Author(s): Mouratidis, Haralambos., Philip, Ian., Manson, Gordon.
Article Title: A Novel Agent-Based System to Support the Single Assessment Process of Older People
Year of publication: 2003
Citation: Mouratidis, H., Philp, I., Manson, G. (2003) 'A Novel Agent-Based System to Support the Single Assessment Process of Older People' Health Informatics Journal 9 (3) 149-162
Link to published version: http://dx.doi.org/10.1177/14604582030093003
DOI: 10.1177/14604582030093003

A NOVEL AGENT-BASED SYSTEM TO SUPPORT THE SINGLE ASSESSMENT PROCESS OF OLDER PEOPLE

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ABSTRACT

Older people often have a complex mixture of health and social care needs and several different health and social care professionals are involved in their care. National Policy in England is to promote the Single Assessment Process (SAP), an integrated assessment of health and social care needs of older people. However, most of the current information systems do not adequately provide the functionality that is required by health and social care professionals. In this paper we discuss the suitability of agent technology explaining why we selected it as offering the greatest potential for efficient and flexible information collection and sharing, and for supporting effective care planning. Also we point out benefits derived from the use of agent technology in the development of health and social care systems, such as the minimization of health and social care professionals' workload. In addition, we describe how we have developed a model for an integrated information system, based on agent technology, for health and social care needs assessment of older people. Finally, we discuss issues, such as security and mobility, involved in the development of such a system, which will need to be designed and tested prior to its implementation in health and social care practice.

Keywords: Integrated Health and Social Care Information Systems, Agent Based Systems, Security, Mobile Agents, Single Assessment Process, Older People.

INTRODUCTION

The assessment of health and social care needs is at the heart of good practice in the care of older people. Older people often have multiple impairments and health problems, and complex support systems involving several health and social care practitioners and family carers. Sharing of assessment information is important to avoid unnecessary repetition and to ensure that all relevant information is available to support effective care planning. Recognition of the need to share assessment information has stimulated standardisation of assessment methods. These in turn have been used to help standardise care planning and referrals following assessment. Information technology has the potential to improve efficiency and effectiveness in the collection and sharing of assessment information.

In England, the Department of Health has issued guidance to develop a single assessment process for the health and social care of older people [1]. A fully developed and integrated national electronic records system is to be in place by April 2004, with the introduction of integrated manual or electronic local system from July 2002.

Many different issues are involved in the development of a national electronic system, both for the computer scientists and developers of services. These include the complexity of the system and concerns about integration, mobility and security. In a distributed health care setting different health and social care professionals, such as general practitioners, nurses and social workers must cooperate together to provide the patient with appropriate care.

An agent is a software[1] program that can possess some of the human capabilities such as intelligence, autonomy and mobility. Because of those properties, agents are well suited for the development of health and social care information systems.

Although the number of agent-based systems has increased in the last few years, this is not the case in the development of health and social care information systems. More traditional technologies, such as web and databases, are still mainly used in the development of such systems. However, web and databases technologies fail to adequate address the main reason of using computer systems in the health and social care information systems, which is to reduce the workload and make procedures easier and quicker for health and social care professionals and to improve quality of care for the older people.

We believe that agent technology provides an effective solution in the development of those systems. The management of an older person involves many professionals. Each professional has their own data and expertise and they need to cooperate to provide the best care for the older people. An agent could be allocated to each professional, and it would be given enough intelligence so that it can negotiate with agents of other professionals to minimise the workload of the professionals and maximise the cooperation required for efficient care of the older people.

However, there are still open issues that need further investigation so that agent technology is widely used in the development of health and social care information systems. Such issues include the lack of a complete and mature software engineering methodology [3] that will help in the analysis and design of such systems. Security and mobility are also important concerns.

[1] In this paper when we refer to an agent we always refer to a software agent.

