FollowMe

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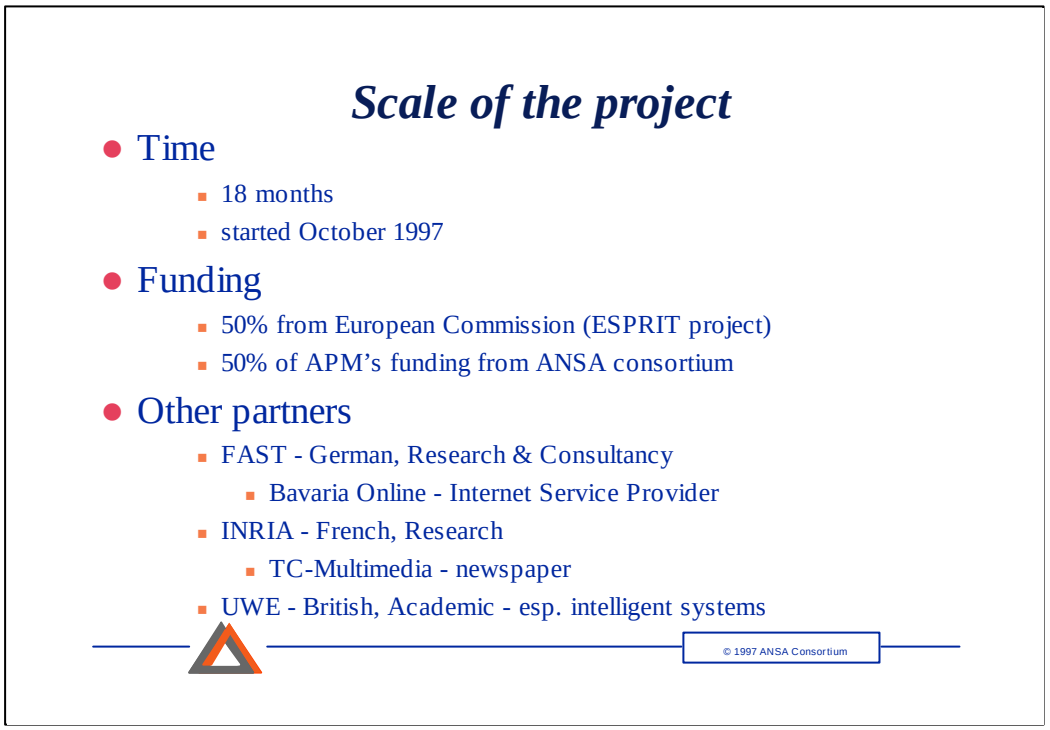
Goals

- Understand Agents
  - Mobility
  - Location
  - Autonomy
  - Negotiation
  - Scalability
  - Security

The Goals of the FollowMe project (once called the ‘ Puppies’ project) are to understand a number of issues around mobile agents. The project will build a working mobile agent system, with two pilot applications to be deployed in the real world. These allow the project to collect real world requirements without being tied to one particular model of the application space.

The project has decided to avoid ‘ intelligent’ agents, and to concentrate instead on the infrastructure for mobility which such agents could leverage in the longer term as more sophisticated intelligent systems develop.



The work is funded 50% by the European Commission (EC) as part of the ESPRIT research programme, and the ANSA consortium provides the other 50% of the funding for APM' s involvement. FollowMe results are made available to ANSA sponsors.

The project commenced in October when the EC provided the money and has made for an excellent start.

Fujitsu' s Takanori Ugai has been extremely helpful in several areas of the work so far. In particular, his work on comparing agent technologies and on security issues have been particularly important.

The other partners are:

• FAST - Bavarian Research for Software Technology

• Bavaria Online - promotes day to day use of the Internet for small to medium sized businesses

• INRIA - French software research

• TC-Multimedia - part of Ouest-France newspaper, daily in west of France, many editions. Currently runs ETEL electronic newspaper project on proprietary ISDN connection, would like to expand into ETEL++

• UWE - University of the West of England. ICSC (Intelligent Computer Systems Centre) is a self-funding organisation within UWE.

