



INTELLIGENT SYSTEMS OVER THE INTERNET

Web-Based Intelligent Systems

- Intelligent systems use a Web-based architecture and friendly user interface
- Web-based intelligent systems:
 - Use the Web as a platform to deliver services
 - User interfaces are Web enabled

Web-Based Intelligent Systems

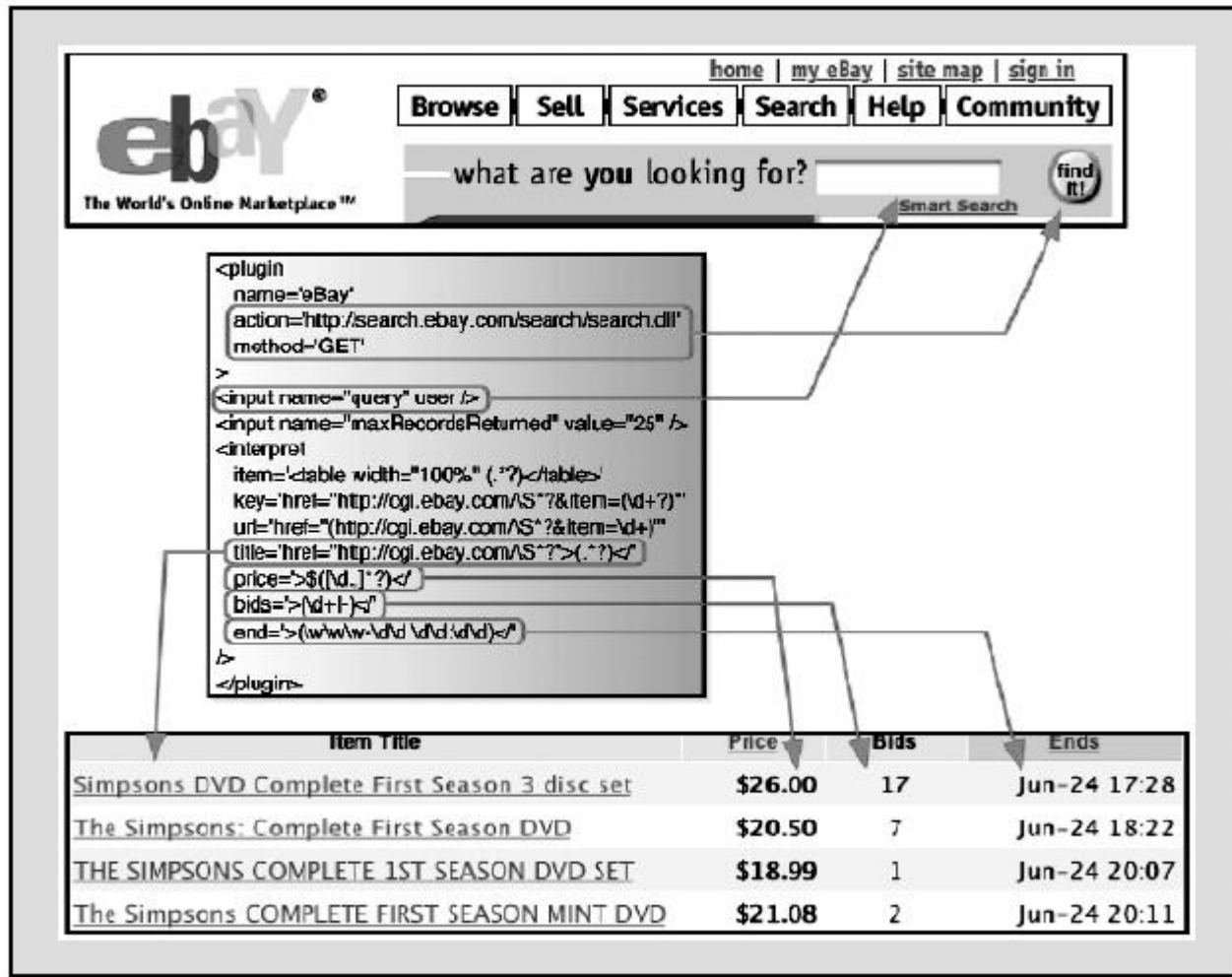


FIGURE 14.1 A Simplified Mechanism for Product Searching in a Web-Based Intelligent System

Web-Based Intelligent Systems

- Small systems that perform very specific tasks are often called *agents*
- *Information agent* take a request and navigate to the appropriate page on a Web site, locate the required information, and return it as an XML document for processing by another agent
- *Monitoring agents* are built on top of the information agent to keep track of previously returned results

Web-Based Intelligent Systems

- *Recommender or recommendation agents* assist in customization and personalization services that are critical to maintaining good customer relationships

Intelligent Agents: An Overview

- **Intelligent agent (IA)**

An expert or knowledge-based system embedded in computer-based information systems (or their components) to make them smarter

- The term *agent* is derived from the concept of agency, referring to employing someone to act on your behalf

Intelligent Agents: An Overview

- Types of agents
 - Software agents
 - Wizards
 - Software daemons
 - Softbots

- **Bots**

Intelligent software agents; an abbreviation of robots. Usually used as part of another term, as in knowbots, softbots, or shopbots

Characteristics of Intelligent Agents

- Reactivity
 - Agents perceive their environment and respond in a timely fashion to changes that occur in it
- Proactiveness (or persistence)
 - Agents are able to exhibit goal-directed behavior by taking initiative
- Temporal continuity
 - Agents are continuously running processes that can be temporarily inactive while waiting for something to occur

Intelligent Agents: An Overview

- Intelligence levels
 - *Level 0*—Agents retrieve documents for a user under straight orders
 - *Level 1*—Agents provide a user-initiated searching facility for finding relevant Web pages
 - *Level 2*—Agents maintain users' profiles
 - *Level 3*—Agents have a learning and deductive component to help a user who cannot formalize a query or specify a target for a search

Intelligent Agents: An Overview

- Components of an agent
 - Owner
 - Author
 - Goal
 - Subject description
 - Creation and duration
 - Background
 - Intelligent subsystem

Characteristics of Intelligent Agents

- Autonomy or empowerment
 - An agent that takes initiative and exercises control over its own actions have these characteristics:
 - Goal oriented
 - Collaborative
 - Flexible
 - Self-starting

Characteristics of Intelligent Agents

- Communication (interactivity)
 - Many agents are designed to interact with other agents, humans, or software programs
- Automating repetitive tasks
 - An agent is designed to perform narrowly defined tasks, which it can do over and over without getting bored or sick or going on strike

Characteristics of Intelligent Agents

- Personality
 - Agents must be believable and be able to interact with human users
- Operating in the background: Mobility
 - An agent must be able to work out of sight (in cyberspace or other computer systems) without the constant attention of its user
 - Remote execution
 - Mobile agents

Characteristics of Intelligent Agents

- Intelligence and learning
 - For an intelligent agent, learning goes beyond mere rule-based reasoning because the agent is expected to learn and behave autonomously

Why Intelligent Agents?

