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## Professional Searching Assistant (PSA)

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# 1. System Specification

## 1.1 Business Case.

In current networked information society, the ability to abstract what you really want from the information sea has begun to play a more and more crucial role in our routine work and life. Many advanced techniques such as Google have been developed and widely used. But people in their effort to search the information still face many great difficulties, waste much time and are usually frustrated with depression. What's the problem in our search?

### 1. 1. 1 What's behind key word?

We all know the aim of searching is to get a special kind of information. Most current search techniques are based on "keyword". But use's query includes much information that only keyword can't efficiently convey. A query usually consists of at least three layer concepts. One is the object of the information, the second is the type of the information itself, and the third is the exist status of information. The object of information, as an entity, may possess various properties such as type, field, domain, scope, etc. the type of information may be a kind of knowledge, instruction, representation, methodology, news etc. Fig1 shows the composition structure of a general query.

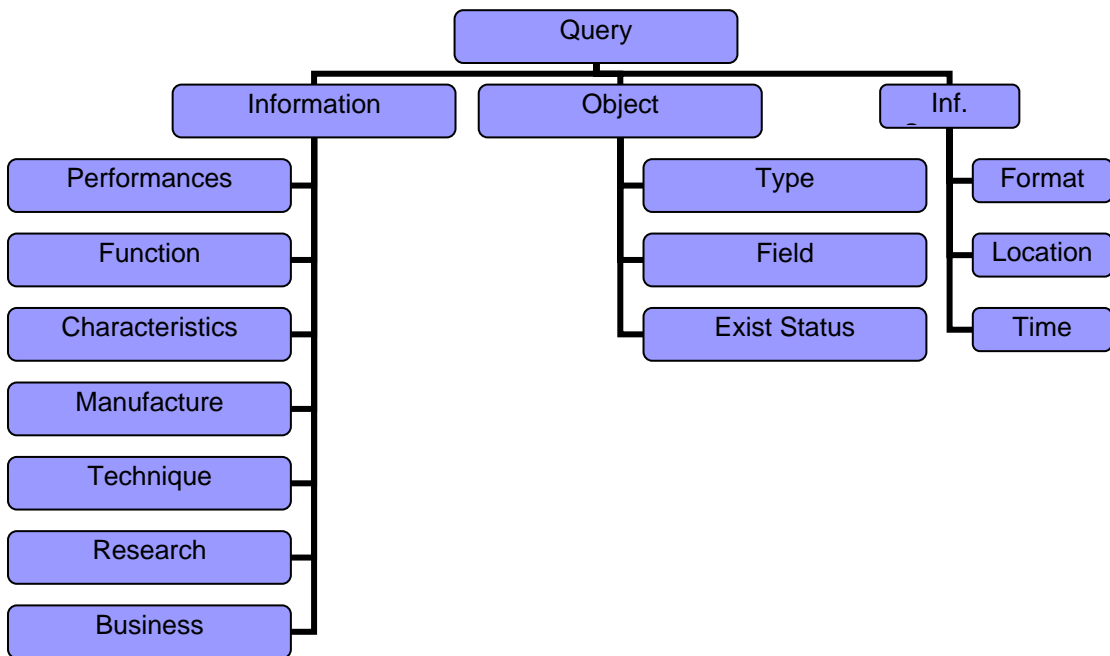


Fig. 1 Basic Concept Structure of a General Query

For example if we want find the information of where we can buy lens for digital camera. The object of information is lens. First it is a kind of industry product, the field is optical assert. It has different application field and different model and may produce by different technique. The information is the knowledge about the factory includes location, reputation, rank. The information can be get from the web, special online database. The related information existing form may be special evaluation, advertisement, news and introduction of products. It is obvious that the keyword is too plain to convey such information with its abundant hierarchy.

So in our current search activity, when we submit our query to machine at the beginning of search, we have lost much information that in actually is very crucial for the search process. Our system is designed to take the advantage of intelligent property of agent base system to get maximum query information from the client at the first step of search

### ***1.1.2 How to professionally search***

As the most important technique supplier, Google [4] supplies over 100 searching methods that can be choose to satisfy different search requirements. In Current society over 80 percent person may only able to use two or three. Even for the skilled researchers, engineers, managers and businessmen and journalists it is difficult to effectively and synthetically use existing searching techniques. By means of the autonomy, proactivity and search knowledge base, the Professional Search Assistant System (PSA) can assist people professionally use various advanced search techniques.

### ***1.1.3 what is the way to organize information***

We are very familiar to the way Google give us search results. It is boring, cut and dry, not flexible, not so clear. With the help of agent based technique the PSA will abstract information based on its machine understanding and use different show statistical technique such as charts, table, 3d, to organize and display acquired information.

## **1.2 System description**

Professional Search Assistant( PSA) is a knowledge-based intelligent multi-agent system that is able to 1) intelligently interact with clients to get more detailed query information, 2) synthetically utilize various existing searching technique according to the characteristics of the given search, and 3) autonomically organize and submit the acquired information based on the properties of information and the requirement.

PSA is an open system that it can add the most advanced search techniques. The PSA is designed to have self learning and decision-making ability that in the

application it can continuously accumulate various special search knowledge and experience, which it learns from great number of search activities.

### **1.3 Wishing List**

The following items are wished to be extended in the future development of PSA.

