based on the re-structured 'communities_ of_creation' and 'mutual_innovation' knowledge stored previously.

Based on these characteristics and relevant specifics mentioned above, CSS for book publishing is thus designed as shown in Figure 8 to support interactions between **the teacher** and **the book publisher** via three intermediaries.

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 hurdles 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 collected correspondingly 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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