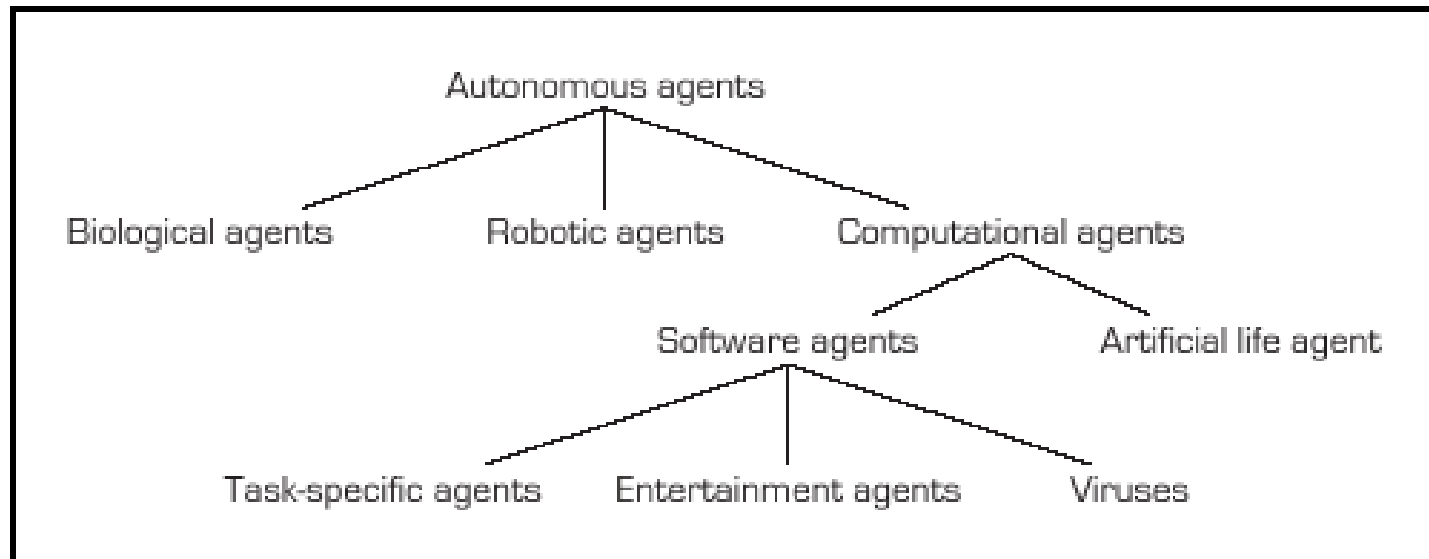
- Information overload
 - A major value of intelligent agents is that they are able to assist in searching through all the data
 - Intelligent agents save time by making decisions about what is relevant to the user

Why Intelligent Agents?

- Reasons for the success of agents
 - Decision support
 - Repetitive office activities
 - Search and retrieval
 - Domain experts

Classification and Types of Intelligent Agents

FIGURE 14.2 Classification of Intelligent Agents



Classification and Types of Intelligent Agents

- **Classification by application type**
 - **Public (organizational) agent**
An agent that serves any user
 - **Private (personal) agent**
An agent that works for only one person

Classification and Types of Intelligent Agents

- Software agents and intelligent agents for:
 - Workflow and business process management
 - Distributed sensing
 - Retrieval and management
 - E-commerce
 - Human–computer interaction
 - Virtual environments
 - Social simulation

Classification and Types of Intelligent Agents

- **Classification by characteristics**

- **Agency**

- The degree of autonomy vested in a software agent

- **Intelligence**

- A degree of reasoning and learned behavior, usually task- or problem solving—oriented

Classification and Types of Intelligent Agents

- **Classification by characteristics**

- **Mobility**

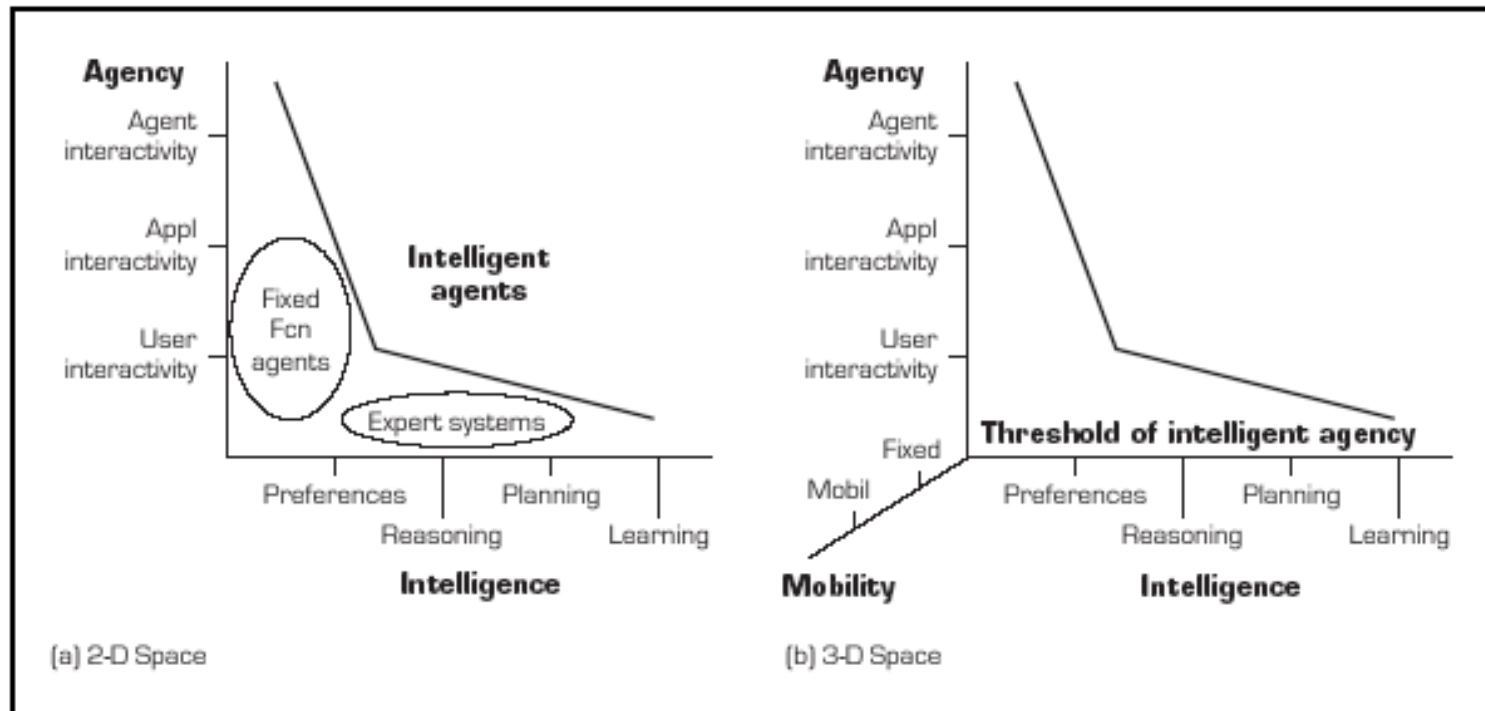
- The degree to which agents travel through a computer network