- !) It is able to be extended to support mobility and accept search query from different media.
- 2) On the basis of the belief that the real search queries are finite (compare to the capacities of computers), the PSA will be extended to possess distributed warehouses of prepared queries and related search clues.
- 3) Except the method based on existing search techniques and experiences, it is desired that PSA will set up advanced algorithms and mechanism to efficiently understand , abstract and organize information from the miscellaneous search results

## 2. System Analysis

As a knowledge-based multiagent system, the PAS is developed by applying MAS-CommonKADS [1] at analysis and design stage. Based on the characteristics of the system, the open architecture is used and the development will be implemented on the FIPA Platform [3].

In PSA design, we focus on the accuracy, match and fine organization of the goal information. The search speed is the secondary consideration factor.

### 2.1 Conceptualization

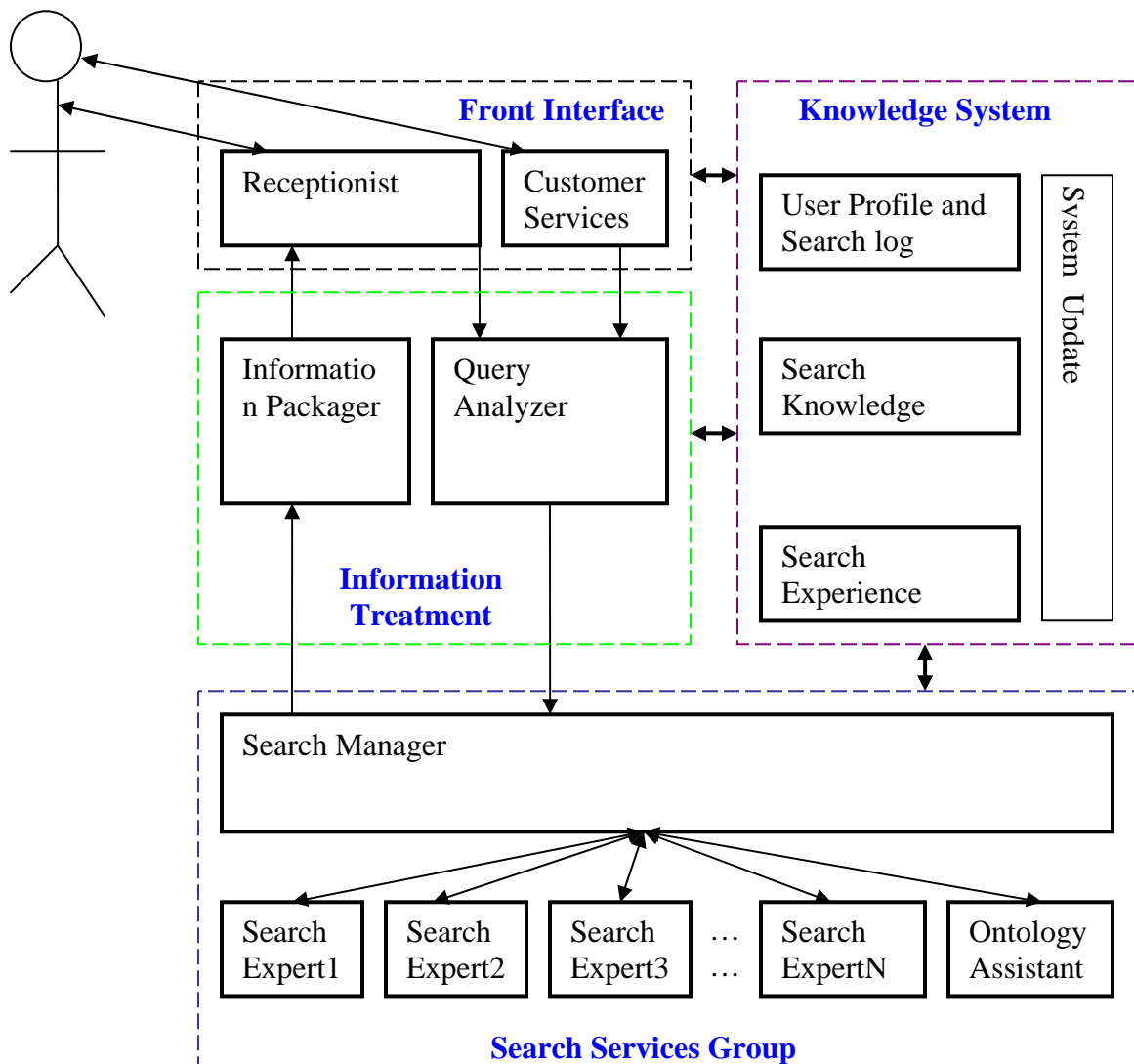
An initial phase corresponds to the conceptualization. This phase aims to carry out an elicitation task to obtain a general description of the problem by following a user-centered approach based on use cases. In this approach, an *actor* represents a role played by a person, a piece of hardware or another system that interacts with our system. A *use case* corresponds to a description of the sequence of actions needed to produce an observable result useful for an actor. Table1 identifies the possible actors of the PSA and the possible user goals and describes the ways of achieving these user goals. Figure 2 show the relation between them.