In this paper we provide an introduction to the Single Assessment Process (SAP), an integrated health and social care needs assessment of older people and describe the functional linkage of our model. Then, we give a short overview of agent technology, and we analyse the suitability of agent technology in the development of health and social care information systems. Furthermore, we provide an overview of the system, and we discuss issues involved in the development of it. Based on personal experience from the development of the system, we provide a brief discussion on the necessity to analyse and design such a system before implementing it, and we discuss the issue of integrating security and mobile agent support during the development stages. Finally we draw some conclusions and outline some future work.

A SINGLE ASSESSMENT PROCESS FOR HEALTH AND SOCIAL CARE OF OLDER PEOPLE

In March 2001, the Department of Health published its National Service Framework (NSF) for Older People's Services [1]. The NSF sets national standards for the health and social care of older people, with an implementation plan, to be completed by 2005. Standard 2 (Person-centred Care) includes requirements to establish a single assessment process for integrating the assessment of health and social care needs of older people. Local health and social care communities have to introduce standardised shared systems for assessing needs, with convergence towards a fully integrated and electronically based national system by April 2004. The Department issued further guidance in February 2002, listing requirements for contact, overview, specialist and comprehensive assessment, and a range of assessment instruments, which could be used for these types of assessment.

Contact and overview assessments would typically be undertaken by front-line primary health and social care practitioners, with specialist and comprehensive assessments undertaken by secondary care specialists or multi-disciplinary teams. Contact and overview assessments would provide the basis for specialist and comprehensive assessment, with the breadth and depth of all assessments undertaken according to the perceived needs of the older person. Domains and items to be covered in an overview assessment are shown in Table 1. As these are fairly extensive, it is likely that only some would be covered fully at any one assessment, with a complete picture built up over time. We have categorised the domains and items according to their incorporation into EASY-Care [4], an assessment instrument which is now widely used for overview assessment. It should be noted that elements of self-assessment are to be encouraged, and there is a strong emphasis on including the older person's views in establishing the focus of attention in assessing need and planning care. An information system to support integrated assessment of the health and social care needs of the older person, should therefore build on contact and overview assessment in primary care, with maximum involvement of the older person in prioritising the assessment domains and in care planning.

FUNCTIONAL LINKAGES

An information system to support the above should build from contact and overview assessments in primary health and social care, where the key practitioners in contact with older people are community nurses, social care workers, general medical, dental and ophthalmic practitioners and pharmacists. As community nurses, social care workers and general medical practitioners have a broader range of interests in relation to the domains of the single assessment process, our system focuses first on integrating

their assessment processes, with the potential to link to specialist assessments by other primary care groups, to secondary care health professionals, other local government officers (eg housing), and voluntary and private sector providers. The system should also generate aggregated data to measure and compare local population needs (Figure 2).

A number of software companies [www.liquidlogic.co.uk] are developing electronic systems to deliver the Single Assessment Process, using traditional methods such as web technology and databases. However, we feel that agent based systems would provide benefits that are not possible using these technologies. We believe that an agent-based system would minimise the work required by the professionals and improve the care of older people. Before we can demonstrate this, we need to provide an overview of Agent Technology and this is given in the next section.

AGENT TECHNOLOGY

Agent technology is emerging in different areas of Computer Science research and development. This technology is based around the concept of an agent. The term agent derives from the present particle of the Latin verb *agere*, which means to drive, act, lead or do [5]. According to Wooldridge & Jennings [6] an agent is "…. A hardware or (more usually) software based computer system that enjoys the following properties:

Autonomy: agents operate without the direct intervention of humans or others, and have some kind of control over their actions and internal state.

Social ability: agents interact with other agents (and possibly humans) via some kind of agent-communication language.

Reactivity: agents perceive their environment, (which may be physical world, a user via a graphical user interface, a collection of other agents, the Internet, or perhaps all of these combined), and respond in a timely fashion to changes that occur in it.

Pro-activeness: agents do not simply act in response to their environment; they are able to exhibit goal-directed behaviour by taking the initiative.

Software agents can be classified according to some special characteristics that they might have. Thus agents can be classified according to characteristics such as mobility, intelligence, learning, and their ability to communicate [7]. A mobile agent for example, is able to transport itself from one machine to another on the network. Thus, a mobile agent can move to a system in which there is the information that it wants to obtain. A mobile agent when it transports itself it transports its state and code [8]. The code of a mobile agent is the class code that the agent needs in order to execute, while the state of a mobile agent is the values that determine what the agent will do after it transport itself.

