Mobile Agents

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The Browser Problem

- Passive networks
  - Manually driven
  - Impersonal
- Active users
  - Short of time and expertise
  - Overloaded with information

The Agent Solution

- Active networks
  - Tasks delegated to agents
  - A personalized view
- Less active users
  - Information is customized
  - Information is volunteered
  - A proactive network
Approach

Advantages
- Communication efficiency
- Network fault tolerance
- Disconnected operation
- Development ease
- JIT software distribution
- JIT protocol agreement

Assessment

“While none of the individual advantages of mobile agents...is overwhelmingly strong, we believe that the aggregate advantage of mobile agents is overwhelmingly strong.”

*Mobile Agents: Are they a good idea?*  
Harrison, Chess, Kershenbaum  
IBM T. J. Watson Research Center

Mobile Agents
- Motivation
- Applications
- Concepts
- Safety
- Systems
- The Web
- The Future
Agents Can Watch

Personal Travel Agent

P.I.C. ➔ Pager notification ➔ Flight status place ➔ Airline feed ➔ Event occurs (watching) ➔ Paging place ➔ Network

Agents Can Search

Personal Shopper Agent

P.I.C. ➔ Collect ➔ Search Directory ➔ Type ➔ Good Guy ➔ Night Out Date ➔ Your Hotel Name ➔ Collect ➔ Network

Agents Can Orchestrate

Personal Concierge Agent

P.I.C. ➔ Ticket Service ➔ Restaurant Listing Service ➔ Florist Shop ➔ Your Maiden Place ➔ Collect ➔ Network

Agent Applications

- Electronic commerce
- Group collaboration
- Workflow automation
- Active messaging
- Event monitoring
- Information gathering
- Customization
- Distributed simulation
- Network management
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Agents Occupy Places

- Agents consume the services of places
- Agents (and sometimes places) have...
  - Autonomy (i.e., threads)
  - Authority (e.g., Ticketron™)

Agents Can Travel

- An agent travels to use a remote service
- An agent travels programmatically (“go”)
  - Arguments specify destination and travel terms
  - Transportation failures produce exceptions

Agents Can Meet

- Agents meet to transact business
- Agents meet programmatically (“meet”)
  - Arguments specify agent and meeting terms
  - Meeting failures produce exceptions
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Agents Are Interpreted

- Agents are written in a “safe” language
  ```
  // go to the warehouse
  *.go(Ticket(nil, nil, warehouse));
  // show an interest in prices
  *.enableEvents(PriceReduction(*.name))
  ```
- An agent’s language...
  - Prevents direct access to computer resources
  - Has other safety features (e.g., code signing)
  - Requires an interpreter

Agents Are Authenticated

- An agent is identified by credentials

Agents Are Constrained

- An agent is limited in capabilities

- An agent’s capabilities...
  - May limit its lifetime, size, spending, etc.
  - Are established at birth
  - Are re-negotiated for travel
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Agent Definition

- An agent is a program that can...
  - Exercise a person’s or organization’s authority
  - Run unattended for a long time (e.g., a week)
  - Meet and interact with other agents
- An agent executes on either...
  - One computer system (stationary agent)
  - Different systems at different times (mobile agent)

Agent Systems

- An agent is a figment of the imagination of an agent system
  - Language (for programming agents)
  - Library (for equipping agents)
  - Interpreter (for executing agents)
  - Protocol (for transporting agents)
  - Security regime (for protecting agents and places)

Agent Systems (Java)

- Some mobile agent systems ride the crest of the Java tidal wave
  - Aglets (IBM TRL)
  - Concordia (Mitsubishi)
  - CyberAgents (FTP Software)
  - Internet System Environment (OSF)
  - Sumatra (UMCP)
Agent Systems (Non-Java)

- Other mobile agent systems view the tidal wave from below
  - Agent Tcl (Dartmouth)
  - April (Fujitsu)
  - Clearlake (Guideware)
  - M0 (Univ. of Geneva)
  - Obliq (DEC SRC)
  - Tacoma (Univ. of Norway & Cornell Univ.)
  - Telescript (General Magic)
  - Wave (Univ. of Surrey)

Agent Languages

- Programming languages (e.g., Java)
  - Agents written by programmers
  - Then customized by MIS, etc.
  - Then parameterized by users
- Scripting languages (e.g., VBScript)
  - Enable the creation of ad hoc applications by developers numbering in the millions

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The Browser Problem

- The Web offers interactive access to corporate data
- Interactive access...
  - Supposes a human user
  - Lavishes attention on data appearance
  - Entirely obscures data meaning
The Agent Solution

- The Web should offer automated access to corporate data as well
- Automated access...
  - Requires a protocol for agent entry and exit
  - Requires metadata that gives the meaning of data

Agent Standards

- OMG is adding to CORBA a mobile agent facility (MAF)
- Collaborators
  - Crystaliz
  - General Magic
  - GMD FOKUS
  - IBM
  - Open Group

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Prediction

- Mobile agents will join the ranks of the important communication paradigms, e.g., packets, connections, RPC, and RP
- Leading indicators include...
  - Systems (Java & Non-Java)
  - Standards (e.g., OMG, FIPA)
  - Conferences (e.g., Dartmouth, Ottawa, Berlin)
  - Organizations (e.g., Agent Society)
Prediction

Q “What will be the next “sea change” in computing?”

A “A secure, truly mobile agent language—way beyond Java—will eliminate the Tower of Babel that prevents us from harvesting more of the benefits of computing and communication today.”

Marc Andreessen, CTO
Netscape Communications
Byte Magazine, December 1996, p. 86