

Subject: Puppies work-shop summary

Dear ANSA Sponsors

Last week we held the work-shop to gather ideas and set direction for the PUPPIES project. This proved a success and we obtained much valuable feedback.

As we hope to enlarge the project with ESPRIT funding we invited the main partners of that proposal. INRIA and FAST gave presentations outlining their pilot applications. Due to illness UWE were not able to attend, but we were also much obliged to NORTEL who stepped in at late notice to discuss their views on intelligent agent technology.

The format of the day consisted of a series of informal presentations and discussions. These were designed to outline the project and to investigate a range of topics.

Through feedback from members present, we attempted to clarify the direction of the project. Discover what the important areas for sponsors and which topics ANSA should concentrate on.

The areas we covered were:

- * Initial aims and goals of the project
- * Outline of the ESPRIT proposal
- * Overview of the two pilot applications
- * The proposed mobile agent model
- * Security issues, in particular those relevant to mobile code.
- * The limits and successes of intelligent agents
- * Examination of "Aglets" - mobile agents from IBM
- * Responsibilities and possibilities of the infrastructure
- * Realistic user interface goals.

As you may gather, it was a full day and with a good deal of interaction from the audience.

I have attempted to present a summary of the day as a series of topics which were discussed, and the implications for the Puppies work-plan. Some of these are direct feedback to questions presented, others are spontaneous input from the audience.

Generally, the implications for each of these topics fall into three broad categories. These are:

A topic will be:

- * Incorporated as part of the project
- * Investigated, but not necessarily implemented. For example: discussed in, or as part of a report.
- * Sufficient work already exists in area, investigate the architectural questions only.

On most items there were a general agreement about what was important. Occasionally, members did differ. In these

cases I hope I describe the majority view.

I have grouped topics into various areas which the day covered. Those topics which fall into more one areas I have attempted to list them under the most suitable heading.

AREAS COVERED

General:

- (1) It was essential that a "tool kit" approach to the system should be taken. The architecture must be modular and allow the constituent parts to be used and investigated separately.
- (2) Any design should be efficient. However, it was realised that current shortcomings may make an implementation slower than in a "production system". Java and the Java Virtual Machine are examples of this.
- (3) The project should concentrate on "application" level software. Where possible, available software should be utilised. This would be particular relevant in the user interface work and in some of the infrastructure components.
- (4) It is essential that the project produces results which sponsors could exploit. Again it was felt that the best means to achieve this was to concentrate on the application level aspects.
- (5) Although there are few "standards" in the mobile agents world, it is important that we keep abreast of these and employ them - if they become available in the correct time frame.

PUP Model:

- (1) The proposed model of Personal agents (PUPs), Task agents and information gatherers (PIGs) seemed a reasonable starting point. The division of roles and responsibilities also appear to conform to the security requirements. We will therefore use these components as the basis of the design.
- (2) It was generally agreed that a conventional programming language APIs would not be sufficient to obtain information from thousands of different vendors world-wide. These interactions would need to be performed at a more abstract level. It was therefore important that we investigated current approaches to tackling the problem and incorporate a solution into the project.
- (3) The concept of a PUP learning its master preferences is a very important aspect of the project. A PUP should be intelligent enough to apply what it has learnt from one situation to another which is similar.

An example of this is a users' newspaper preferences. A user's profile created by reading one paper could be applied to another source. This is to be investigated and if possible implemented. Ideally, this capability could be applied to less closely aligned information sources.

- (4) It is not only the user who requires access to their profile. The ability to derive general preferences or knowledge from a community of users is important to network and service providers. Both pilot applications could use this pooled information for load balancing and predictive calculations.

The questions of which data third parties can access from a user's "personal" information is therefore an issue. This is an important issue which the project needs to address.

- (5) Similar to the above is the issue of third parties being able to store information in a user's profile. Only the creator of this data, or their agents (sic) would be allowed to modify it. This could be used in billing for example. This topic will be investigated.
- (6) In the current PUP model, there is a separate agent which is responsible for gathering information. This is known as the PIG. Members of the audience foresaw there could be a market for PIG developers, with the user being charged for its use. Specifying the requirements that the user wishes these third party agents are to adhere to, is complex. This area will be investigated and if possible implemented.
- (7) Public networks is the intended home turf for the Puppies project. Members of the audience raised the question quality of service over this type of network. Obviously, no guarantee of service can be provided. However, one objective of the project is the ability for the user to perform actions while off-line. An example of this is the general ability to fetch information and have it cached "locally" for better access times.

Intelligent Agents:

- (1) Goal based adaptive agents were seen as potentially powerful tools. If realised, they could provide a convenient and efficient means of performing work. This could be particularly beneficial if the user was connected via a device with limited capabilities (for example a mobile phone).

Members of the audience with experience of this world stressed it was a non trivial task. The best approach was often an amalgamation of AI and conventional techniques. This input was very valuable and we would like to discuss this further with sponsors.

