Mobile Code and Agents

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Mobility

- Movement of bytes
- Movement of typed data
  - \texttt{Int i = 1002; Send (s, i);}  \textit{--- you are sending a type defined in C/Java/C++/Smalltalk}
- Movement of member functions
- Movement of processes
- Movement of objects
- Movement of objects with state
- Movement of devices
- Movement of agents
Agents

• What are agents?
  – Are objects agents?
  – Are mobile objects agents?
  – Are servers agents?
  – Should agents be always mobile?
  – Is broker an agent?
A definition of agent

• Persistent
  – Code runs continuously—though it could be on demand

• Autonomous
  – No human intervention!

• Social
  – Communication and collaboration with other agents

• Proactive
  – It perceives/reads environments and acts on it, on its own
A Classification of Agents

● Autonomous Agents
  – Biological
  – Robotic
  – Computational
    ● Software agents
      – Task specific
      – Entertainment
      – Viruses
Degree of agent-orientation

- **Non agent**
  - Does not show the characteristics defined earlier

- **Moderately an agent**
  - Spell-checker (persistent, autonomous, but reactive, non-social!)

- **Strongly an agent**
  - If the spellchecker can communicate with other spellcheckers and update its local dictionary
Shohm's Agents

- Agent has mental components such as beliefs, capabilities, commitments

What computations are rightly modeled as agents?

- Should light switch be modeled as an agent?
- Should Operating system be modeled as an agent?
Objects Vs. Agents

- Objects perform predefined tasks

- An agent can evolve another agent giving it a new capability
Some Mental Characteristics of Agents (e.g. Agent-0 language)

• Action
  – e.g. Agent robot raises arm at time t

• Belief
  – e.g.. At time t, an agent A believes that fact F is true

• Obligation
  – Agent a is obliged to have dinner with b at time t

• Decision
  – Agent a has taken decision to open door at time t

• Capability
  – Agent a is capable of opening the door at time t
Example: Plane agent

- Plane is controlled by ground control unit
  - Where to go and at what time

- Plane takes that action only when it is capable of doing so
Recent Developments

- FIPA (Foundation for Intelligent Physical Agents) standard
  - (now an IEEE standards committee)
- 1997-98 about 25 specs were released
  - Abstract agent architecture
  - Agent content language
  - Agent management
- JADE (Java Agent Development Environment)
A Typical Agent State Machine

- **Waiting**
  - Wait
  - Wake up
  - Move
  - Execute

- **Active**
  - Wait
  - Resume
  - Move
  - Invoke

- **Suspended**
  - Resume
  - Suspend

- **Initiated**
  - Create

- **Unknown**
  - Quit
Mobile Ambients

- Calculus of mobile agents
  - Software
  - Devices

\[
\begin{align*}
n & \quad \text{names} \\
M := & \quad \text{capability} \\
in n & \quad \text{can enter into } n \\
out n & \quad \text{can exit out of } n \\
open n & \quad \text{can open } n \\
P, Q, R := & \quad \text{processes} \\
(new n)P & \quad \text{new name } n \text{ in } P \\
0 & \quad \text{nil process} \\
P \mid Q & \quad \text{composition} \\
!P & \quad \text{unbounded copies available of } P \text{ (replication} \\
n[P] & \quad \text{ambient} \\
M.P & \quad \text{action}
\end{align*}
\]
An Example Ambient System
Another Example Ambient System

Open n.P

Q