REGIS-DARWIN Specified in the π-Calculus

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REGIS is a programming system for the development of distributed and parallel programs. REGIS programs consist of three parts. Firstly, there is a configuration part, written in the DARWIN language, which provides a hierarchical structure of components with dynamic binding. Secondly, there is the actual communication part which provides the interaction and synchronisation required by the system. Finally, there is the computation part providing the component programs written in C++. The subdivision of concurrent programs into the three separate parts of organisation, communication and computation leads to programs that are easy to specify, compile and execute.

The DARWIN configuration language is an interconnection language for the configuration of modules across processors. The REGIS communication system enables message transfer for receipt at ports. An important characteristic of the REGIS-Darwin system is that it enables systems to be configured dynamically by making the addresses of ports first class objects.

In order to specify precisely the behaviour of REGIS-DARWIN programs, we have translated the organisation and communication primitives into the π-calculus, a formalism for modelling concurrent processes. The π-calculus semantics enables us to deduce behavioural properties of REGIS-DARWIN programs. The motivation for this work is that it is notoriously difficult to say with certainty what can be expected when programs are executed on parallel or distributed systems. Giving a formal semantics to a programming language removes the uncertainty.

Milner's recent system the π-calculus was used because it is designed to model concurrent computation consisting of processes which interact and whose configuration is changing. It does this by viewing a system as a collection of independent processes which may share communication links or bindings with other processes. Links have names. These names (or addresses) are the fundamental building blocks of the π-calculus. REGIS's port addresses are like these names, helping to make the π-calculus a good system for describing the communication.

The core operation of the REGIS-DARWIN system is binding two components together to enable the transference of data. From the π-calculus semantics it can be shown that the order that binding takes place cannot effect the execution behaviour of programs.

There now is a translator for DARWIN programs that automatically generates their π-calculus equivalents. A variety of errors in DARWIN programs can be detected at the π-calculus level. These include detection of recursive structures, unbound ports and ports that are bound in the wrong direction. The translation has also enabled the investigation of various models for the communication system. It can also be used to confirm whether two REGIS-DARWIN programs are equivalent.

The decomposition hierarchy of an executing REGIS-DARWIN program is *flattened* at run-time. The process of *flattening* eliminates all composite components and their ports. Communication links then only exist between ports of primitive components. Fortunately from the π-calculus translation it can be seen that flattening is a meaning preserving transformation.

Another useful property of a program is whether it will terminate. Since there is nothing to prevent a REGIS-DARWIN programmer from explicitly writing a communication cycle, a program can be checked by translating it into the π-calculus and then reducing. Only terminating programs will reduce to processes with no communication between them.

Because the underling model of the π-calculus, where communication is primarily about exchanging names which then may be used for further communication, is very similar to the the configuration language notion of a service, it has led to a short, clear definition of REGIS-DARWIN. This definition in turn, has enabled the behaviourial properties of REGIS-DARWIN programs to be investigated.

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