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Conclusion & Future Scope
This chapter summarizes the contributions of this research to the agent migration and usage of this service to build a decentralized and fault-tolerant network for data propagation. It also describes a few technical directions for future work.

8.1 CONCLUSION

The DDS proposed has attempted to introduce dynamically distributed service as inherent to an inter-network. The rationale for, and the main features of the basic scheme have been described. Process intensive applications will be the main beneficiaries of the scheme.

In this dissertation, a proposal has been presented for the mobility of agents between various agencies, based on the agent communication language (ACL) proposed by FIPA. This has been the key to fulfilling the double objective of maintaining consistency with the generally accepted agency model and also permitting interoperability between platforms of a different type.

This work solves the problem of interoperability in mobile agent systems, probably, one of the main obstacles to the deployment of this technology. Despite that, considerable research work on interoperability exists, most of it is focused on specific levels and a few of them tackle the problem as a whole.

In the present study, it is shown that mobile agents’ mobility and static agents’ communication have analogous problems. For this reason, one of the most widely extended interoperability models (FIPA specifications) have been adopted for communicating static agents as foundations proposing a solution to mobile agents’ interoperability.

This solution sets a first layer of interoperability in communications level. Moreover, the expressivity of ACL Messages and protocols can be used, not only to build extensible, negotiable and highly configurable mobility protocols but also to set the basis to attain interoperability at other levels, at least to express the conditions to reach it, in a powerful way.

In this directions went a deprecated FIPA specification (due to a lack of implementation) that has been tried to extend and discuss, in this work. From the study of the drawbacks of this specification, and following the same philosophy, it is proposed to standardise framework protocol rather
than a specific protocol, which enables the possibility of handling several mobility protocols based on ACL and enhance interoperability capabilities of the platforms.

The implementation has been carried out as an extension of JADE, the most commonly used agent platform at present. After carrying out various experiments, it has been confirmed that the system's performance does not decline even when it has to administer hundreds of migrations while other agents are executed. This migration proposal is therefore feasible for both large and small systems.

The efficient utilization of network resources is an important issue. The problem is complicated due to the distributed nature of computer networks, high communication demands and the desire for limited communication overheads. One solution to such challenges is to design efficient, decentralized and fault-tolerant data propagation model which accomplishes tasks with no access to global network information. Mechanisms of agent propagation are useful and effective because agents can be organised into efficient configurations without imposing external centralised controls. Operation without a central coordinator eliminates possible bottlenecks in terms of scalability and reliability. The other most interesting properties of modern networks are mechanisms of biologically inspired self-organisation[18].

The contribution of this work lies in the fact that by data propagation in a network (provided by DDS), execution time is reduced(Objective 6). Agents, with their ability to react on changes in the environment, i.e. changes in the number of agents on a node, are able to adapt to current conditions using migration. Available resources can be adjusted to needs of computation by migrating agents using a load balancing algorithm [15].

8.2 LIMITATIONS

It is very important to stress that the security implications of using inter-platform mobility are very crucial, typically more so than those of intra-platform mobility. Activating the DDS naturally implies that the machine(s) hosting a JADE platform may execute code shipped from potentially any system reachable via a network connection. At the present time, the DDS has no access control mechanism to decide which incoming
agents will be executed and which will not. Currently, access control can only be performed by means of a secure MTP (for instance the HTTPS MTP provides some simple authentication features that can be used for this purpose), or by using network firewalls to prevent connections from specific platforms. Until a more complete access control system is implemented, it is recommended that platforms using DDS take some basic security precautions:

1. Do not use the DDS in an open environment or on machines containing sensitive information.
2. Try to restrict network access to platforms by using firewalls.
3. Try to use MTPs with some intrinsic form of authentication.

It is expected that forthcoming versions of the DDS will provide comprehensive and configurable security mechanisms.

8.3 FURTHER SCOPE

There are basically three areas in which this work may be continued. Firstly, the scheme could be expanded, by adding privacy and authenticity protection mechanisms, considering the security aspects that will arise in new ACL specifications. Secondly, to improve overall performance, the Java threads planner could be modified, to include a reactive architecture. This would make the system suitable for processing thousands and tens of thousands of agents. Finally, another of these lines could be the development of applications using this scheme.

The performance results show that a lot of work must be done in the transport area, defining fast MTPs, and using lightweight content languages in order to make ACL based migration more competitive in terms of performance.