Benefits to ANSA

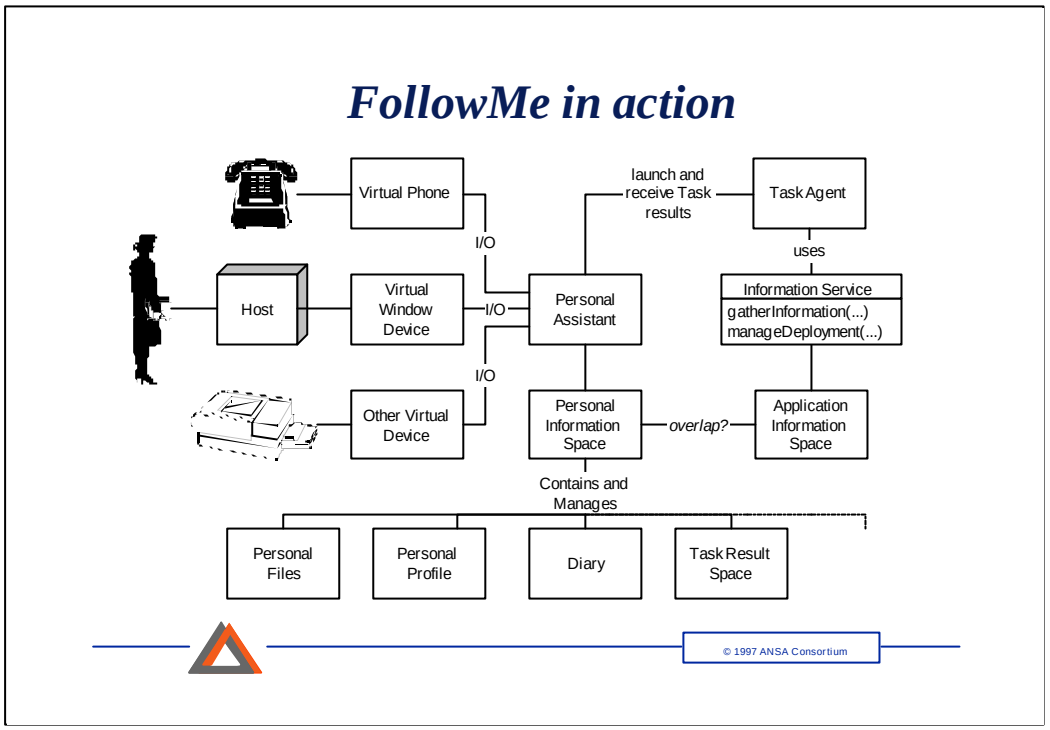
- Are agents a useful Internet applications model?
- What are the system needs of agent applications?
  - distributed, mobile objects and information spaces
  - migration of agents
  - security of agent code, agent data, places, services
  - directories
  - trading and request broking between agents and services
- Working with real world applications
- Short time scale

The benefits to ANSA are several, and build on the current focus of the research programme by extending distributed systems with mobility. The FollowMe project gives the consortium and its members the chance to experiment with agents as a possible Internet applications model, while also using two real world applications over a short time scale - the project is only eighteen months long, and all the components that make up the system (not the pilot applications) are due by the end of month 14 - November 1998.

Some of the issues we will be examining in detail, include:

- mobility
- migration
- security
- directories
- trading and request broking

We have already discovered that approaching these issues from the viewpoint of distributed systems has allowed us to avoid many of the mistakes made by some other implementers of mobile agent systems.



This diagram gives a non-detailed use-case scenario of FollowMe in action. Central to the system is a Personal Assistant - a type of agent. It controls Task Agents, which interact with services, which have Application Information Spaces which they may need to access. The Personal Assistant feeds results (or reads data) from a Personal Information Space. In this space are found a variety of different types of information, such as Personal Files, Diary and a Profile of the user.

The User interacts with the FollowMe ‘ system’ via Personal Assistant, but may do so in a variety of ways. These all happen via ‘virtual device’ - this is part of the User Access work package.

It should be noted that the Mobile Object Workbench is not visible in this diagram. This is because it sits at a level below this description, and is used by many (if not all) of the components shown. It is not expected to be visible to the average user in any way.

