Smart Spaces

Chapter 2:

Agent interaction models: Blackboard and Publish/Subscribe

Outline

§ 1. Shared Information Store

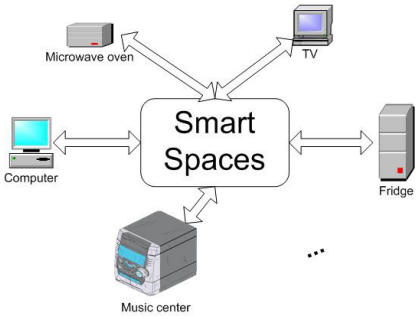
§ 2. Publish/Subscribe

§ 3. Software Agents

§1. Shared Information Store

Smart space:

a virtual, service-centric, multi-user, multi-device, dynamic interaction environment that applies ***a shared view of resources***



Model of interactions:

Blackboard

Some Properties

- Localization and dynamic hub
- Personalization
- Adaptability
- Proactive construction and delivery of services
  - Given context (situation): Personal, Environmental
  - Discover or produce the most suitable services for the user

Operations (Smart-M3)

Operation	Description
Join, Leave	Session to access a smart space
Insert, Update, Remove	Atomic transactions for an element of data. Act of publishing
Query	Requesting information. Various query languages
Subscribe, Unsubscribe	Set up (resp. cancel) a persistent query. Changes are reported to the subscriber

Space computing

- Space content:
  points, tuples, facts

  $S = (I, \rho)$

  - Information set = { points }
  - Rules to deduce new knowledge
- Shared multi-domain Knowledge Base
- Corpus-based knowledge representation

§2. Publish/Subscribe

A paradigm for large-scale Internet-based systems

1. **Publishers:**
   generating and feeding the content
2. **Subscribers:**
   specifying content of their interests
3. **Infrastructure:**
   matching subscriber interests with published content and delivering matched content to the subscribers

Key Idea

- Subscribers
  - register their interest in a topic
  - then asynchronously receive events matching their interest
  - regardless of the event publisher
- They are
  - not directly targeted by the publisher,
  - indirectly addressed through the content

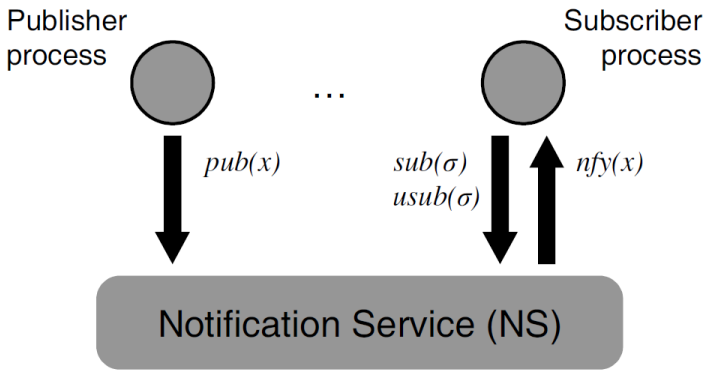
Properties

- Asynchronous communications
- Many-to-many communication paradigm
- Anonymity: The interacting parties do not need to know each other
- Decoupling in time: Partners do not need to be up at the same time
- Decoupling in flow: Sending/Receipt does not block participants
- Information diffusion

Classification

1. Topic-based
   - Publishers and subscribers are connected together by predefined topics (channels)
   - Subscription to a topic to receive asynchronous updates
2. Content-based
   - Subscribers query on the content
   - Content filtering to match subscriber interests with published content
3. Hybrid of the two
   - publishers post messages to a topic
   - subscribers register content-based subscriptions to one or more topics

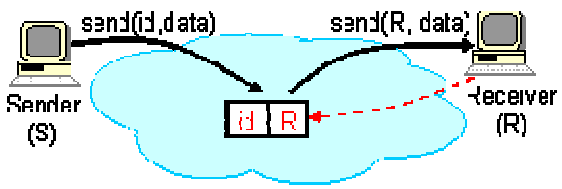
Notification Service



A pub/sub system interaction through notifications

Case study 1: i3 Model

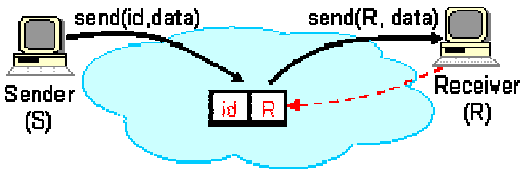
- Source (S) sends packets to a logical identifier, id
- Receiver (R) expresses interest in packets sent to an identifier
- Delivery is best-effort like in today's Internet, no guarantees about packet delivery



i3:
Internet Indirection Infrastructure

i3 Logical Rendezvous

- id represents a logical rendezvous between the sender's packets and the receiver's trigger
- This indirection decouples the sender from the receiver
- The senders need neither be aware of the number of receivers nor their location
- The receivers need not be aware of the number or location of senders



Case study 2: Pub/Sub Web

- Frequently updated content
  - Blogs (Weblogs)
  - Wikis (collaboratively authored web pages)
  - News sites
- Deliver updates to users quickly and efficiently
- Asynchronous update notification

Naïve approach

- Repeated polling at the subscriber side
  - E.g., Robots
- Uncoordinated polling suffers from poor performance and scalability
- Slow receiving updates
  - Limit posed by the polling period
  - Polling at faster rates -> high bandwidth load
  - the same content is polling independently by many subscribes

Brokers

- Publishing information through a broker
  - Middleware or infrastructure
  - In Smart-M3: Semantic Information Broker (SIB)
- Each broker maintains its subscribers
  - Subscription table
  - Filtering
  - Store and forward function to route messages from publishers to subscriber
- Infrastructure for routing and information diffusion between brokers
  - Peer-to-Peer Overlay Networks

References

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2. L. J. B. Nixon, E. Simperl, R. Krummenacher, F. Martinrecuerda. Tuplespace-based computing for the semantic web: A survey of the state-of-the-art. Knowl. Eng. Rev., vol. 23, pp. 181–212, June 2008.
3. R.Baldoni, M.Contenti, A.Virgillito. The Evolution of Publish-Subscribe Communication Systems (2003)
4. P.T. Eugster, P.A. Felber, R. Guerraoui, A.-M. Kermarrec. The many faces of publish/subscribe. ACM Comput. Surv., vol. 35, pp. 114–131, June 2003.

§3. Software Agents