In a Multi-Agent System a software agent is considered as a problem-solving entity. In this type of system a complex task is accomplished by combining different software agents that posses different skills (expertise). All the different software agents that co-exist in the system possess their own expertise, which can be related to the other agents of the system but it is distinct, and they use this expertise at different stages of the solving process in order to accomplish their aims.

Multi-Agent Systems are very attractive to researchers because they can be viewed as human societies (a health and social care society in our case) in which the software agents play the roles of human beings, or there is a mix between human beings and software agents that cooperate and communicate in order to solve a complex problem. Thus, a software agent in a multi-agent system can be viewed either as an entity that

acts on behalf of a human, or as an autonomous entity that possesses some expertise and is able to cooperate and communicate. In addition multi-agent systems help to develop a behavioural model for the animation of believable virtual humans in a virtual environment [9]. That means, that multi-agent systems help designers to realise some of the potentials and the limitations of human-based systems before the actual implementation.

SUITABILITY OF AGENT TECHNOLOGY

The use of agent technology during the last few years has increased. However, this is not the case in the development of health and social care information systems. This type of systems is mainly developing using other technologies such as databases or web technologies.

We believe that agent technology provides a novel and well-suited approach in the development of integrated health and social care information systems, mainly because its characteristics are well suited in the development of health and social care information systems.

Agent technology can provide an effective solution in the development of an integrated health and social care information system for many different reasons. In Huang et al they note [10] that the medical environment is dynamic and unpredictable. Problem solvers (like software agents) are required, as they are able to exhibit intelligent goal-oriented behaviour and they are able to response to changes in the environment. In addition, maintenance and expandability of an agent-based system is relatively easy. More agents can be added to the system (and others removed) without modifying the existing ones (or with minimum modifications to some of them) or any other

components of the system. This is very important in our case, since agents corresponding to professionals will be added and removed from the system quite often. Furthermore, using agents helps the robustness of the system, since if one part of the system fails (if the computer of a professional goes down for example), the other agents of the system will notice that, and try to solve the problem without involving the broken part.

Mobility can also be an important factor in the development of an integrated health and social care information system. As it was mentioned, the concept of a mobile agent could play an important role in such a system. To make the role of mobile agents more clear we consider two different versions of a scenario. The story of the scenario (created having in mind the Single Assessment Process) is as follows:

A health professional is performing an assessment and identifies that the patient needs a specialist assessment (such as housing assessment for example). The professional must identify the most suitable care specialist to perform the specialist assessment.

In the first version of the scenario the professional will try to identify the most suitable specialist from a database of professionals. Then they should try to contact them to pass the information of the initial assessment and set up an appointment. Difficulties arise in this version of the scenario. First of all, it is likely that the professional will be in the house of the older person where connection to the database of the professionals might not be possible, so they must try to repeat the procedure when they return to their office where access to the database will be available. In addition, it might prove quite difficult to contact the specialist (They could be out of their office performing assessments). When the specialist receives the notification for the assessment and the details, they must provide some information back to the health professional such as acceptance of the

date of the assessment. It is more likely that the specialist will have difficulty finding the health professional as well. All these problems mean the health professional has to spend more time, after the initial assessment, of the patient, and since health professional usually have to perform many assessments per day, this can influence the effectiveness of the assessments they perform. The same concerns occur with the specialist.

In a mobile agent version of the same scenario, an agent knows the capabilities and the commitments of the associated professional. The professional provides a mobile agent with all the important information, such as what kind of specialist is required (in fact that can be done automatically by the *professional agent*) while in the older person's house. Then the mobile agent will "travel" through the network and it will try to identify the specialist for the more specialised assessment. Instead of trying to contact a database, the agent can determine which professional is able to carry out the required task by communicating directly with the other agents on the system. In case that connection is not possible, the mobile agent will keep trying until it gets the access. Then it will identify the specialist, it will contact their agent to set up a date for the assessment, and pass the information of the assessment. When the professional returns to their office (or any place where connection is available) the mobile agent will inform them about the progress, indicating the name of the specialist that was appointed and the assessment date.