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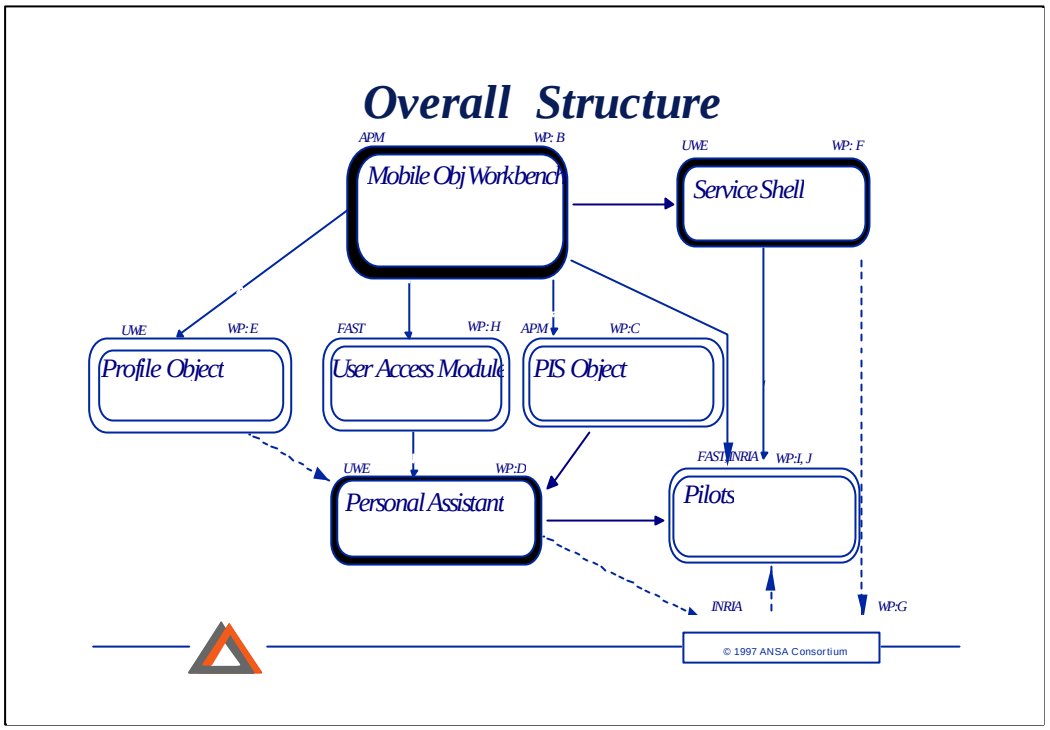

This slide briefly explains the different parts of the FollowMe project, and the responsibilities of the partners involved. As can be seen from the diagram, the Mobile Object Workbench is required by all the other parts of the project, directly or indirectly.

The partners responsible for each part, and the name of the work package, are also provided.

APM's involvement

- Work package A - Architecture
  - maintain conceptual consistency
- Work package B - Mobile Object Workbench
  - provides mobility at the object level
    - not agents
  - provides concept of ' place' - an environment for objects
- Work package C - (Personal) Information Space
  - a single and consistent (i.e. logical) view of an information space
    - designed for mobile users

APM is work package leader for three work packages, and therefore in charge of the majority of work in each.

Work package A (10 months total: APM 5 months)

Architecture - APM' s task is to coordinate this work package to maintain an architecture which keeps conceptual consistency across the project.

Work package B (29 months total: APM 26 months)

Mobile Object Workbench - a low-level framework and API, building on distributed systems expertise, providing an environment for mobile objects and basic facilities. Distinct from an agent framework.

" This work package will deliver a workbench upon which the other strata will be implemented. It is intended to provide facilities for object movement to allow the creation of a variety of high level services, but does not include the creation of these services."

Work package C (8 months total: APM 8 months)

(Personal) Information Space - now no longer specifically for people, but for any entity within the system, it provides a logical view of an information space which may well be distributed and whose constituent parts mobile.

" The information space provides a facility for maintaining, accessing and collating information. It provides mobile users with a single and consistent (i.e. logical) view of an information space irrespective of where they are located. Both users and agents may potentially access an information space - though it may be that only Personal Assistant agents have access to a user' s personal information space."

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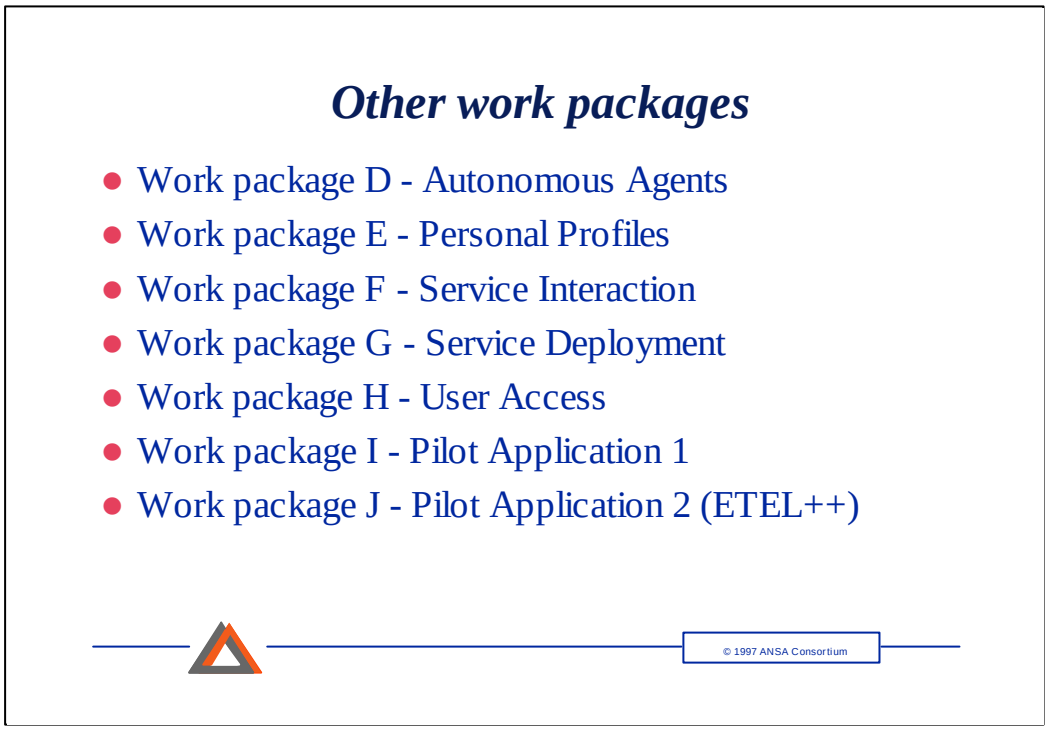