- **Mobile agents**

- Intelligent software agents that move across different system architectures and platforms or from one Internet site to another, retrieving and sending information

Classification and Types of Intelligent Agents

FIGURE 14.3 Intelligent Agents' Scope in Two Dimensions (a) and in Three Dimension (b)



Classification and Types of Intelligent Agents

- Other classifications
 - Personal use
 - Network management
 - Information and internet access
 - Mobility management
 - E-commerce
 - User interface
 - Application development
 - Military applications

Internet-Based Software Agents

- Nine major application areas:
 1. Assisting in workflow and administrative management
 2. Collaborating with other agents and people
 3. Supporting e-commerce
 4. Supporting desktop applications
 5. Assisting in information access and management, including searching and FAQs
 6. Processing e-mail and messages
 7. Controlling and managing network access
 8. Managing systems and networks
 9. Creating user interfaces, including navigation (browsing)

Internet-Based Software Agents

- E-mail agents (mailbots)
 - Control unsolicited e-mail
 - Alert users by voice if a designated message arrives
 - Automatically forward messages to designated destinations
 - Consolidate mail from several sources
 - Search the Internet for sources and deliver them to the user by e-mail
 - Distinguish business-related e-mail from private or personal mail
 - Automatically answer mail and respond according to conditions
 - Perform regular administrative tasks involving desktop e-mail

Internet-Based Software Agents

- Web browsing assisting agents
- FAQ agents

Internet-Based Software Agents

- Intelligent search (or indexing) agents

- **Search engines**

- Program that finds and lists Web sites or pages (designated by URLs) that match some user-selected criteria

- **Metasearch engines**

- Search engines that combine results from several different search engines

Internet-Based Software Agents

- Internet softbots for finding information
 - An *Internet softbot* attempts to determine what the user wants and understand the contents of information services
- Network management and monitoring
 - Intelligent agents have been developed to:
 - Monitor
 - Diagnose problems
 - Conduct security
 - Manage Internet (or other network) resources

Internet-Based Software Agents

E-commerce agents

- *Need identification*
- *Product brokering*
- *Merchant brokering*
- *Negotiation *
- *Purchase and delivery*
- *Product service and evaluation*
- *Fraud-detection agents*
- *Learning agents*
- *B2B information sharing*

Internet-Based Software Agents

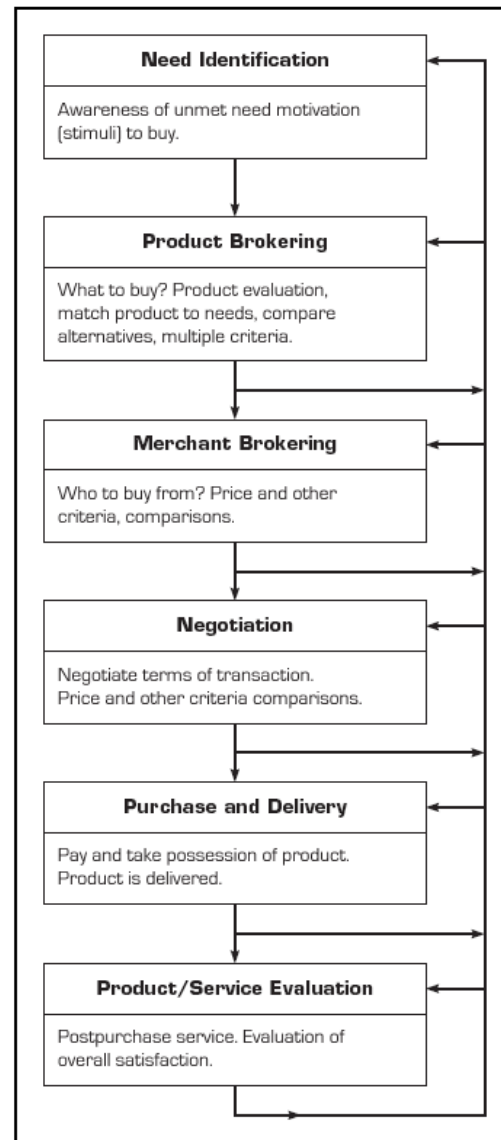


FIGURE 14.5 The Purchasing Decision-Making Process

Internet-Based Software Agents

Other agents

- User interfaces
- Learning and tutoring
- Supply-chain management
- Workflow and administrative management
- Web mining
- Monitoring and alerting
- Collaboration
- Mobile commerce
- System agents
- Recommender agents
- Profiling agents

DSS Agents and Multiagents

- Five types of DSS agents:
 1. Data monitoring
 2. Data gathering
 3. Modeling
 4. Domain managing
 5. Preference learning

