Tutorial

**Title: Implementing Agent Applications in Java:
           Using Mobile and Intelligent Agents.**

Presenter(s):

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Tutorial Abstract:

Agents are Intelligent software components that act autonomously on the   behalf of users, can analyse and access a diverse range of information,   can react to changes in their environment, and can cooperate and   coordinate their activities to complete a goal. Such components may be   distributed across a network, and may work seamlessly to perform this goal. The availability of programming languages such as Java and object   systems like CORBA, provide features that are conducive to the use of agents in application development, due to the availability of specialised class libraries (such as networking) and interfaces to standard services,   such as persistence, life-cycle support, match-making, amongst others.   This tutorial identifies common features between object orientation and   multi-agent systems, and uses this as a backdrop to study implementation   approaches which utilise objects with behaviour, and objects that can   migrate autonomously based on changes in their operating environments.

Detailed Description:

1. CONCEPTS

- Are agents not just objects? -- why the fuss?
  This is a commonly asked question, and even today continues to plague' discussion forums and mailing lists on agents. This will be the first topic considered Agents will also be compared with Actors
- What then IS an agent?
  Various definitions will be covered, based on different communities involved in agents research -- software engineering, logic programming, autonomous robotics
- Common Services: Objects and Agents
  Common features of multi-agent systems will be used to describe services that may be employed from object environments, such as CORBA. The audience is not expected to know anything about a CORBA system.
- Agent themes:
    - Aspects of agency will be described briefly, as follows:
    - The 'Belief-Desires-Intention' model and Agent-0

- Common Agent Architectures: What's inside an agent -- look at an internals of an agent from one commercial and one academic agent development tool: LALO (CRIM, Montreal) and AgentBuilder (Reticular Systems, San Diego, California)
- Describing 'Concepts' in Agent Systems: The Role of Ontologies

2. INTELLIGENT AGENTS and INTERACTION
- FIPA standards for intelligent agents
- An overview of the standard will be provided, giving a summary of FIPA ACL, KQML and agent interaction
- Common agent Services and Protocols (two examples: English Auction, Dutch Auction)
- The role of Ontologies and domain dictionaries

- Agent Communication
- Messaging and layering techniques used for agent interaction
- Expressing knowledge using Object Oriented techniques
- Implementing FIPA Agents
- FIPA-Open Source from Nortel Networks will be discussed which implements FIPA-97. The product is available free of charge from the Nortel web site, and delegates can download for their own use. FIPA-97 requires the use of Iona's OrbixWeb or Object Space's Voyager ORBs as transport. FIPA-97 also requires XML to encode agent communication. FIPA-Open Source is implemented in Java, and delegates will be expected to know a little about this programming language.

Both CORBA and XML will already have been discussed with reference to the 'Common Services' in the Concepts section (1) above.

- Implementing Intelligent Agents
- A commercial tool, AgentBuilder from Reticular Systems will be used to explain how to construct intelligent agent systems. The tool uses the Belief-Desires Intentions model, and is being widely used within the Agent community.
- A buyer-seller agent example will be discussed in detail, which involves a simple interaction between buyer and seller agents, interacting with each other using Java RMI. The programmer does not need to know Java RMI, and must simply describe ports over which agents need to communicate. The rest is automatically handled by AgentBuilder.

3. MOBILE AGENTS
- Differences between Mobile agents and mobile objects
- How mobility is achieved with mobile objects -- check pointing state of an object, migrating and re-storing state
- Thread check pointing
- Autonomous migration and writing class loaders in Java for support of mobility
- Mobile agent standards: locating and naming mobile agents

Mobile Agent Framework (MAF) and Mobile Agent System Interoperation/Integration Facility (MASIF) will be described

- Describing and changing travel itinerary
- Linking and interacting with other information sources -- such as databases
- Implementing mobile agent applications
- Aglets mobile agent libraries

The Aglets API will be summarised with a sample application

- Issues in mobile agent design
    - Mobile agent security
    - Thread migration vs. agent migration
    - Message handling and multi-cast groups
    - Activation/Deactivation of mobile agents
    - Cloning and dispatching mobile agents
    - Event handling in mobile agents
    - Use of mobile agents for load balancing

- Common themes in mobile agent development tools
    - Aglets (IBM) vs. Voyager (Object Space)

The two most popular libraries will be compared, based on the following criteria:
- ease of development
- ease of integration with other information sources
- support for third party APIs, such as XML
- ease of maintaining software
- support for security

4. JINI -- INTELLIGENT NETWORKING WITH JAVA
- JINI forms the core infrastructure for the DARPA project CoABS (Control of Agent Based Systems) -- this part of the tutorial will look at core services provided by JINI that are important for agent development
- How JINI relates to a distributed computing infrastructure with reference to the various components of a JINI system -- in particular how JINI relates to Enterprise JavaBeans and CORBA systems
- Each aspect of the JINI system will be briefly discussed, such as:
    - Describing services in JINI
    - Using the LookUp service and enabling dynamic device connectivity via the Join-Manager
    - Distributed Leasing and implementing a Lease Consumer
    - Exporting and Managing Leased resources
    - Brief overview of Remote Events
    - Brief overview of JavaSpaces
- The use of Web servers and HTTP protocols to enable dynamic device discovery and device connectivity

5. QUESTION and ANSWER SESSION
- - Applications focus: developing high performance applications using Agents.
- Areas:
    - Data Mining (Commercial)
    - Molecular Dynamics (Scientific)
    - Bridging the gap between commercial and scientific computing using agent technology
    - Debate
        - (5 to 10 minutes)
        - audience interaction to determine the perceived role of autonomous agents

Schedule:
  Part 1 (30%): Concepts
  Part 2 (25%): Intelligent agents and interaction
  Part 3 (30%): Mobile agents
  Part 4 (10%): JINI - Intelligent networking with JAVA
  Part 5 (5%): Question and answer session
Note - % indicates the percent of overall time dedicated to each topic.