Autonomous Agents - This work package will provide a framework to allow the selection, dispatch and subsequent return of agents acting in order to complete tasks.

Personal Profiles - The aim of work-package E is to determine a representation for the storage of personal information in support of other FollowMe components. This profile is a human-readable document from which one or more profile objects may be constructed. The profile object will present an interface by which the content of the profile may be obtained.

Service Interaction - The aim of this work-package is to define a pattern for making services available to FollowMe agents. This will develop a service description language and tools which use these descriptions for service location. A major aim is extensibility; the ability to add new services without rebuilding the code. Consequently, these descriptions are characterised as service profiles using similar techniques to those in the Personal Profiles work-package.

Service Deployment - This work package will deliver: low-level tools which provide applications with performance measurements and predictions; an example of a service deployer dedicated to Etel++.

User Access - The User Access will provide: access to Java enabled devices for output and input; access to fax and telephones (not Java enabled) for output and input; error feedback to the agent who required the delivery, e.g. "device not responding"; feedback to the agent responding to delivered information, e.g. providing a way of communication between the agent who required the output of information and the user.

Pilot Application 1 - The scope of the pilots is to implement applications with the following core features:

Applications enable automated task execution while the user is off-line. Information retrieved and processed (i.e. filtered) by agents is stored in a location close to the user (i.e. in the user's LAN or at the ISP of the user). Applications allow the user to be mobile. This means that the user will be able to access the applications from different devices (i.e. Java-enabled devices, fax-machines, mobile phones) and from any geographical location. Information related to the user will be stored in a user trusted environment (in personal profiles).

Pilot Application 2 - The purpose of ETEL++ is to show the benefits of having mobility to users and data. Its goal is to unveil low-level features (mainly MOW and Service Deployment) via the manipulations of an electronic newspaper across a network.

Work so far - WP A

Work package A - Architecture

- Architectural backbone
  - RM-ODP based OMT models
  - shared concepts, terms
  - issues to be resolved
  - dependencies
- Strata
  - represent work from each work package
  - status, scope, issues, OMT models, “components”, function, API, requirements on other strata

Work package A, the Architecture work for the FollowMe project, has been split into two parts, the architectural backbone, and a set of strata (levels). There is one stratum for each technical work package (e.g. Autonomous Agents, Service Deployment). Although these two parts are kept separate, there is a great deal of connection between them.

The backbone holds information which is ‘ shared’ across the project, such as models for interaction and terminology. In particular, there are OMT models (based on an RM-ODP approach), a set of shared terms and concept which are explained in the text, a list of dependencies between the strata. It is here that issues which are yet to be decided in the project are kept, so that discussion can go on around them until it is decided which stratum should claim them.

Input to the strata is controlled by the partners in charge of each work package, and represents a summary of the work currently done within each. This allows other partners in the project to keep up to date with issues and requirements from other strata.

Each stratum follows a template so that they contain similar information, though the amount of information will change as work proceeds at different paces for each work package.