DSS Agents and Multiagents

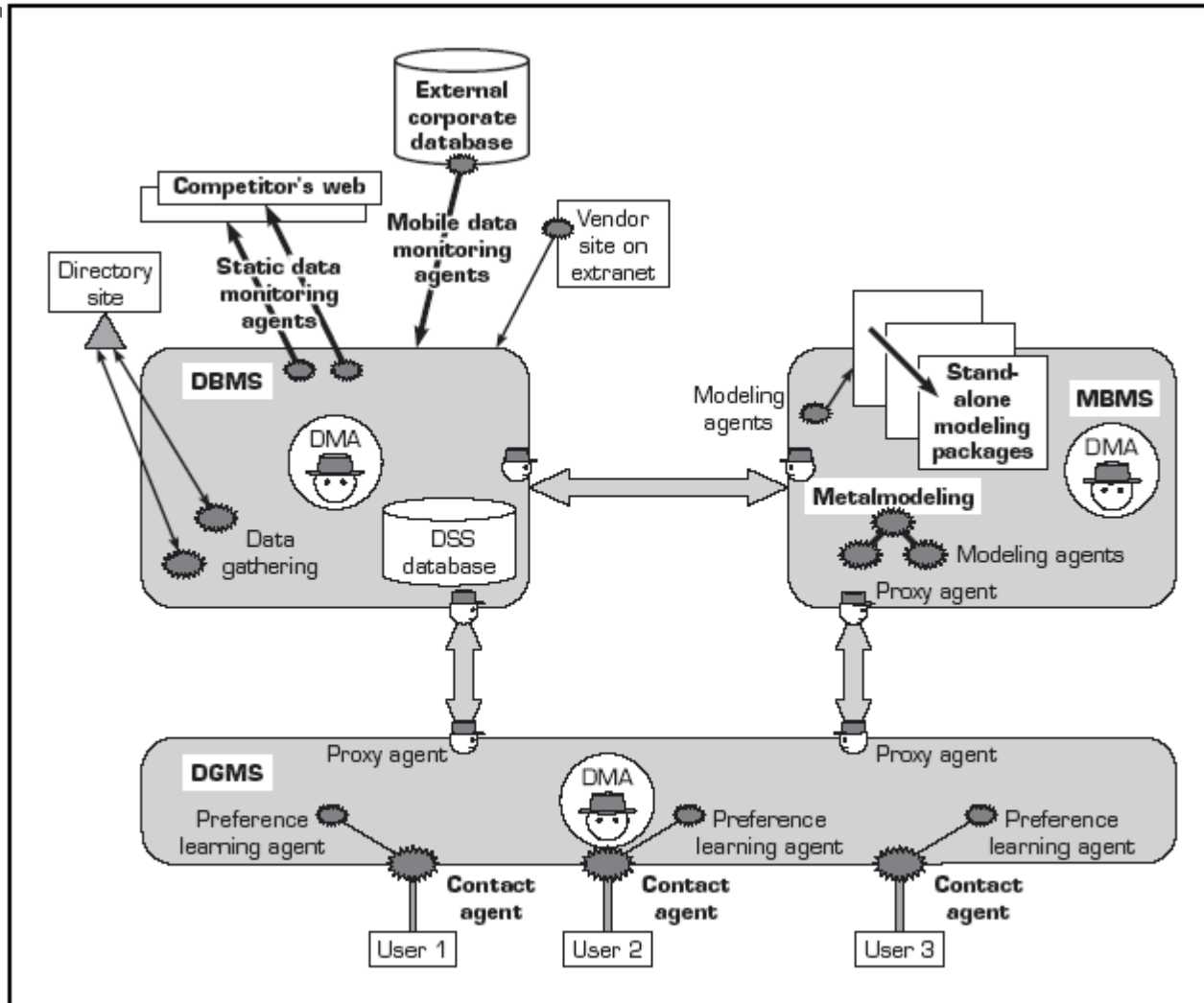


FIGURE 14.6 The Agent-Enhanced General DSS Framework

DSS Agents and Multiagents

- Multiagents

- **Multiagent system**

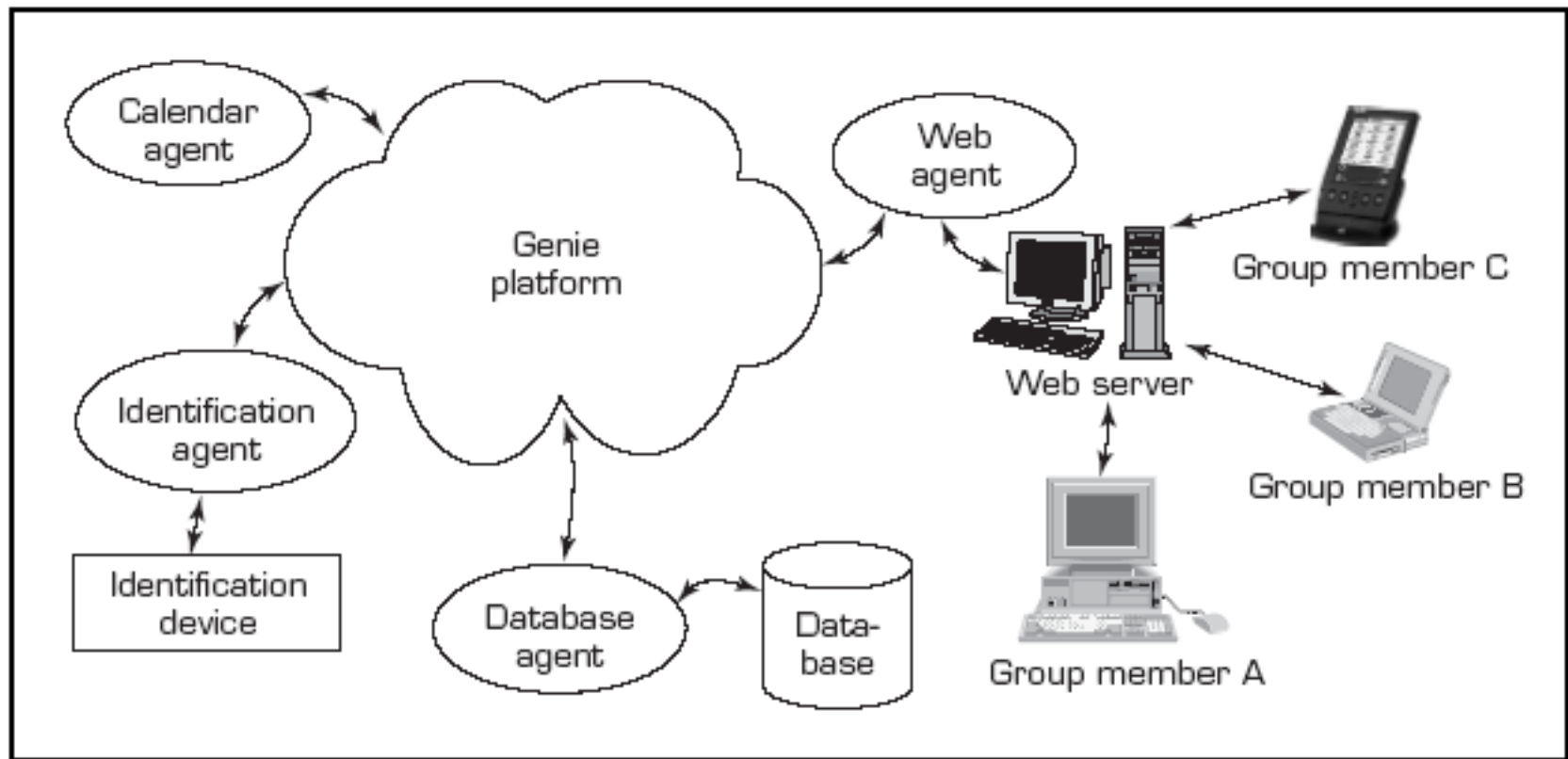
- A system with multiple cooperating software agents

- **Distributed artificial intelligence (DAI)**

- A multiple-agent system for problem solving. Splitting of a problem into multiple cooperating systems in deriving a solution