Duration:

Half day tutorial.

Level:

Varies depending on the part of the tutorial. Delegates will be encouraged to attend part of, or the complete tutorial. In this way, delegates may be able to attend multiple tutorials being offered on the same day, depending on their particulars interests.

Required experience:

All delegates will be expected to know:
  • General principles of object orientation
  • A familiarity with the Java programming language -- however, the 'CONCEPTS' and 'QUESTION and ANSWER SESSION' will not require this. Delegates who are interested in learning about implementing agent systems and in particular, identifying overlaps between objects and agents are encouraged to attend.

Expected audience:

The tutorial will be beneficial to participants working in object oriented systems, and interested in applying agent technology. The tutorial begins with a general introduction about various themes in the area, then focuses on particular aspects of agent techniques that could benefit large scale object oriented systems, such as code mobility, recommendation services, match making in the context of data mining and load balancing across clustered environments. A comparison with other systems such as LSF, CONDOR and Codine will be provided to motivate the tutorial. Common things that can be shared between agents and existing resource management systems will be highlighted.

The intended participants should have an appreciation of techniques such as multi-threading and object oriented programming. The ideal participant will be one who has heard about agent based computing, and is now interested in finding out more, and perhaps how these techniques could be applied in his/her own application programs, or development environments.

Developers will be given some code samples and implementation guidelines to try out -- but non-developers will be welcome to attend the first part of each of the four presentations, which will concentrate on concepts and best-practise, rather than implementation details.

The participants will gain an insight into the use of mobile and intelligent agents with object oriented systems such as CORBA. The difference between thread mobility, active messages and mobile agents will be highlighted using a data mining algorithm. Extensions to other application domains will also be discussed, in particular load balancing and automatic software configuration.

The emerging areas of dynamic and intelligent networking based on JINI will be discussed, and delegates will be encouraged to raise issues that may have impact in the particular applications they are developing. Mobile objects can be employed within any application that makes use of the object oriented paradigm, and therefore the generality of the approaches discussed will enable participants to employ these techniques in a wide range of contexts.

The extension to dynamic resource discovery, using KQML/KIF libraries, such as JKQML from IBM Research will also be demonstrated, with example programs. The use of KQML based messaging, built over MPI, will be demonstrated for building a large society of agents, some of which may be mobile.

Presenter's profile:

Dr. Omer Rana

University of Wales, UK

Dr. Omer Rana is an assistant professor (lecturer) at the Department of Computer Science at the University of Wales Cardiff, UK. He has been actively involved in the public understanding of science, working with BBC radio and   television, Channel 4 and the Discovery Channel as part of ScienceLine. He has been a visiting research fellow to BT Labs, where he has worked with Aglets for implementing parallel data mining applications in telecommunications. He was a visiting research fellow to the North East Parallel Architectures Center
at Syracuse University, in New York, where he worked on high performance Java under Professor Geoffrey Fox. Dr Rana participates in the European AgentLink network under the 'Methodologies and Software Engineering for Agent Systems'
special interest group, under which he is co-ordinator with Mario Kupries (from Potsdam, Germany) of 'Architecture based approaches to developing High Performance Multi-Agent systems'.

He teaches distributed computing, multi-agent systems and AI to both undergraduates and postgraduates, and has also presented these courses to local companies, such as BT, Nortel and Hyder. He has also been actively involved in special interest groups in high performance Java. Dr Rana organised the 'Agent based High Performance Computing' workshop, jointly with Professor David Kotz (Dartmouth College) at the 'Autonomous Agents 99' conference in May. He is co-organiser for a workshop on 'Infrastructure for Scalable Multi-Agent Systems" at Autonomous Agents 2000, to take place in Barcelona, Spain, and a workshop on Emergent Computing in Cardiff, both in June 2000.

His research interests are performance engineering for Scalable Multi-Agent communities, Problem Solving Environments and High Performance Computing. Dr Rana holds a PhD in Neural Networks and Parallel Architectures from Imperial College, London.

- Part of the tutorial given at the JavaGrande conference is available from:
  http://www.cs.cf.ac.uk/User/O.F.Rana/tutorial/introduction.ps in postscript format
- Web site for the course on Distributed Multi-Agent systems is at:
  http://www.cs.cf.ac.uk/Igds/distagen/
- Web site for Agent based conferences organised (or co-organised) by the presenter:
  http://www.cs.cf.ac.uk/User/O.F.Rana/agents99/
  http://www.cs.cf.ac.uk/User/O.F.Rana/agents2000/
  http://www.cs.cf.ac.uk/emergent2000/