**Table1: Use Cases of PSA**

Actor	Description	Use case
Users	Person who wish to search	User profile; User Rights in search; Evaluation for query decision and search result. Use of research
Receptionist	Accept the query, get maximum query information	According to user profile and search requirement intelligently ask for the information about the type, exist status, domain, properties; make decision of search query by means of natural languages; Get the confirmation of the users
Query analyzer	Deal with the analysis of query Decide the search schedule based on the search knowledge and use preference Supply the organization requirement	Based on the query requirements and knowledge database decide the search goal field; select the possible effective search methods; submit search schedule and related information. From the characteristics of query decide what kind of display methods and organization is suit for the query

Search experter1 (general web search)	The searcher with expertise in general search	General search service supplier based on Google engine : (web search)
:Search Expert2 (special web search) :	special field or suit for a kind of search :	Special search: include given media type search; special site search; special group search.
Search Expert3 (database search)	Search various online database( patent , e-journal , e-books, professional articles)	Search online e- resources and relate them with user access right
..... Search Expert4	Non Google search engine service	Other search engine with advantage in a given search.
Search Expert N	New possible search techniques	Advanced search techniques.
Search Manager	Responsible to assign search task and organize , harmonize the search work of the search team	Master the function and performances of various search experts; based on the search requirement submitted by analyzer , schedule the search tasks to respond experts and coordinate the search work of experts; based on the search results decide the refinement and reschedule the search task; transfer the final results to the information packager
Knowledge Database	Database system with the search classification, available search resource, information distribution on domain , Information composition	Information about online database Information about Various subject site Information about newsgroup, forum Information about various yellow and white page; information about search methods
User database	User preference, search history, Search correlation	User personal profile, user right to resource, user search history , user interest correlation
Information packager	Organize , filter and submit the required information	Accept the final result sets from manager; compare, analyze and organize the information ; decide the display method; submit the organized information and package requirements

Ontology Assistant	Find the ontologies needed for abstracting and filtering retrieved information	From related web services and web ontology library, find the special ontologies for the given information abstraction and organization.
Customer services	Collect the suggestion, accept the search refine requirements	Find the answer in database , or supply the information to information analyzer who will find the solution and update responding knowledge



**Fig 2. Interaction and Relationship of Actors**

## 2.2 Analysis

**2.2.1 Agent Model:** the agent model specifies the characteristics of an agent, and plays the role of a reference point for the other model. An agent is defined as any entity capable of carrying out an activity. The identification of agents is based on the actors and use case that are generated in the conceptualization.

- 1) **Front Agent:** considering simplifying the communication, we map the actors: receptionist, customer services, into this agent. The textual agent template is filled as following:

### Front Agent (FA)

**Type:** Intelligent Agent

**Role:** Receptionist/ Customer Services

**Location:** Agent Society

**Objectives:** Treat all the interactions with the user

**Exception:** Overflow of the retrieved Information; User's query exceed the knowledge Scope

**Input Parameters:** User Profile; User's Selection and Input; the packaged information delivered by the information Treatment Agent; User's related Information supplied by the Database Agent

**Output Parameters:** the complete query; ask for user's profile; forwarded search results; user's opinion.

**Expertise:** autonomically look for the complete query information based on user's profile, concept of information format, and user's correlation; Learn and accumulate query skills from the interaction with user ; submit the query and forward the retrieved information ; report customer opinions and find basic FAQs answer

**Communication:** Database Agent; Information Treatment Agent

**Coordination:** Database Agent

**2) Information treatment Agent:** include two actors: the query analysis and information organization

### **Information Treatment Agent (ITA)**

**Type:** Intelligent Agent

**Role:** Information Analyzer/ Information Organizer

**Location:** Agent Society

**Objective:** Get the optimized search schedules for a given query  
Get the optimized organizing plan of retrieved information  
Analyzing the user' opinion

**Exception:** Absence of information that match the query  
Fail to filter the retrieved information

**Input Parameters:** Front agent's query; Database Agent's Knowledge; Search Manager Agent's retrieved information Package

**Out put Parameters:** Search Schedule; Treated information; Analysis report and evaluation report for the search result and user opinion

**Communication:** Front Agent; Database Agent; Search Manager Agent

**Coordination :** Database Agent ; Search Management Agent

**Expertise:** Based on the query requirement and knowledge database decide the search goal field; select the possible effective search methods; submit search schedule and related information.

From the characteristics of query decide what kind of display methods and organization is suit for the query; Filter the redundant information; build up new experience and search knowledge through evaluating search work and user's opinion

### **3) Database Agent**

#### **Database Agent (DA)**

**Type:** Intelligent Agent

**Objective:** Storage the knowledge, experience, and use profile that various search needs

**Role:** Data Management/Data Update

**Exception:** data lock, data loss

**Expertise:** Supply knowledge, experience, and methodologies base for professional search; update ability from learning and active search.

**Input Parameters:** Use's profile from front; query and update information from information treatment agent, ask from search management agent.

**Output Parameters:** data to front agent (FA); data to information treatment agent (ITA)

**Coordination:** front agent(FA); information treatment agent (ITA)and search managements agent (SMA)

**Communication:** front agent(FA); information treatment agent (ITA) and search management agent (SMA)

#### 4) Search Management Agent

##### Search Management Agent( SMA)

**Type:** Intelligent agent

**Role:** Manager/Coordinator

**Objective:** manage and control the execution of search task

**Exception:** Overtime and overflow of search; lost answer from some search agent

**Input Parameters:** search Schedule, Search evaluation Report, return information from different search agent

**Output Parameter :** Search order, summarize information

**Expertise:** Master the function and performances of various search experts; based on the search requirement submitted by analyzer , schedule the search tasks to respond experts and coordinate the search work of experts; based on the search results decide the refinement and reschedule the search task; transfer the final results to the information packager