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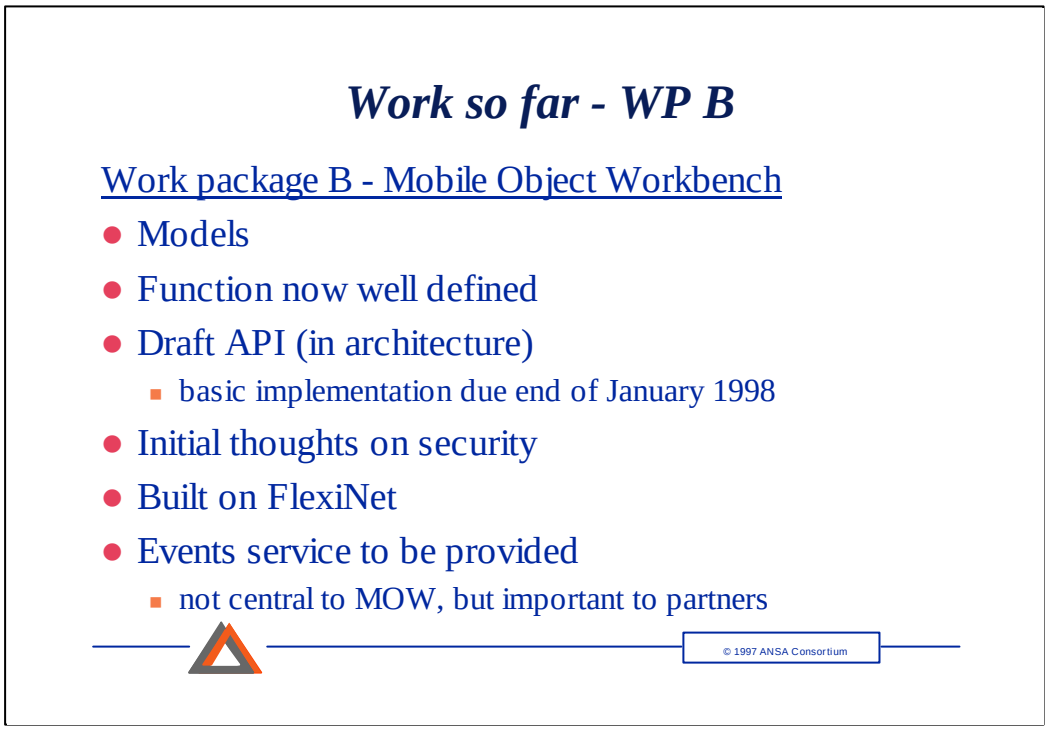
Work so far - WP A (cont.)

- Status
  - delivered 28 Nov. 1997
  - available to Fujitsu
- Will evolve as the project progresses
  - deliverables March 1998, September 1998
- Input received from all partners
  - different levels of detail
    - as expected
    - allowed us to agree on important concepts

The first deliverable for work package A (the Architecture) was delivered to the partners in the project at the end of November, and is available to Fujitsu and other ANSA sponsors. It is not, and was not planned to be, a 'finished product', but will evolve through the project, as more information is available from each work package. There are further deliverables in March and September 1998.

Among the decisions made has been to use Java 1.1 as the base language for the project. A move to 1.2 is likely once the partners agree that it is stable enough for use in this setting.

Although it is not complete, we have been very pleased with the state of the architecture. Considering that the project only started at the beginning of November, and that we have several partners in different parts of Europe, all with different ideas of the project, we have come to a remarkable amount of agreement. The partners have all worked very hard, and have provided more input than expected. These are at different levels of detail, but this is as expected, given than some work packages are further on than others.



Work package B - the Mobile Object Workbench - is continuing very well. We now have models for interaction, including state diagrams for movement, and the functionality of what should be included in the workbench is now well defined. A draft API is available, and included in the architecture - a basic implementation to this API (or close) is due for the end of January 1998. Work for this in proceeding smoothly.

We are collecting some initial thoughts on security at this level, but integration of security into the API is not due for the January release.

The Mobile Object Workbench (MOW) will be built on top of the ANSA Flexinet results.

In addition to the API for the workbench, it has been decided to provide a simple events service for use by the project. Although this is not central to the MOW, and will sit outside the API, it was felt to be important to other partners and the work in their strata. We believe that it sits well within this work package, and will deliver it at some time after the January implementation.

Work so far - WP C

Work package C - (Personal) Information Space

- Early work (only officially started December 1997)
- Space to maintain, access, collate information
- Single and consistent (i.e. logical) view of an information space irrespective of where users are located
- For use by agents and users
- Mobility important
- JavaBeans a possible technology

Work package C - (Personal) Information Space.

Work has only just started (in December) on this work package, although some preliminary work was undertaken in order to submit input to the architecture.

The Information Space is a space in which entities can maintain, access and collate information. One of the decisions already taken has been to remove the ‘ Personal’ , as it may be that entities other than people - e.g. companies and services - might want to use it.