- (2) The ability for agents to cooperate was seen as an important aspect of the project. They allowed users to get the job done more quickly, and were important to the infrastructure to eliminate duplication. This is will be investigated and incorporated into the project.
- (3) The ability to learn about a users' preferences has been discussed above. There was some discussion about the best way to implement this. Conventional techniques such as context dependent were discussed. In addition, more A.I. approaches - such as neural networks were suggested. There was some feeling that conventional mechanisms may be too area specific. However, this is an essential part of the project and we will investigate which approaches (or combination thereof) may give the best results. Once again, we would like to discuss this with sponsors.

Security:

Although many of issues surrounding security are technically complex, the legal problems seem to be the more challenging. Numerous organisations (including some ANSA sponsors) have taken sustained legal advice on the subject. The puppies project adds a few extra complications.

Mobile agents will both communicate and migrate over international borders. In addition to the normal complex rules on the security mechanism which can be deploy in a particular country, mobility could require these change before or even during an interaction.

- (1) There are a number of security issues which we could investigate. For agents to be mobile, they must first ensure that the place they intend to move to is "secure". We will investigate possible means of achieving this and implement a suitable level of trust.
- (2) From the other point of view, the node may wish to restrict those agents which it allows "in". One possible solution is signed applets. Much external work is already being done on this area. We will therefore limit our research to designing general means of incorporating this style of trust. We will track developments and implement a protocol if one becomes available in the correct time frame.
- (3) Communication over public network also needs to be secure. It is foreseen that numerous packages already or will exist in a relevant time frame. However, given that PUPPIES requires a "plug and play" style of architecture we will attempt to encapsulate these package in a standard interface.
- (4) Another important question arising from this modular approach is the requirement to negotiate which security protocol to use. This decision is also influenced by legal issues. We will investigate approaches to negotiation.
- (5) Agents acting on a user's behalf may given empowered

to carry out transactions for that user. An extremely detailed audit trail would be required to demonstrate the circumstances where a transaction took place. This audit trail would have to be kept for many years.

It is not the intention to build a complex or legally compliant audit trail. Only basic event histories will be captured. If time permits, we will investigate, but not implement, approaches for capturing audit trails in this type of distributed system.

Infrastructure:

- (1) Puppies aims to cater for "homeless" users. These could be either mobile or domestic users. The common characteristic is that their data is held on "the network" with their access device acting as a gateway.

A key question about the infrastructure is how information and services can be maintained and made available to a very large user community. This is made more complex as members of that community are potentially mobile. These are some of the key issues for the project.

- (2) The ability to efficiently name, locate and track mobile entities is essential to the project. These entities may be the users themselves, agents acting on their behalf, their data or services which they wish to access.

Various possible models were presented. These ranged from standard traders to more peer based approaches. It is proposed that more investigation is done to determine a suitable model.

- (3) In order to attempt to unify the above mobile entities, it was proposed that we examine using mobile agents to encapsulate parts of the infrastructure. The areas suggested were: intelligent agents, data, facilities, and information and service providers. This could lead to some powerful possibilities such as mobile filing system. There were also other spin-offs such as anonymous service providers.

There was some concern that this would lead to inefficient implementations with objects carrying unnecessary baggage. However, there was general consensus that this approach should be investigated as some the benefits could be applicable well outside this particular project. We will therefore investigate and implement these encapsulations.

- (4) The problem of attempting to "prune" information or agents from a system is non-trivial. It would however be essential to any real puppies system. Suggestions ranged from pricing strategies to spotting unused or unwanted resources. It is clear that eventually a node provider may have to either evict mobile entities or remove them. The project will attempt to investigate mechanisms to determine which objects should be "pruned". However, this will not be a major research topic.

- (5) There are numerous ways which users could be charged for using a Puppies system. These range from renting PUP space from an internet service provider, to the use of a PIG, and also charging for accessing information or other services. It was generally agreed that the project should not concentrate on this subject.

Aglets:

The mobile agent software from IBM seems a reasonable offering. There are questions of access to internals but on the plus side, aglets seem to have the lead on other known offerings.

- (1) It is foreseen that greater access to some the internals may be required. This is to implement some of the infrastructure features and also the security mechanisms.
- (2) Sun may also be developing aglet capabilities into the standard JVM. We will obviously be tracking these developments.

User Access:

- (1) The approach which we outlined seem to meet with general approval. This consisted of separating the device driver from the transformations required to present a particular service. For example, a user on a mobile phone wishing to review a document. These different processes may run on the same or indeed separate machines.
- (2) We attempted to gain input on which devices we should support. Apart from the standard (Web browsers platforms, mobile phones, and PDAs) the audience had no burning issues about which devices they wish incorporated).

References:

Some references for further reading:

The Agent Society:

<http://www.agent.org/>

Intelligent Software Agents:

<http://www.cs.umbc.edu/agents/>

The Intelligent Agent Group

<http://www.cs.tcd.ie/Brenda.Nangle/iag.html>

Conferences on Autonomous Agents

<http://www.isi.edu/isd/Agents97/info.html>

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