**Coordination:** Search Agents(SA); Database Agent(DA); Information Treatment Agent(ITA), Ontology Assistant(OA)

**Communication:** Search Agents(SA); Database Agent(DA); Information Treatment Agent(ITA), Ontology Assistant(OA)

#### 5) Search Agent1 to Search Agent N

##### Search Agent1 To Search Agent N (SA1 to SAn)

**Type :** inactive agent

**Objective:** Professional search with a special kind of strength

**Input Parameters:** manager agent

**Output Parameters:** manager agent

**Exception:** lose link to resources or engine

**Expertise:** the abilities to take advantage of various search techniques.

**Communication:** manager agent

## 6) Ontology Assistant

### Ontology Assistant

**Type:** Intelligent Agent

**Objective:** Get the ontologies needed for information abstraction and organization.

**Input Parameters:** Order and parameters from Search management Agent

**Output Parameters:** subset of the wanted ontologies.

**Exception:** the special ontology is not available.

**Expertise:** The ability to search and acquire the asked ontologies.

**Communication:** Search Management Agent(SMA)

**Coordination:** Search Management Agent(SMA)

### 2.2.2 Task Model

Every instance of the task model describes all the related activities for an agent to fulfill a goal. The tasks are decomposed following a top-down approach and described in an and /or tree as following:

#### 1) Forming a complete query (Front agent)

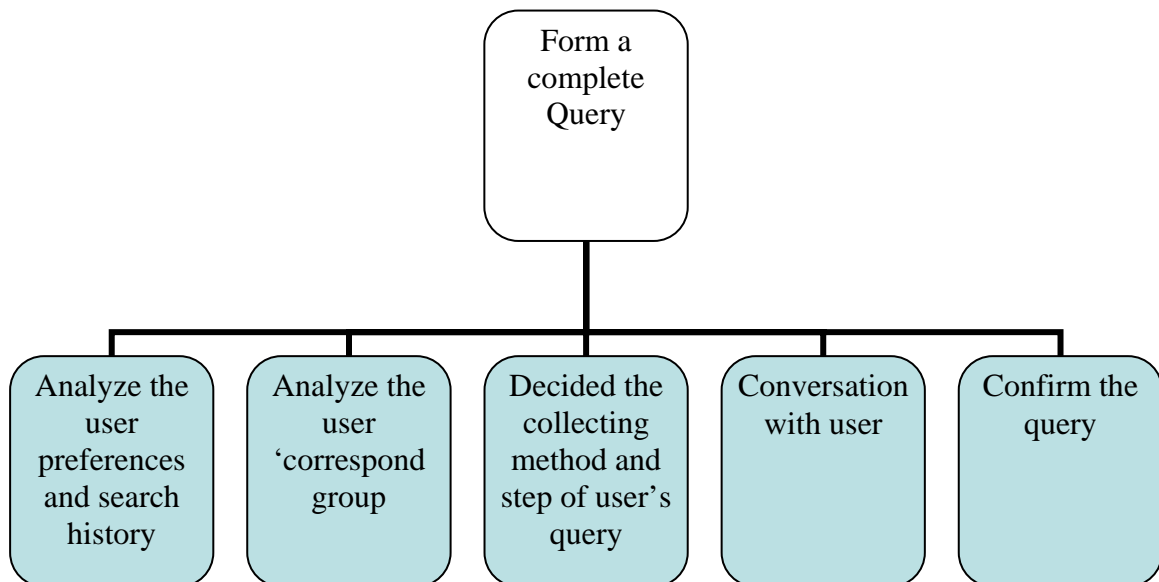


Fig 3 Task of forming search query

## 2) Accept and answer User's Opinion (Front Agent)

**Task:** Collection user's Opinion and Question

**Ingredient:** field, Size, Location, Format. Correlation

**Description:** deal with the question about refine, related group interest, suggestion. Etc.

**Constraint:** none

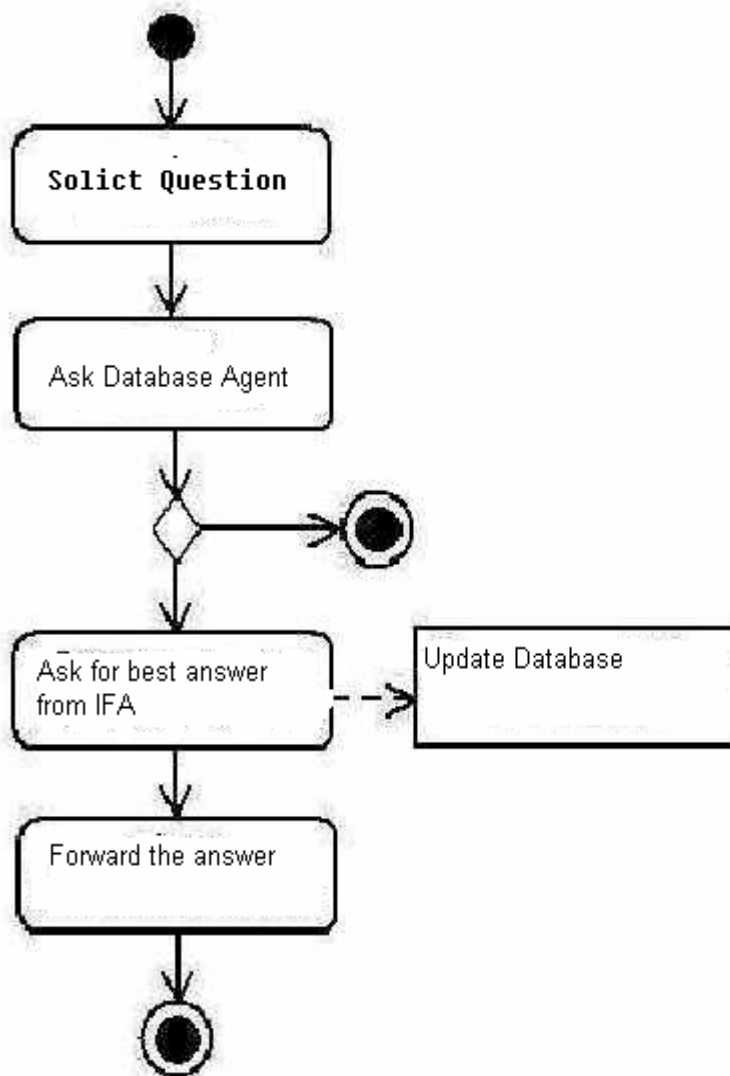


Fig 4 Task of Accepting and Answering user's opinions

### 3) Analyzing query (Information Treatment Agent)

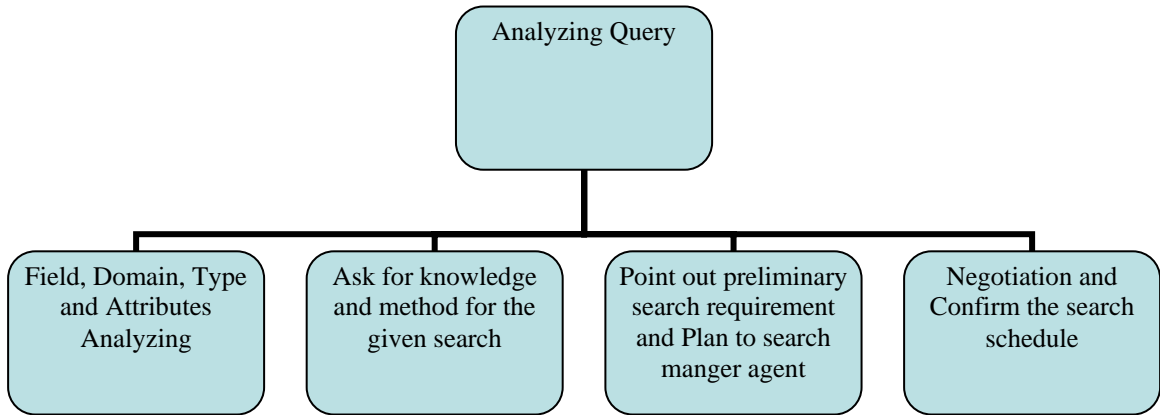


Fig 5 Task of analyzing query

### 4) Organizing Information

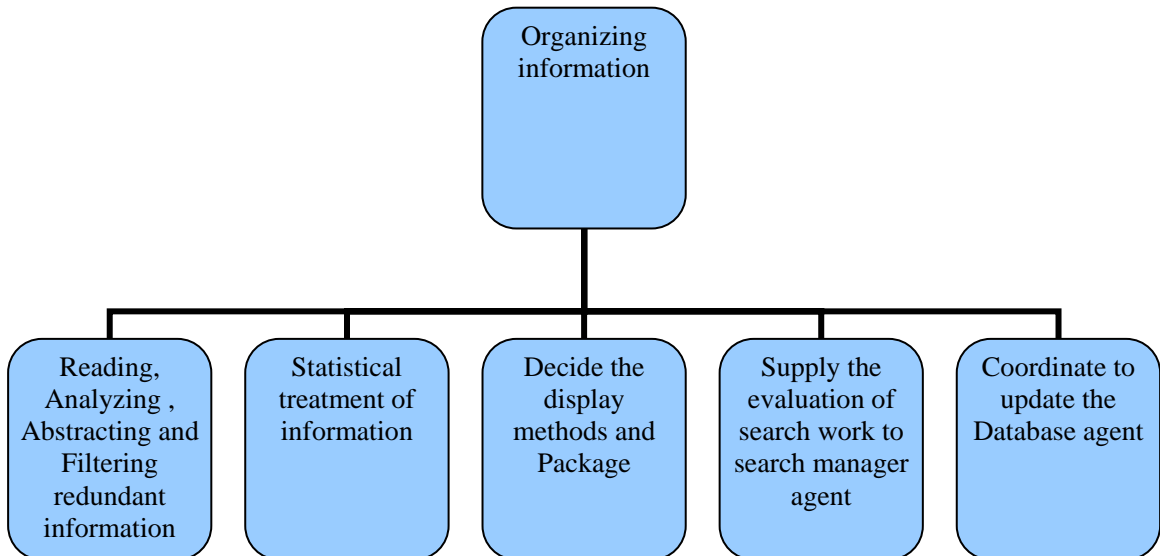


Fig 6 Task of organizing information

5) Scheduled Update ( Database Agent)