As it can been seen from the two different versions of our example scenario, the main difference is that a mobile agent will perform the tasks without the intervention of the human professional, while traditional techniques require some kind of intervention from the professional. Thus, the use of mobile agents can reduce (in some cases) the time and

the administration tasks that health and social care professionals have to perform, and thus allow more time for the actual care.

Furthermore, the agent paradigm displays some mutual characteristics with the Single Assessment process as shown in Table 2. An agent-based system can consist of many different software agents, which can cooperate with each other, share information (distribute information) and each of them possesses some expertise.

In addition, the agent-oriented paradigm brings a different level of abstraction in developing complex computerised systems [2]. A complex computerised system (multi-agent system) is decomposed into smaller, simpler systems (individual agents) that communicate and cooperate to achieve the goals of the complex system. From personal experience, by dealing with developers of services and Computer Scientists, we have concluded that this level of abstraction helps in better mutual understanding. The Computer Scientists can better explain the functionalities of the system, by decomposing it to smaller autonomous entities (agents) that possess characteristics similar to humans and the service providers can use the concept of an agent to describe more precisely the needs of the system.

THE SYSTEM

In our system, the software agents will act on behalf of professionals. Each professional will have their “own” software agent, which they will customise according to their needs. The agent will have enough information about the professional, such as personal information and professional commitments, and it will be intelligent enough (capable of analysing the information and take decisions) to enable it to act on their behalf, and also

negotiate for the interest of the professional. The system will have the following characteristics:

- The system will consists of software agents as well as human professionals.

- Professionals will have their own software agent.

- The professionals must be able to customize their software agents through an easy-to-use interface.

- The software agents must have enough information about the professional (personal and professional) to act on their behalf.

- The system must be developed with network mobility in mind since many of the professionals will use it whilst in the older person's house.

- The system must be secure.

- The software agents must be capable of analysing information and taking decisions.

- The software agents in the system must be able to communicate with and cooperate with each other as well as with the human professionals.

In addition, since the system must support person-centre care, a copy of the care plan or the assessments will be given to the older person. Initially it is more likely that this will be a paper copy since the current infrastructure in the older persons' houses usually does not provide support for advanced technologies, or internet connection and also more likely the older person will not have the necessary knowledge to deal with computer systems. In the cases where the infrastructure is available and the older person feels comfortable with computer systems, our system will support agents capable of acting on behalf of the older person. In this case the care plan or assessment results will be transferred to the older person's personal agent automatically from the system and the older person will be able to influence the form of their care plan.

We believe that the number of older people that use agents to act on their behalf will increase in the next few years, due to the advance in technologies (such as GPRS [11]) that will make connection almost possible from everywhere. In addition, the older population in few years will be much more comfortable with computer systems.

ISSUES INVOLVED

There are many different issues involved in the development of our system. The most important of them are related to the design of the system prior to its implementation. These include security concerns, and mobility issues.

In developing such a system the first step is to analyse and design the system. Designing and analysing a system before it is actually implemented helps in the understanding of the system requirements, the user needs and thus the whole system. Starting to implement a system without designing it might work for small systems that only require a few lines of code and one developer. However, trying to implement

complex distributed systems (as in our case), that require hundreds or thousands of lines of code, and large teams of developers, without a design proves to be a very difficult, and time consuming task.

It is recognised in the agent research community [3,12,13,14] that there is a need for a complete analysis and design methodology for multi-agent systems. The main role of such a methodology will be to help in all of the phases of the development of an agent-oriented system, and more importantly to help capture and model the unique characteristics that agent-oriented systems introduce such as flexibility, autonomous problem-solving, and the rich interactions between the individual agents. An adequate analysis and design methodology also needs to capture and model the interactions between agents and non-agent elements (e.g humans), the states (internal and external) of the agents that constitute the multi-agent system, as well as the goal-directed behaviour and the actions of the agents. Furthermore, trying to model integrated health and social care systems introduces some extra requirements [15]. The need to capture the environment of the system is essential, especially when there is no existing system (like in our case), either "manual" or electronic.