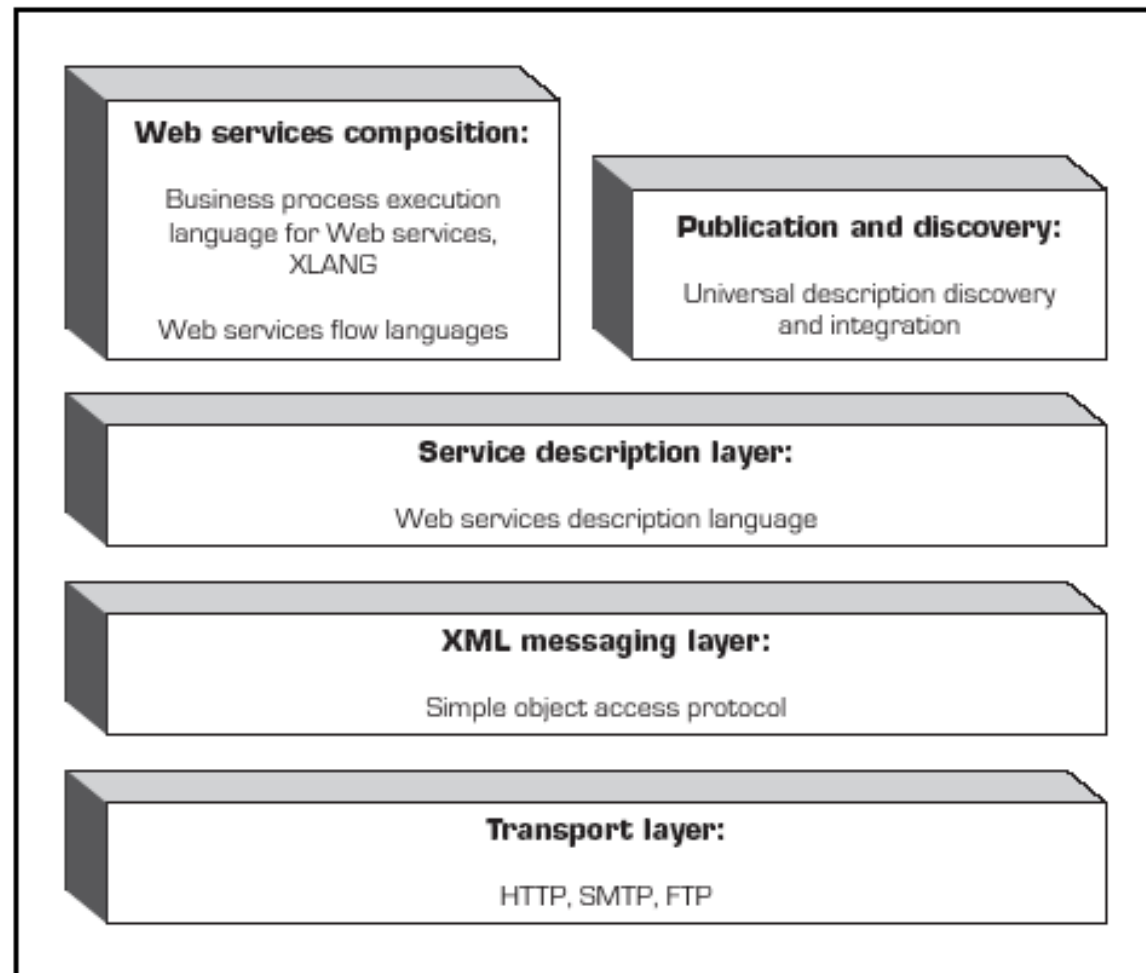
DSS Agents and Multiagents

FIGURE 14.7 Genie of the Net: A Sample Multiagent System



The Semantic Web: Representing Knowledge for Intelligent Agents

FIGURE 14.8 Architecture of Web Services



The Semantic Web: Representing Knowledge for Intelligent Agents

- **Semantic Web**

The semantic Web is meant to enable an environment in which independent, Internet-connected information systems can exchange knowledge and action specifications, resulting in the execution of an activity acceptable to all systems involved

The Semantic Web: Representing Knowledge for Intelligent Agents

- XML and Web Services

- **Web services**

An XML-based technology that allows software components to be integrated more flexibly through dynamic communication. It has gained much support from most major software companies such as IBM, Microsoft, and Sun Microsystems

The Semantic Web: Representing Knowledge for Intelligent Agents

- XML and Web Services
 - Four layers of Web services:
 1. Transport layer
 2. XML messaging layer
 3. Service description layer
 4. Publication and integration layer

The Semantic Web: Representing Knowledge for Intelligent Agents

- The layer cake of the Semantic Web
 - A unifying data model
 - Language with defined semantics
 - Ontologies of standardized terminology for marking up Web resources