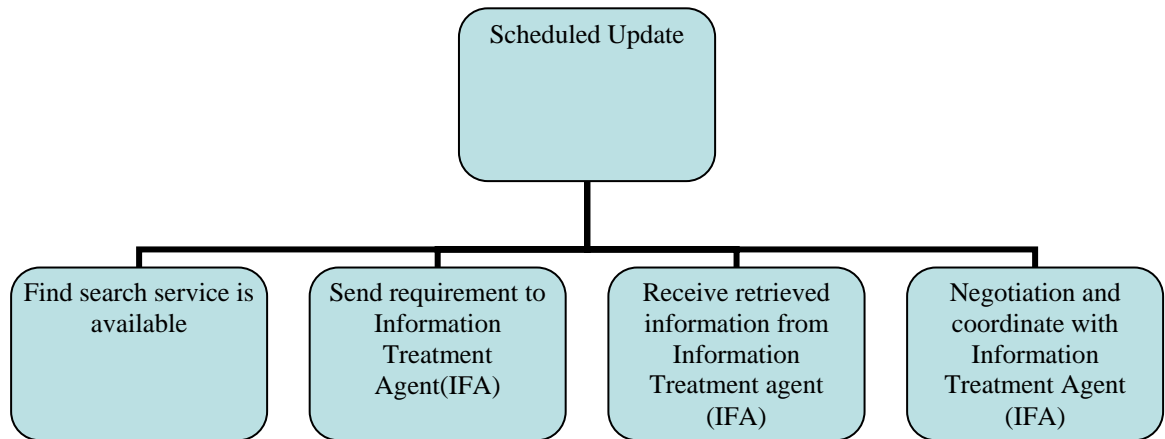


Fig 7 Task of Knowledge Update

6) Search Management ( Search Management Agent)

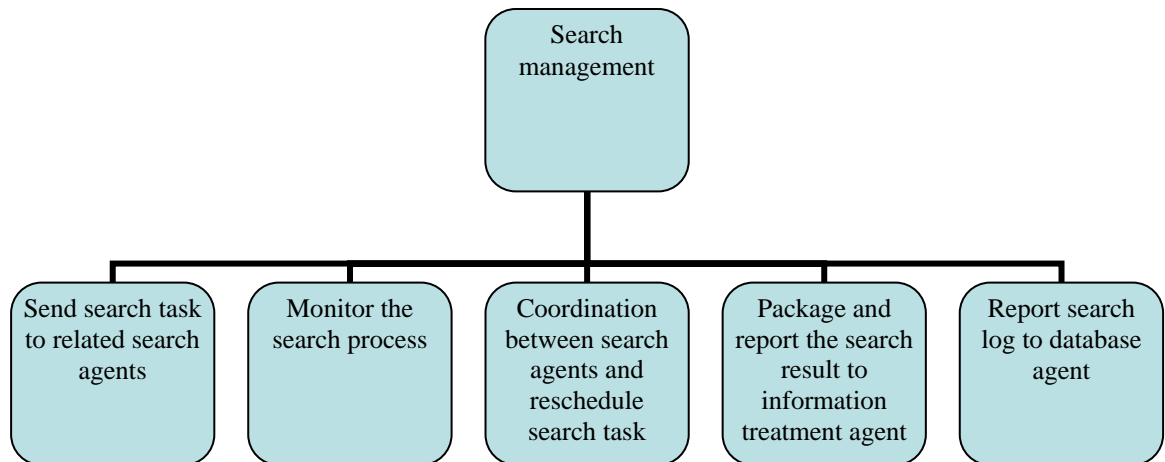


Fig 8 Task of search management

### 2.2. 3 Organization Model

The structural organization and the inheritance relationships are derived directly from the agent model. The agent organization of PSA is shown as Fig 9