Security is another major issue in the development of our system. The system will contain personal and medical information and thus must be as secure as possible. Security of personal health information is one of the priorities of many health care systems in different countries of the world including England. In addition, the English government has agreed that the electronic health care records should be at least as well protected as the paper ones. Nevertheless, the advances of information technology and the introduction of nationwide networks have made health and social care professionals as well as the patients worry about security. If patients (in our case older people) do not

trust the security of the system, they will refuse to provide complete information about their health and social care needs, leading to many problems such as wrong assessment of needs, which could lead to wrong care plans.

The system under development lies in this category, as it is intended to be used nationwide in England. Health and Social care professionals are worried that using such a system introduces risks for the privacy *("it is privacy that empowers the patient, rather than confidentiality that empowers the organisation. This distinction although it is familiar to medical ethicists, it is less familiar to computer security world" [16])* of personal health and social care information. Thus privacy of health and social care information is a major concern in such a system. According to the Good Medical Practice [http://www.gmc-uk.org/standards/good.htm], "*Patients have a right to expect that you will not pass on any personal information, which you learn in the course of your professional duties unless they agree".*

Other important security concerns are integrity and availability. Integrity assures that information is not corrupted and availability ensures the information is always available to authorised health and social care professionals. If assessment information is corrupted or not available the care provided to the older people by the health and social care professionals will not be efficient or accurate.

Mobility is another important issue in the development of our system. In an integrated health and social care system, mobile agents[2] can be proved an effective solution because of the advantages they offer [8]. So far, mobility is currently considered mainly during the implementation stage. Very little thought is given to it during the analysis or the design of the system. This sometimes leads to incorrect usage of mobile agents or

[2] Mobile Agents have the ability to move around the network in order to achieve their goals. For example they can migrate to a different computer to obtain some information that the use requires.

use of static agents in cases where a mobile agent would be a more effective solution. Many times developers face the question “shall I use mobile or static agents?”. Many of them give an answer by taking into consideration the advantages of mobile agents, while others take into account the disadvantages.

Security and mobility support

Trying to give answers to the above issues is the main aim of an ongoing project [17]. The project aims to expand Tropos [18] agent-oriented software engineering methodology to deal with the above issues, i.e. security and mobility. Tropos was chosen because of two important advantages that Tropos offers in comparison with other existing methodologies (see for instance [3] for an overview on the state of the art). First, Tropos covers the early stages of requirements analysis [18], and thus allows for a deep understanding of not only the system itself, but also of the environment where the system will operate and also helps to better understand the interactions that will occur in the system between the software agents and the humans, something which is very important in the eSAP development. Second, Tropos covers the full range of the software development phases from the early analysis to the actual implementation and testing [18].

We are specifically interested in security and mobility issues that are very important in the development of our system. During our analysis of the system we concluded [19] that we should take into consideration security and mobility issues throughout the whole development stages. Similar conclusions have reached by other researchers both for security [20] and mobility [21].

Currently the definition of security requirements is considered after the implementation of the system. This typically means that security enforcement mechanisms have to be fitted into a pre-existing design therefore leading to serious design challenges, which usually translate into software vulnerabilities. Modern computer systems (including medical systems), applications and operating systems are full of security vulnerabilities in many levels. Adopting a security focus through the overall system development process represents a solution to mitigate such problems.

The agent-oriented paradigm represents a feasible approach for the integration of security to software engineering. As mentioned by Jennings and Wooldridge [22], agents act on behalf of individuals or companies interacting according to an underlying organisational context. The integration of security within the context will require for the rest of the subsystems to consider the security requirements, specified in the security policy, when defining their objectives and interactions therefore causing the propagation of security requirements to the rest of the subsystems.

In our work, to ensure the development of a secure system[3] we consider security aspects in the whole development stages. Thus, the security requirements are captured and analysed, then the development of the system takes place having in mind these requirements, and making sure they do not conflict the functional requirements of the system.