It is intended for use not just by humans, but also be their agents, so its structure and API must reflect this.

It should provide a single and consistent view of an information space, and support use by users who may well be mobile. In particular, the view that users have should be the same, irrespective of their location.

Initial work on this work package suggests that JavaBeans and JavaSpaces may well be an appropriate technology to support some of the functionality of this work package.

Mobile Object Workbench - some detail

- The basis for FollowMe
  - sits below the Agent and application levels
- Different to many other 'Agent' systems
  - extends distributed objects with mobility
  - deals with the Object level
  - provides basic functionality
  - easily extensible for specific requirements
    - secure places, robust places, etc.
- 100% Java
  - but CORBA - or any other system - can be accessed

These last few slides look in some more detail at the Mobile Object Workbench, the basis on which the rest of FollowMe rests. In particular, it sits below the Agent and application levels, and is used by them as the basic mechanism for mobility.

It should be stressed that the Mobile Object Workbench is very different to many other 'Agent' systems such as Voyager or Aglets. Rather than trying to design a mobile agent system in one go, we have been careful to look rather at extending distributed objects by adding mobility. This allows us to build on ANSA experience and expertise and we believe will produce a better designed system.

Another difference is that the Mobile Object Workbench does not deal with Agents, but with Objects. Agents can be built on top of mobile objects, as they will be in the work package 'Autonomous Agents', but the paradigm exists at a lower level. We are a providing a basic functionality, rather than trying to create a complete agent framework in one go. Most importantly, it provide basic functionality which is easily extensible to provide for specific requirements, such as security or robustness.

The Mobile Object Workbench will be 100% Java, but it is worth pointing out that this does not stop other systems, such as CORBA systems, from being accessed.

MOW - Basic Concepts

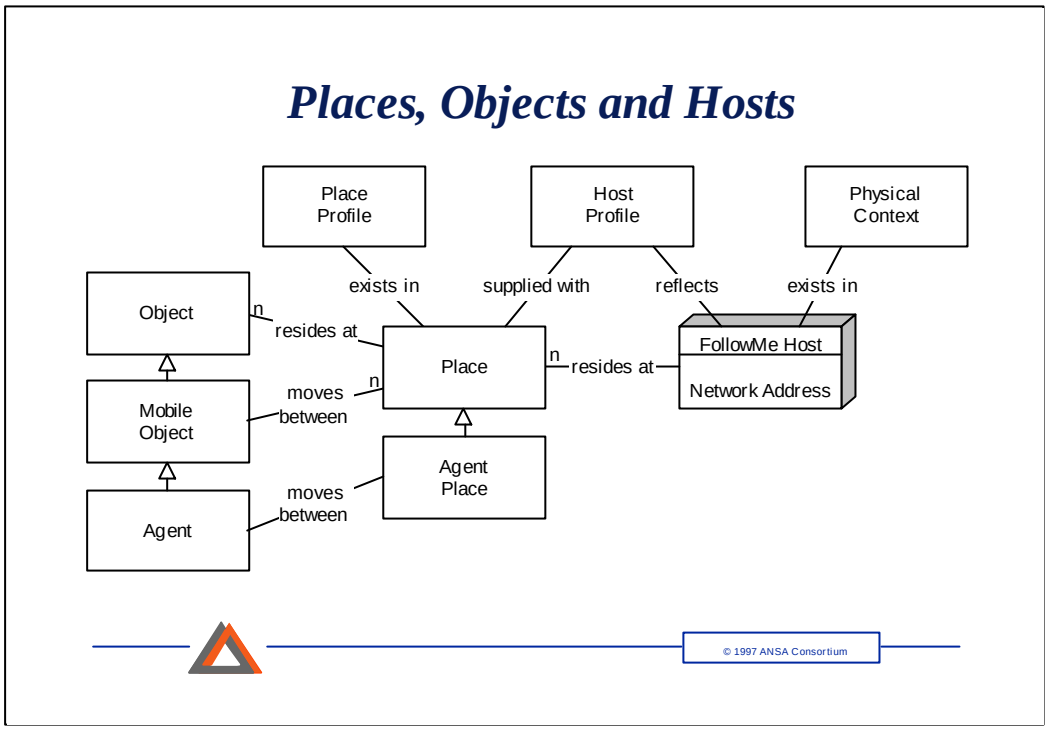
- There are two types of entity, objects and places
  - Objects exists within places
  - Objects are mobile and may move between places
- Objects are autonomous, they cannot be forced to move, but can be destroyed by their current place
  - A particular move may be vetoed by either the source or destination place
- When an object moves it takes with it its current state

We now continue by describing some of the basic concepts of the Mobile Object Workbench.