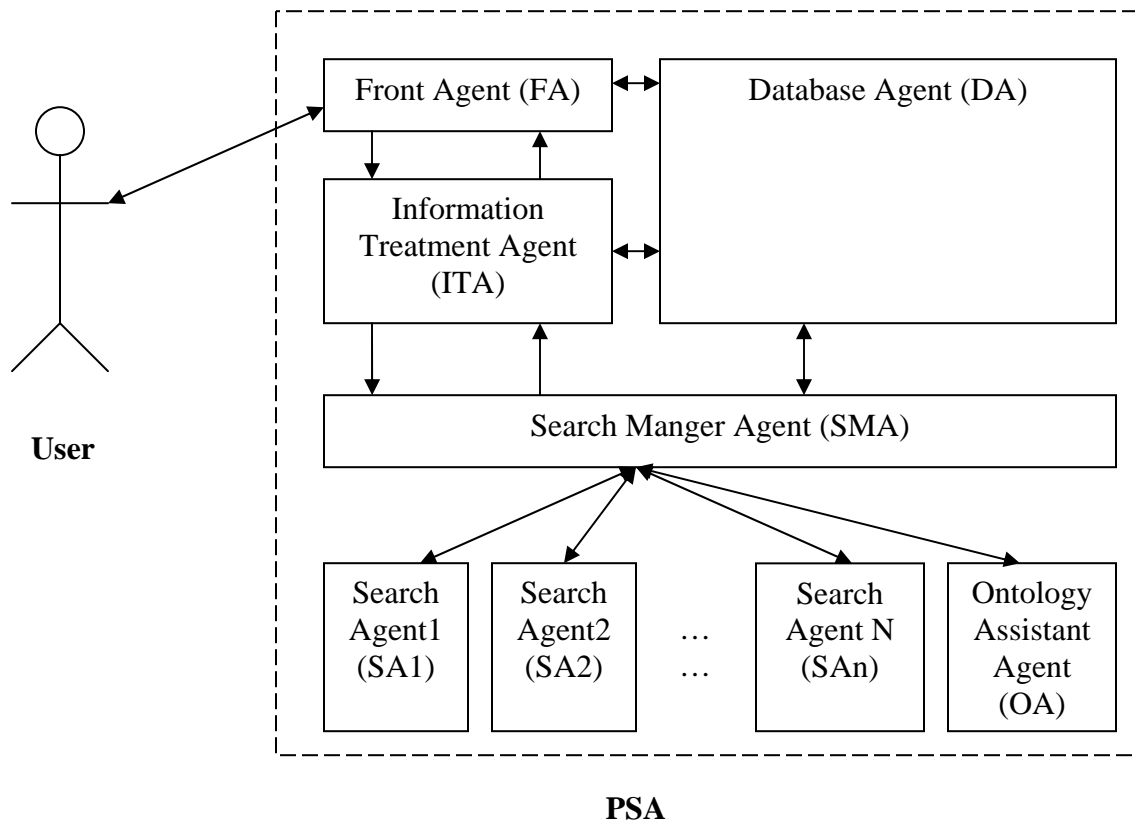


Fig 9 Organization Model of PSA

## 2.2.4 Coordination and communication Model

This model aims to define the communication channels and build a prototype. In this model we begin with the identification of the conversations between agents, where *use cases* play again an important role. At this level, every conversation consists of just one single interaction and the possible answer, which are described by means of templates as illustrated in Table 4.

Table 2 Conversation Description of Determining a search schedule

<p><b>Conversation Name:</b> Determine a search schedule <b>Objective:</b> set up search schedule <b>Agent:</b> Information Treatment Agent(ITA), Database Agent(DA), Search management Agent (SMA) <b>Description:</b> Based on the query supplied by Front Agent (FA), ITA send question to Database Agent to get the related knowledge and skill, then ask SMA the availability of related search services. <b>Precondition :</b> available Search Knowledge <b>Postcondition:</b> Search Schedule <b>Endingconditon:</b> abortion requirement from Front Agent; absence of enough knowledge</p>
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Next, we model the data exchanged in each interaction by specifying speech acts and the synchronization type. We collect all this information in the form of *sequence diagram* as shown in Figure 10.

## 2.2.5 The Expertise Model

The expertise model describes the reasoning capabilities of the agents needs to carry out specific tasks and achieve goals. In PSA the expertise is split into the development of domain knowledge, inference knowledge, task knowledge, and problem solving methods. Table 3 shows the needed knowledge for the related agents.

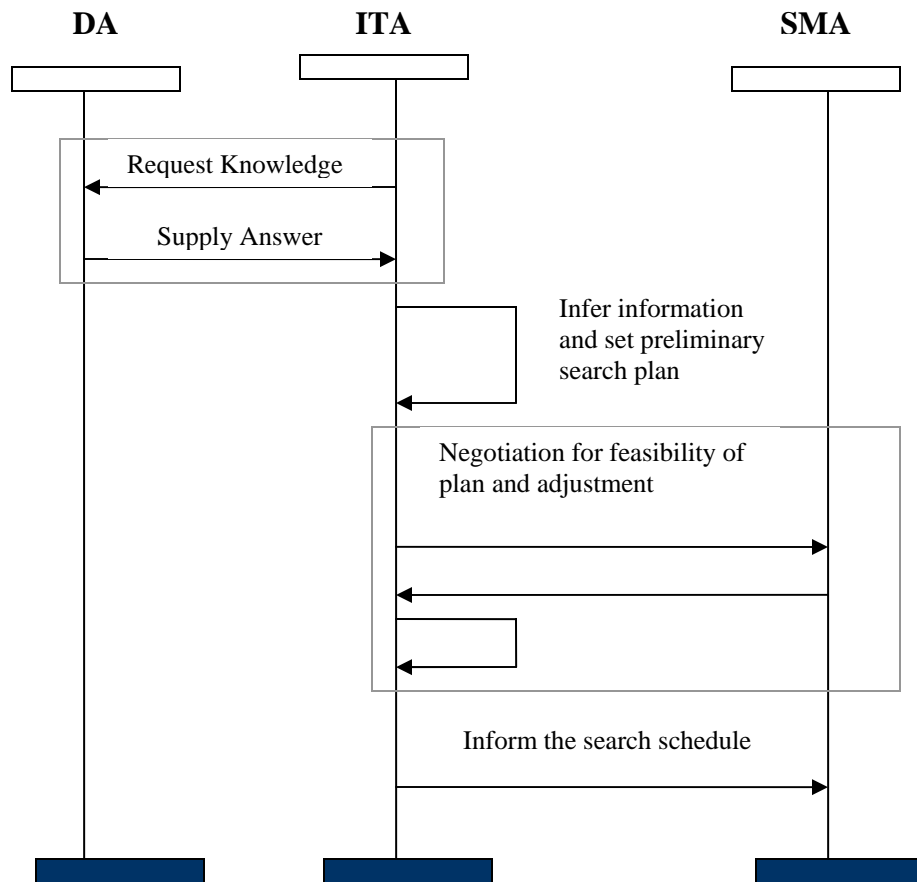


Fig 10 Message Sequence Diagram of Conversation: Determining Search Schedule

Table 3 Needed Knowledge of Agent

Agent	Needed Knowledge and Methods
Front Agent (FA)	Method mining user's query Analyze use's search need from user's profile and search History Inference based on user's same interest group
Information Treatment Agent(ITA)	Analyze query and decompose query Get and apply Knowledge for various search Understand information and extract as well organize information Evaluate search task Evaluate user opinion Extract knowledge from evaluation
Database Agent (DA)	Manage ,retrieve and store search knowledge, user's profile, system log Update knowledge and experience
Search Management Agent (SMA)	Manage and control the work of search group Distribute and coordinate the search task Monitor status of whole search group
Search Agents (SA)	Research database search General Web search Journal search e-media search( mp3,bt, emul, ...) special web search(news group , blog, forum) special field search( product,commodies, factory)
Ontology Assistant (OA)	Find the needed ontology

### **3. System Design**

The *design model* consists of the design of the agent network, the agent and their interaction.