The Semantic Web: Representing Knowledge for Intelligent Agents

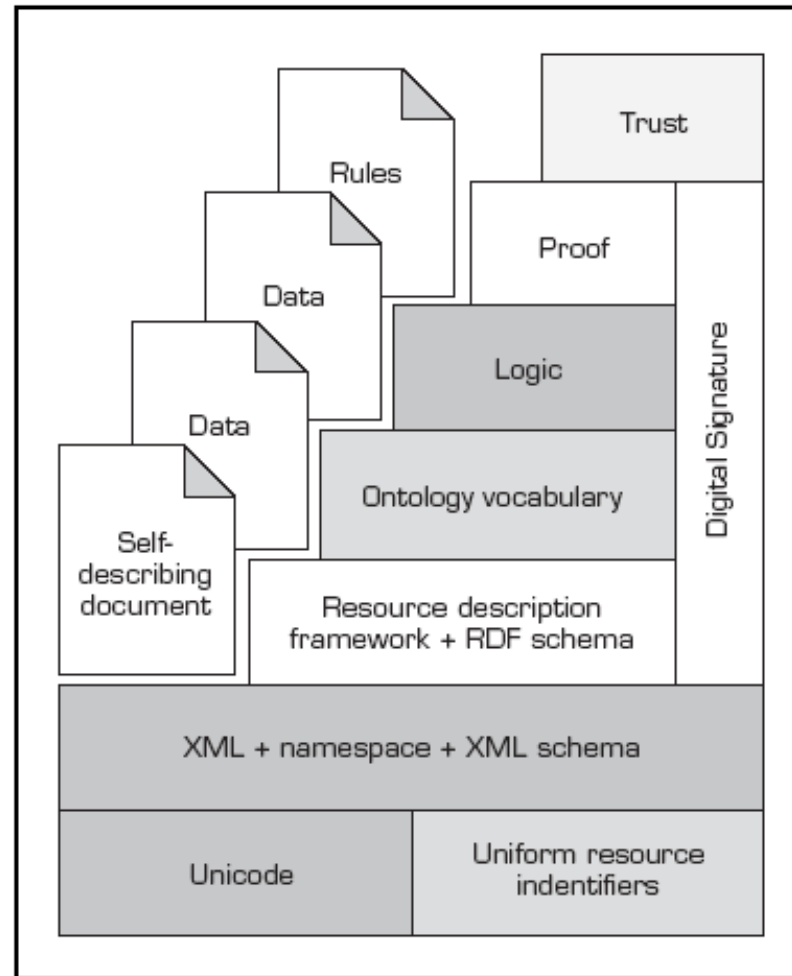


FIGURE 14.9 "Layer Cake" of the Semantic Web by Tim Berners-Lee

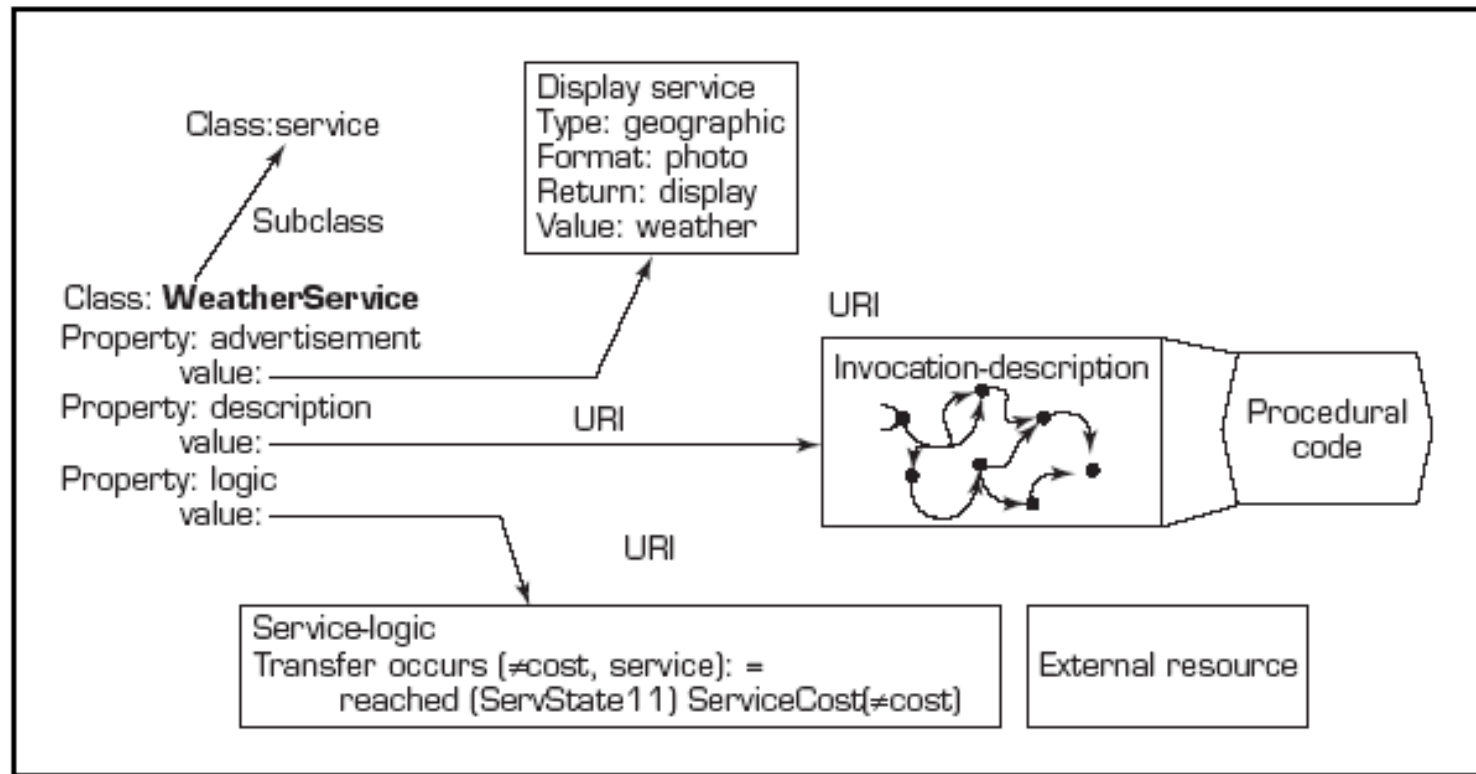
The Semantic Web: Representing Knowledge for Intelligent Agents

- **The layer cake of the Semantic Web**

- Uniform resource identifiers (URI)
- Resource description framework (RDF)
- Ontology: A set of terms related to a knowledge domain, including the vocabulary, the semantic interconnections, and some simple rules of inference and logic for some particular topics

The Semantic Web: Representing Knowledge for Intelligent Agents

FIGURE 14.10 Weather Service Class and Its Properties on the Semantic Web



The Semantic Web: Representing Knowledge for Intelligent Agents

- **Advantages of the Semantic Web**

- Easy to understand
- Easy resource integration
- Saving development time and costs
- Automatic update of content
- Easy resource reuse
- Enhanced search mechanism
- Virtual community

The Semantic Web: Representing Knowledge for Intelligent Agents

- **Limitations of the Semantic Web**
 - Graphical representation may be oversimplified
 - More tools for searching content and building references to preexisting instances must be set up
 - Ontology may not be correctly defined
 - Agents using information that is inconsistent, incorrect, or lacks reliable sources may be contaminated or lead to wrong decisions
 - Security and related issues are key concerns

The Semantic Web: Representing Knowledge for Intelligent Agents

- **Application of Semantic Web Services**

- **Semantic Web services**

- An extension of XML that allows semantic information to be represented in Web services