Finally to test the security of the developed system we employ security scenarios, in which possible attackers try to attack different parts of the system. During this stage we are able to identify not only possible attacks to the system, but also analyse the

[3] We have to note there is no such a system (neither electronic not manual) as a "totally secure system", so when we say development of a secure system we mean a system that will be harder to break.

intentions of the attackers. The output of this stage helps us to identify possible security vulnerabilities and propose solutions.

The usage of mobile agents is mainly decided during the implementation stage and according to general advantages or disadvantages that the mobile agent technology displays. However, the usage of mobile agents depends on each particular system, and taking into consideration only the advantages or the disadvantages of the technology sometimes is not the most effective solution. Also, the choice of mobile or static agents could conflict with other functional or non-functional requirements of the system under development. Taking into consideration mobility during the design helps to identify the conflicts early in the development cycle and also to find the most suitable solution.

In addition, even if the designer has identified the need to use mobile agents, current methodologies do not provide concepts or notation to capture them. Thus, one important part of our work is to provide notations and concepts to give answers to questions regarding mobile agents such as *why* an agent moves from one platform to another, *where* the agent moves to, *when* the agent moves, and *how* it reaches the targeted platform.

CONCLUSIONS AND FUTURE WORK

The development of information technology, and the need to standardise and integrate the assessment of health and social care needs of older people creates a challenge for both computer scientists and developers of services. Agent technology offers a promising basis for supporting real-time information exchange in needs assessment and improved care planning amongst key practitioner groups. It can support a person-

centred approach to care-planning by maximising the involvement of the older person in establishing priorities for assessment and in decision-making about care, with the generation of a common care plan for the older person, family carers and the key primary health and social care practitioners.

In this paper we argued that agent technology is suitable for the development of complete health and social care information systems and also we outlined the benefits of employing agent technology in the development of such systems. On the other hand, we presented some important issues that are involved in the development of a novel agent based information system for the health and social care needs assessment of older people.

As many practitioners may be involved in the older persons care, the security of the system is a key consideration to ensure that individual and anonymised information is only shared with the consent of the older person. In addition, mobile agents can be (in some cases) an effective solution in the development of advanced health and social care information systems.

The identification of these issues is one of the initial steps in our work. Future work is directed towards extensions to support the integration of security and the modelling of mobile agents during the development of our system. Thus, we are extending the Tropos [18] agent-oriented methodology to support integration of security aspects during the analysis and design stages. In doing so we aim to provide a set of concepts and notations customised to security modelling, and a clear process that will guide the developer during the development stages. Future work on mobile agents modelling involves the identification of a process that will help developers to correctly identify the

kind of agents that are suitable for their system, and then provide concepts and notations to capture them.

By doing that, we hope that the "next generation" of health and social care information systems will reduce the workload and make procedures easier and quicker for health and social care professionals.

ACKNOWLEDGEMENTS

The first Author would like to thank the RANK Foundation for the funding of his research project, during which this work was carried out.

REFERENCES

1. English Department of Health. Single Assessment Process (SAP). http://www.doh.gov.uk/scg/sap/; 31st of July 2002.

2. N. R. Jennings. An agent-based approach for building complex software systems. *Communications of the ACM* 2001; 44: 4.

3. C. Iglesias, M. Garijo, J. Gonzales. A survey of agent-oriented methodologies. Intelligent Agents IV, *Lecture Notes in Computer Science*, Springer-Verlag, 1999;1555.

4. I. Philp. Can a medical and social assessment be combined?. *Journal of the Royal Society of Medicine*, 90(32), pp 11-13,1997.

5. M. Bradshaw. *Software Agents*. American Association Artificial Intelligence Publication, 1997

6. M. Wooldridge, N. R. Jennings. Agent Theories, Architectures, and Languages: A Survey. *Intelligent Agents*, Springer-Verlag 1995; 890:1-22.

7. S. Franklin, A. Graesser. Is it an Agent, or juts a Program? A Taxonomy for Autonomous Agents. Proceedings of the Third International Workshop on Agent Theories, Architectures, and Languages, Springer-Verlag 1996.