#### **3.1 Network, Knowledge and Coordination Facilities**

From uses case we can directly build up the agent network with the manager agent supplying network facilities, coordination facilities for search group. The communication relation between Front Agent, Information Agent, Search manager Agent and Database Agent is not so complicated, so the direct mode is used for the communication, knowledge transmission and coordination between them.

#### **3.2 Ontology Consideration**

##### **1) *Internal message exchange***

The internal message exchange for query , search schedule , search knowledge and user profile among Front Agent(FA), Information Treatment Agent(ITA), Database Agent( DA) and Search manager Agent (SMA) are based on a shared basic internal search ontology which is developed from the query concept hierarchy model (fig. 1)

##### **2) *External message exchange***

The Professional Search Assistant System (PSA) input great amount of outsider information from outside web world. To efficiently extract and aggregate information from different sites, the Information Treatment Agent (ITA) must understand these information. So it needs the help from ontology for the given domain, which can supply the machine-interpretable definitions of basic concepts of the domain and the relation among them. Fortunately, in current, many ontologies for different domain on web have been developed for encoding knowledge to make it understandable to electronic agent searching information [5][6]. Our ontology assistant agent will find the necessary ontologies from related ontology web services for a given search requirement. The information treatment agent will use these ontologies to extract, filter and organize the retrieved search results. Because the aim of search is mainly give user a clue to get the detailed information, the needed ontology of a domain for search is usually a simple subset of it. For example, for shopping search, the key factors of the ontology are focused on price, quality, rank etc. On the other hand, the requirement of ontology for different search has great difference. For Mp3 file search, what needed information is the site location and download speed. The ontology is nearly not needed. So based on the use frequency of the concepts,

the Information Treatment Agent can ask Database Agent save the simplified ontology of different domain that is effective for the real search activities.

### **3.3 Communication Languages.**

According to the characteristics of PSA which mainly retrieves information online, we chose XML as Communication Languages. The communication protocol is on the basis of Http. The content presentation languages inside the message also use XML.

Typical Messages are as follows:

#### ***Query:***

```
<Query>
  < sender> FA</sender>
  <receiver>ITA</receiver>
  <content>query.xml</content>
  <type>internal</type>
</Query>
```

#### ***Search Schedule:***

```
<SearchSchedule>
  <sender>ITA</sender>
  <receiver>SMA</receiver>
  <content>Schedule.xml</content>
  <type>internal</type>
</SearchSchedule>
```

#### ***Raw Search Package***

```
<RawSearchPack>
  <sender>SMA</sender>
  <receiver>ITA</receiver>
  <content>ResultPackage.xml</content>
  <ontology>ontologysheet.xml</ontology>
  <type>input</type>
</RawSearchPack>
```

### ***Ask for the related website knowledge***

```
<SiteKnowAsk>
  <sender>ITA</sender>
  <receiver>DA</receiver>
  <content>Key.xml</content>
  <type>internal</type>
</SiteKnowAsk>
```

.....  
.....

The query.xml is as follows;

```
<query>
  <object>
    <name>lens</name>
    <type>Product</type>
    <domain>Industry<domain>
      <subfield>optical </subfield>
      <subfield>material</subfield>
      <subfield>manufacture</subfield>
    </usescope> camera</usescope>
  </object>
  <preinfo>
    <exist form>report</exist form>
    <exist form>article</exist form>
    <exist form>advertisement</exist form>
    <class: timescope="1999-2005"> technique </class>
    <class: timescope="1999-2005">craft </class>
  </preinfo>
  <endinfo>
    <requirement>cost</requirement>
    <requirement>evaluation</requirement>
    <requirement>applicationscope</requirement>
    <requirement>description</requirement>
  </endinfo>
</query>
```

### **3.4 Data Structure**

To make PSA work efficiently and reduce system workload, the knowledge system of PSA is designed as XML-based.

#### 4. System Implementation

The implementation consisted of three phase: creation of document, development of user interface, and construction of multi-agent system, In implementation, as a new technology, agent system should work and integrated with well developed non-agent techniques. We chose the widely accepted agent development platform FIPA to implement the professional assistant system (PSA). FIPA can supply an agent application integration environments based on appropriate industry standards and enable coordination among applications across heterogeneous networked systems; Based on FIPA, the agent management, agent communication and message transport, and agent interoperability of PSA can be efficiently scandalized and fulfilled. On the other hand the system will be of good scalability.

#### 5. Acknowledgements

I would like to thank Dr. Far for his instructions [2], which build up the foundation of this design. I am also grateful for his valuable comments concerning on ontology and information organization.

#### 6. References

- 1) C.A. Iglesias, et al.: Analysis and Design of Multiagent Systems using MAS-CommonKADS, Proceedings of the AAAI'97 Workshop on Agent Theories, Architectures and Languages, Providence, USA, July, 1997.
- 2) SENG 609.22 The Agent Based Software Engineering (<http://www.enel.ucalgary.ca/People/far/Lectures/SENG609-22/>)
- 3) FIPA (<http://www.fipa.org/>)
- 4) Google (Www. Google.com)
- 5) Ontolingua ontology library (<http://www.ksl.stanford.edu/software/ontolingua>)
- 6) DAML ontology library (<http://www.daml/ontologies>)