The Semantic Web: Representing Knowledge for Intelligent Agents

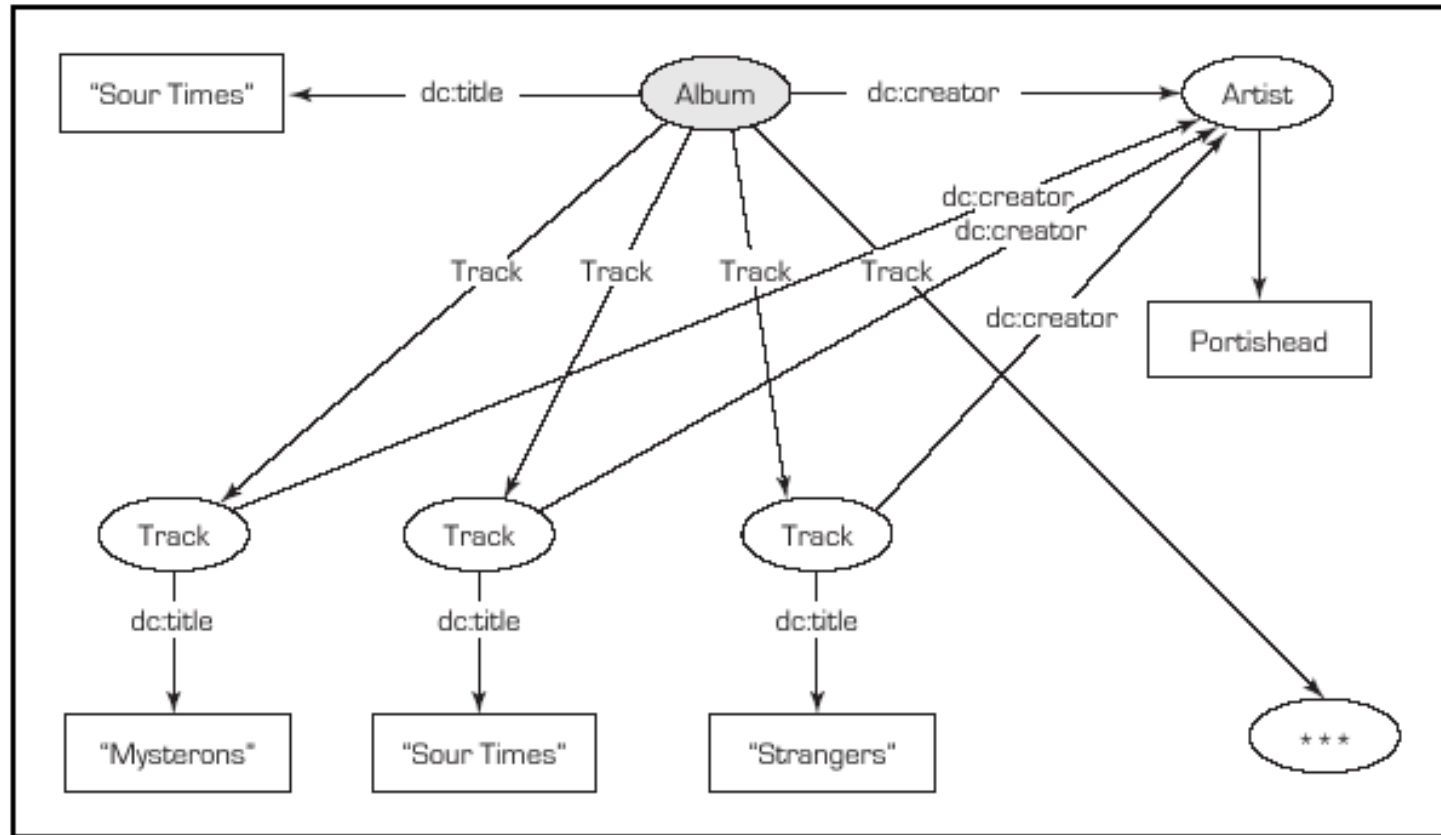


FIGURE 14.11 Graphical Representation of MusicBrainz Data

Web-Based Recommendation Systems

- A major application of intelligent systems in e-commerce is to recommend products to customers
- The major motivation for using recommendation agents is that personalization is a major trend in marketing and customer services

Web-Based Recommendation Systems

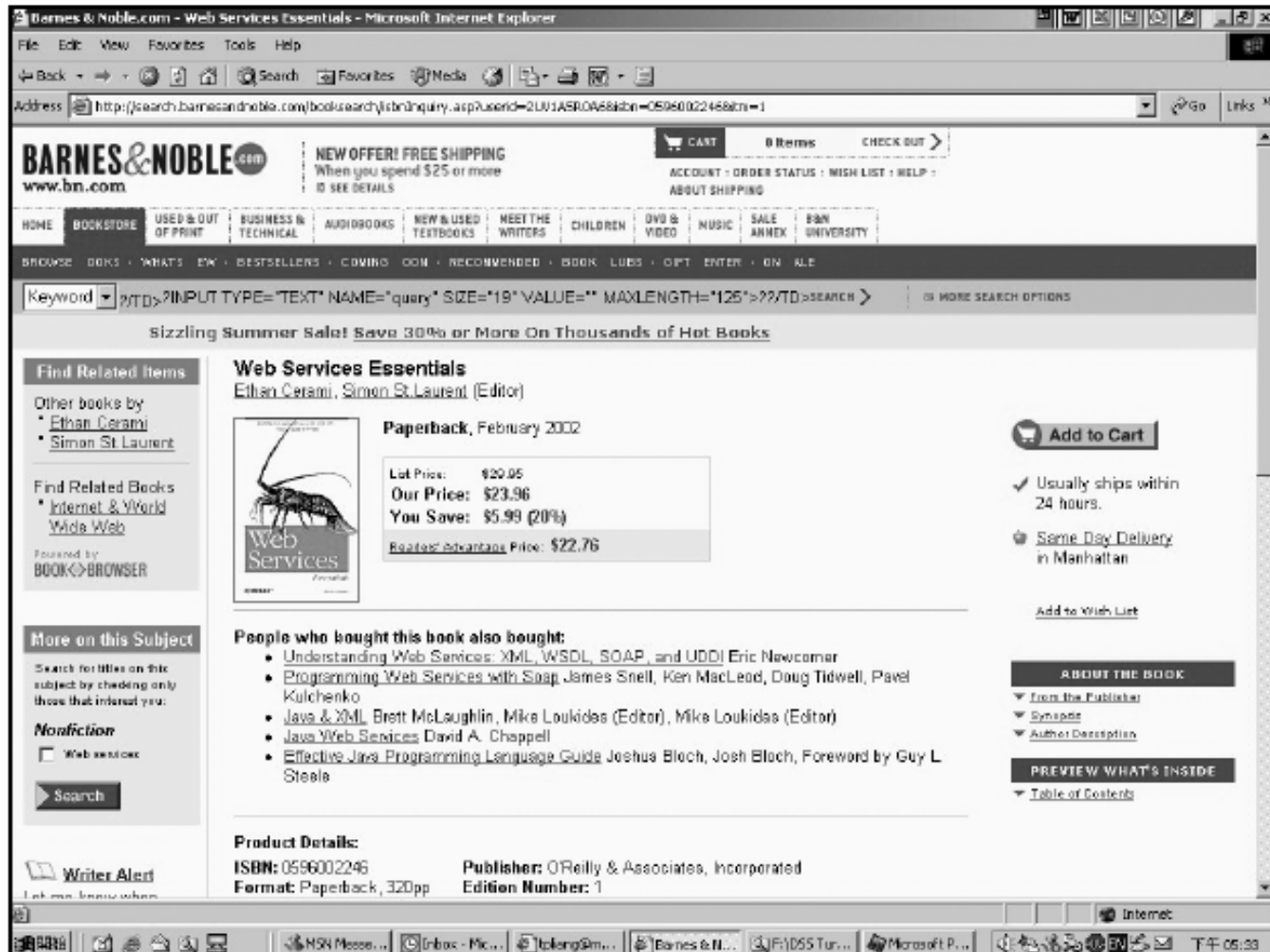


FIGURE 14.12 Book Recommendations at bn.com

Web-Based Recommendation Systems

- **Recommendation systems (agents)**

A computer system that can suggest new items to a user based on his revealed preference. It may be content-based or collaborative filtering to suggest items that match the preference of the user. An example is that Amazon.com's function of “Other people bought this book also bought . . .” function

Web-Based Recommendation Systems

- Taxonomy of recommendation mechanisms
 - Two major functions:
 - Profile generation and maintenance
 - Profile exploitation and recommendation

Web-Based Recommendation Systems

- Profile generation and maintenance
 - User profile representation
 - Initial profile generation
 - Profile learning technique
 - Relevance feedback
 - Profile adaptation technique

Web-Based Recommendation Systems

- Profile exploitation and recommendation

- **Collaborative filtering**

A method for generating recommendations from user profile. It uses preferences of other users of similar behavior to predict the preference of the particular user.

- **Content-based filtering**

A method that recommends items for the user based on the description of previously evaluated items and information available from the content (such as keywords)