8. D. Chess, C. Harrison, A. Kershenbaum. Mobile Agents: Are They a Good Idea?. IBM Research Report (RC 19887), 1995.

9. Angélica de Antonio, Ruth Aylett, Daniel Ballin. Intelligent Virtual Agents. Proceedings of the Third International Workshop IVA 2001, Springer-Verlag 2001; 2190:243.

10. J. Huang, N.R. Jennings and J.Fox. An Agent-Based Approach to Health Care Management. *Applied Artificial Intelligence*: An International Journal, Taylor & Francis London 1995, 9: 401-420.

11. C. Andersson. *GPRS and 3G Wireless Applications*. Wiley, 2001.

12. M. Wooldridge, P.Ciancarini. Agent-Oriented Software Engineering: The State of the Art. Springer-Verlag Lecture Notes in AI 2001; 1957.

13. R. Evans (editor), P. Kearney, J. Stark, G. Caire, F. J. Carijo, J. J. Gomez Sanz, J. Pavon et al. MESSAGE: Methodology for Engineering Systems of Software Agents. AgentLink Publication, September 2001

14. M. Wooldridge, N. R. Jennings, "Software Engineering with Agents: Pitfalls and Pratfalls", *IEEE Internet Computing* 1999.

15. H.Mouratidis, G.Manson, I. Philp. Testing the suitability and the limitations of agent technology to support integrated assessment of health and social care needs of older people. To appear in *Informatica Medica Slovenica* 2002.

16. R. Anderson. *Security Engineering: A guide to building dependable distributed systems*. Wiley Computer Publishing, 2001.

17. H. Mouratidis, i. Philp, G. Manson. Analysis and Design of eSAP: An Integrated Health and Social Care Information System, in the Proceedings of the 7th International Symposium on Health Information Managements Research (ISHIMR2002), Sheffield, June 2002

18. J. Castro, M. Kolp, J. Mylopoulos. A requirements-Driven Development Methodology. In proceedings of the 13th International Conference on Advanced Information Systems Engineering CaiSE '01, Interlaken- Switzerland, June 2001.

19. H. Mouratidis, P. Giorgini, G. Manson, I. Philp. Using Tropos Methodology to Model an Integrated Health Assessment System, Proceedings of the 4th International Bi-Conference Workshop on Agent-Oriented Information Systems (AOIS-2002), Toronto-Ontario, May 2002

20. E. Yu, L. Cysneiros, "Designing for Privacy and Other Competing Requirements", (to appear) 2nd Symposium on Requirements Engineering for Information Security (SREIS' 02), Raleigh, North Carolina, 15-16 November, 2002

21. C. Klein, A. Rausch, M. Sihling, Z. Wen, "Extension of the Unified Modeling Language for Mobile Agents",*In Unified Modeling Language: Systems Analysis, Design and Development Issues*, edited by Keng Siau and Terry Halpin; Idea Group Publishing Book, 2001

22. N. R. Jennings, M. Wooldridge. Agent-Oriented Software Engineering. *In Handbook of Agent Technology* AAAI/MIT Press 2001.