There exist two types of entity within the MOW - Objects, Places. Places are environments in which objects can exist, and Objects are mobile and can move between places.

An important point is that Objects are autonomous in the sense that they cannot be forced to move by another Object or Place, even the Place in which they currently reside. The only thing a Place can do is destroy an Object if it refuses to move. When an Object tries to move either the source or destination Place may veto and block that movement.

An Object may have state, and takes it with it when it moves.



This diagram describes the different entities within the FollowMe system (and not just the Mobile Object Workbench). It includes a Host, which is a physical piece of hardware, with a Physical Context, and which has a Network Address.

Each host may have one or more Places residing on it, and a Host Profile, which is supplied to these Places, reflects information about the Host, allowing information about robustness, CPU availability, etc. to be made available. The Place also has a Place Profile, to give more information about it, and its capabilities.

Places may contain Objects, and a Mobile Object is a specialisation of Object, in that it may move between hosts. An Agent is a specialisation of Mobile Agent, and resides in and moves between Agent Places. Agent Places are specialisations of Place.

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Object Facilities

- Each place has an interface to allow creation of object subject to the place's security policy
  - Objects may be destroyed by their current place
- An object may contain its own thread(s)
  - In order to move, an object must suspend all of these threads. An object may create new threads when re-initialized at the destination place.
- An object may suspend, copy or move itself subject to the availability of these services in the current place, and the veto of the place(s) involved.

More information on the MOW

Objects can be created and destroyed on a Place - in particular, each Place has an interface to allow creation on an Object, but subject to the Place's security policy.

Object may contain their own threads, but in order to move, all of these must be suspended. The MOW does not include support for thread serialisation, but does provide a mechanism for safe movement of Objects, including a locking mechanism. An Object may of course create new threads on arrive at the destination Place.

Copying, suspension and movement are all possible for Objects, given availability of such services and subject to the veto of the Place(s) involved.

Communication

- Objects have typed interfaces
  - All interaction with the object takes place via synchronous method invocation on one of these interfaces
  - Subject to availability and security constraints, and interface may be accessed by any thread, regardless of location.
- When calling an interface, a thread may require it to fail if the implementing object is not local.
- During an invocation, neither the invoker not the object implementing the interface may move. However either party may terminate the interaction prematurely.

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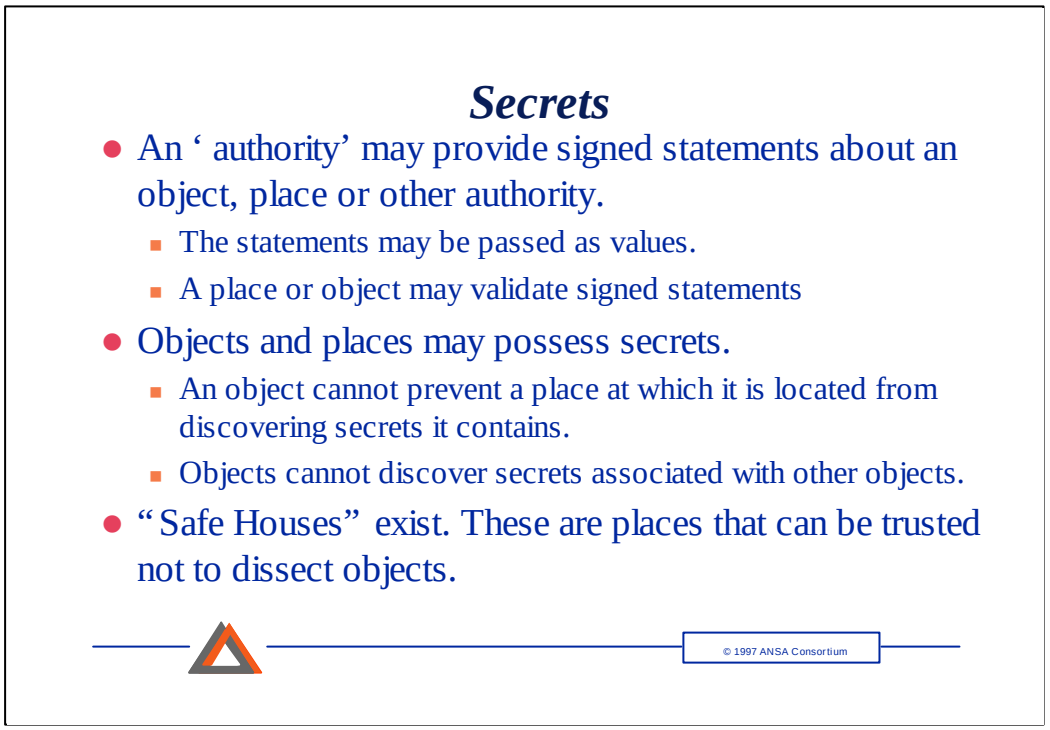
Places

- An object may access contextual information related to its current location
  - This may contain the interfaces to local or remote services
  - The contextual information may be federated between places
- Places control access to system resources
  - CPU, Memory etc.
  - Particular places may provide ‘specialist’ services
- Place names may be passed as values between objects.