Web-Based Recommendation Systems

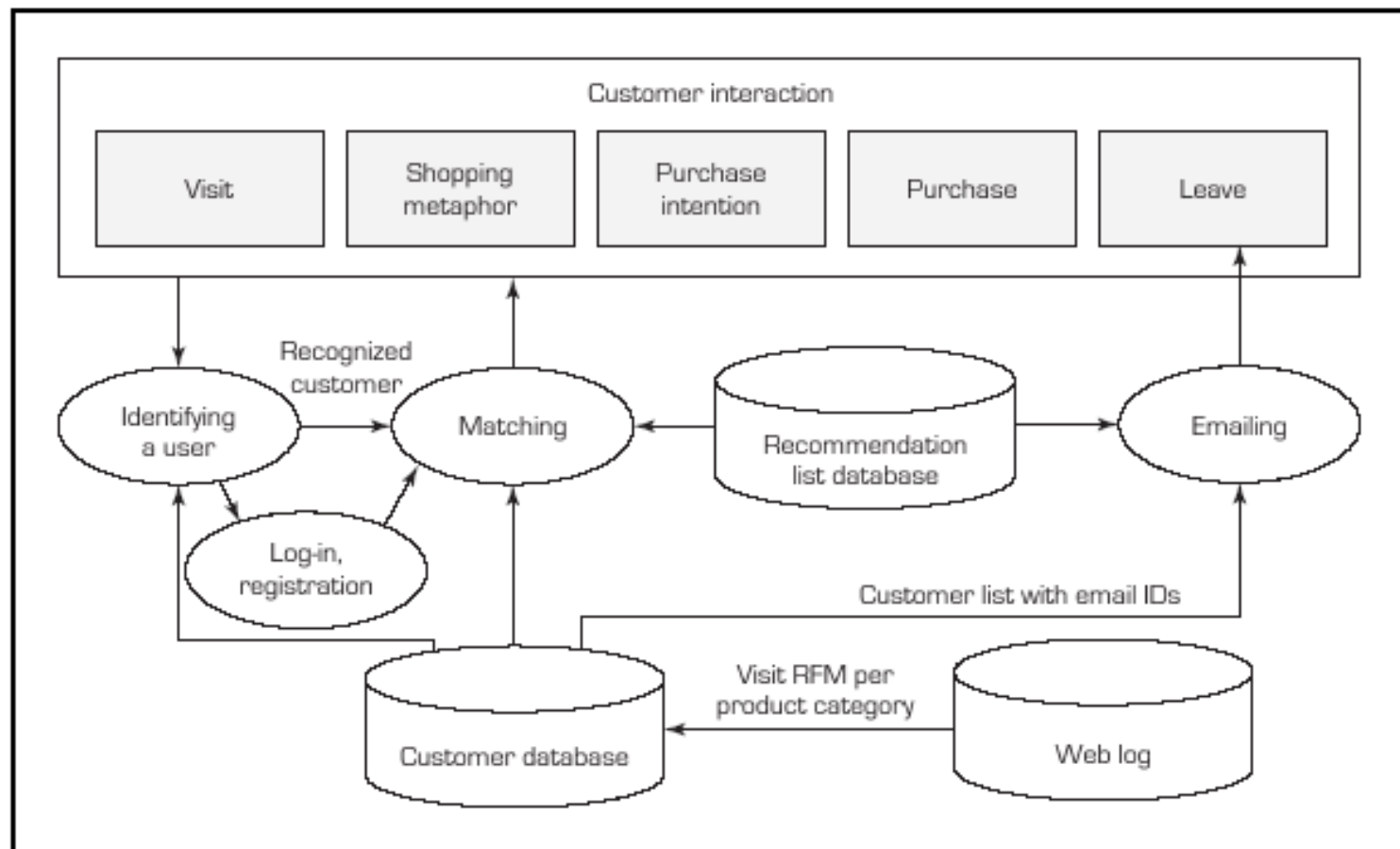
- Profile exploitation and recommendation

- **Demographic filtering**

A method that uses the demographic data of the user to determine which item may be appropriate for recommendation.

Web-Based Recommendation Systems

FIGURE 14.13 An Architecture of Collaborative and Usage-Based Web Recommender



Web-Based Recommendation Systems

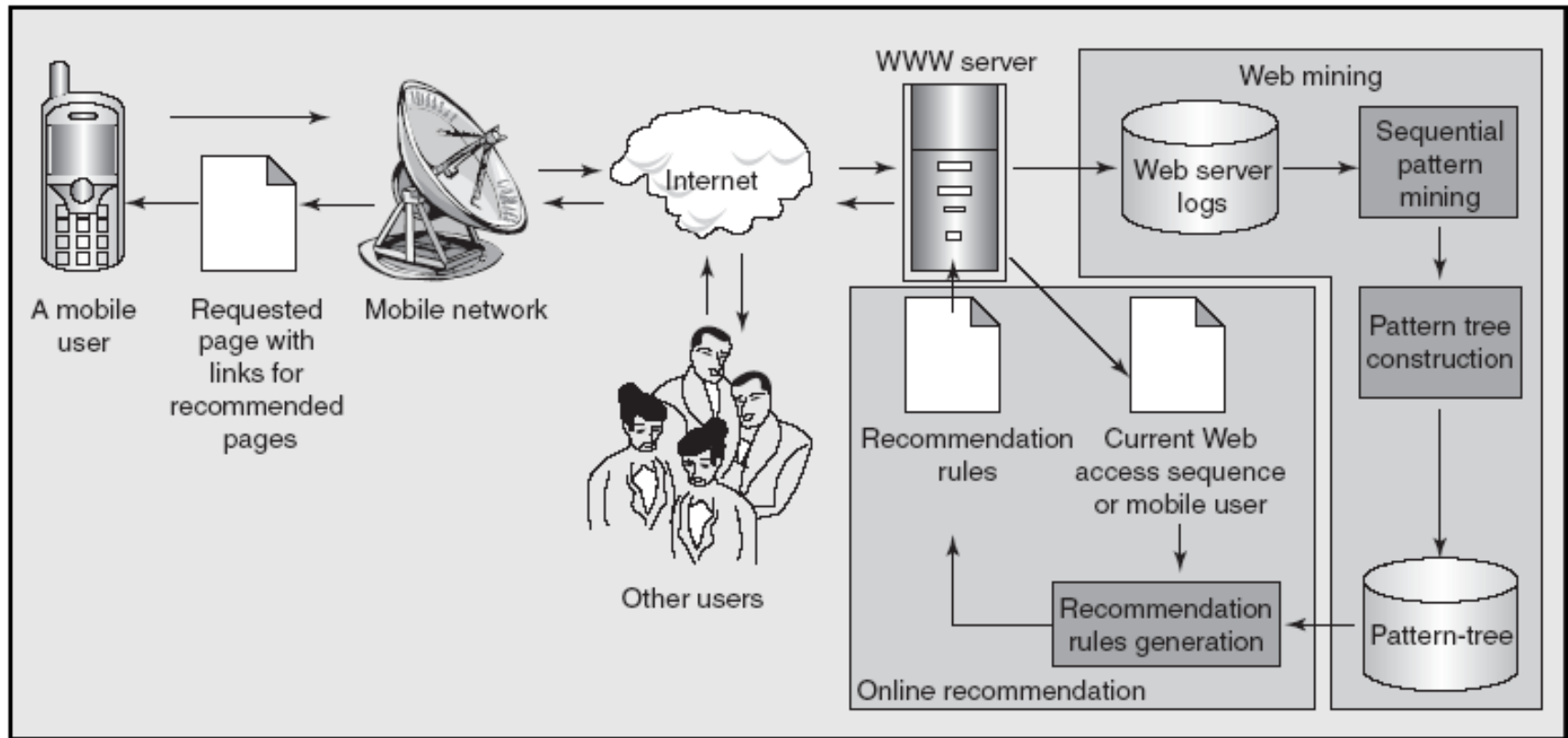


FIGURE 14.14 Architecture of a Mobile Web Recommendation System