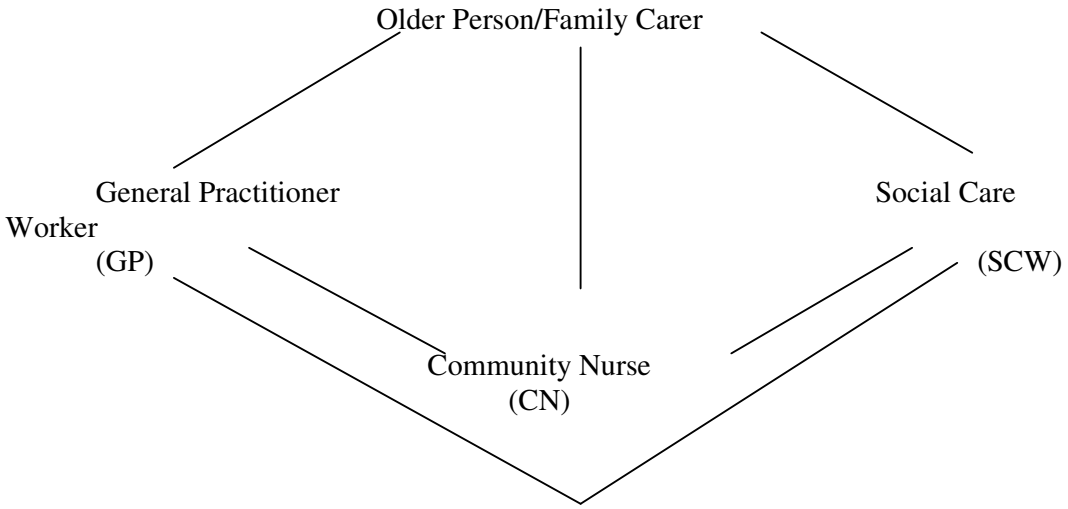
Table 1 – Single Assessment Process: Domains

Domain	Items
Contact Information	**Demographics**
Reasons for Assessment	Older Person's View Carer's View Practitioner's View
Progress since last assessment	Older Person's View Carer's View Practitioner's View
Consent	Sharing individual identifiable information. Sharing anonymised aggregated information.
How are you doing?	General health status Vision, Hearing, Communication Chewing Food, Weight Loss Foot Problems, Falls, Pain Life Satisfaction, Depression Medical Conditions, Hospital Admissions Medicines Use
Abilities	Housework, Meals, Shopping Telephone, Money, Medicines Walk Outside, Mobility Indoors Stairs, Transfers, Toileting Bathing, Grooming, Dressing, Feeding Continence Urine Continence Bowels
Memory	6-Item Cognitive Impairment Test
Housing	Accommodation Adequacy Keeping house warm Size and space of home Condition of home Location of home Cost of home
Safety	Safety indoors Safety outdoors Abuse
Finance	Allowance and benefits
Family and Friends	Help in a crisis Support received
Services	Access to services Support received
Health Promotion	Smoking Alcohol problems Exercise Blood pressure Vaccination Cancer screening Skin care
Other Information	Free text

Summary of Needs and Problems	Free text
Action Plan	Practitioner's Actions Older Person's Actions Carer's Actions Review Date

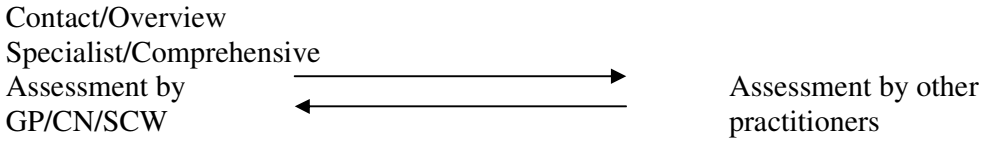
Figure 2 – Functional Linkages

1 Flow of assessment information amongst key primary care practitioners, the older person, and family carers.

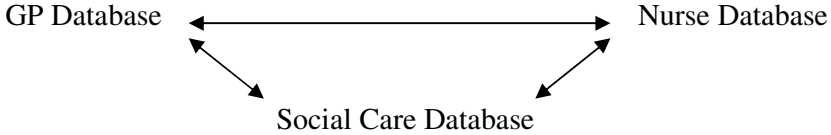


Information flows are real-time, with copies of care-plan generated for each participant.

2. Information flows with other practitioners



3. Local Aggregation of Information



Shared, aggregated information from contact/overview assessment, integrated with information unique to each database.

4. Further Aggregation of Information

Local databases of aggregated information → regional/national international databases for comparative analysis

Regional, national and international databases can be used for locally generated information about health status, well-being and social functioning of different populations to support research and service development.

Table 2- Mutual Characteristics of the Single Assessment Process and an Agent-Based System

Single Assessment Process	Agent-Based System
Professionals	Software Agents
Professionals Cooperate	Agents Cooperate
Professionals have Expertise	Agents display Expertise
Distribution of information	Sharing of information