Contextual information about an Object’s location may be made available to it, including interfaces to services which may be local or remote. This contextual information may be federated between Places.

Places control access to system resources such as CPU and memory. Some Places may have ‘specialist’ services, so all Places will not provide the same services beyond a basic set of functions common to all.

Objects may pass the names of Places between them as values, allowing identification of Places so that Objects can move to them, avoid them, etc..



This slide examines some of our initial thoughts on security and the issue of secrets. As already mentioned, detailed work in this area is not scheduled in this area until later in the project, but it is such an important area that some initial ideas are very important.

Trust relationships in any security scenario require ‘ authorities’. Such authorities may provide signed statements about Objects, Places, or other authorities. These may be passed as values, and validated by Places or Objects.

In addition, Objects and Places may possess secrets which should not be passed to other Objects, so Objects cannot discover secrets associated with other Objects. However, it is clear that as an Object exist within a Place, it cannot prevent that Place from discovering its secrets. In order to prevent this being too much of a problem, ‘ Safe Houses’ exists, which can be trusted (within the limits of a trust relationship, of course) not to dissect Objects. These are Places, therefore, where Objects can go and be certain that their information is safe from being disseminated without their permission.

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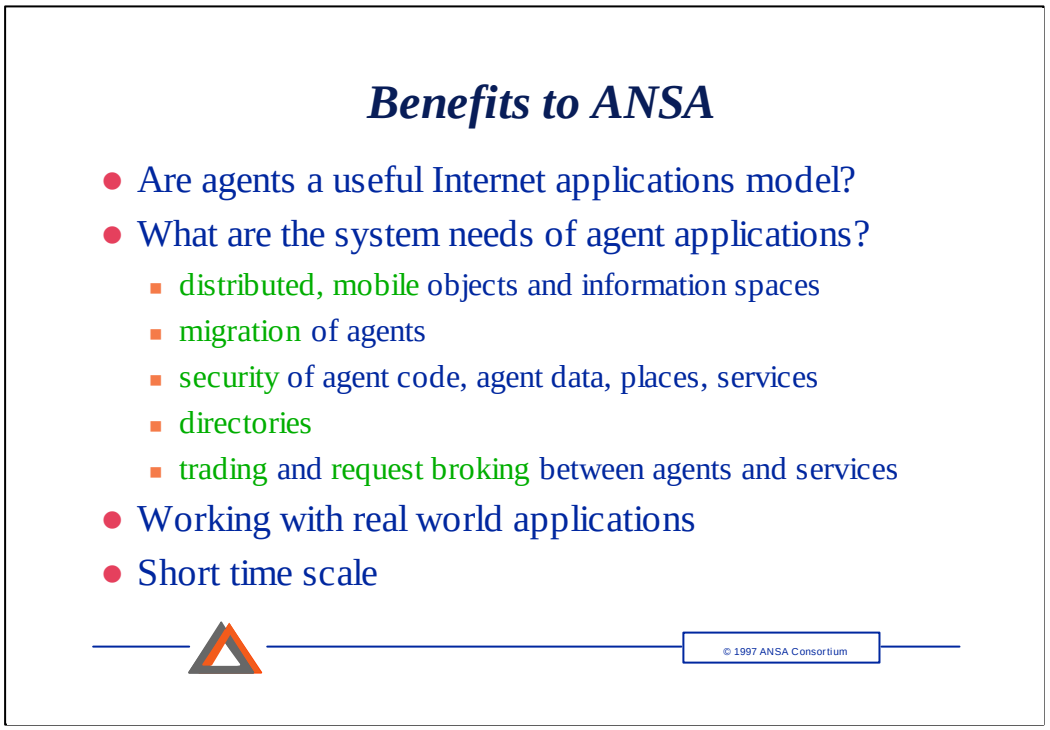

That concludes this presentation, and it ends with a brief restating of benefits to ANSA of the FollowMe project.

We believe that the approach already taken will lead to a better understanding of the issues mentioned above, and provide a useful base for further research into distributed mobile systems.

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